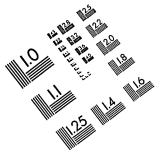

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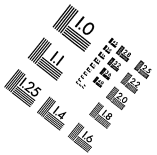

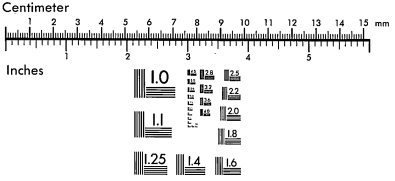

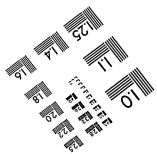

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Menlo Park Scrapbook, Cat. 1026

No. 17A. "Magneto Electric Generators"

This scrapbook covers the years 1880-1889 and contains clippings about generators. There are 139 numbered pages.

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The Maxim Electric Light for Marine and other Uses.

In commenting lately (see our issue for July) on the disastrous collisions of two Sound steamboats, and of two ocean steamers which occurred a few days later, we took occasion to remark that these accidents could in all probability have been avoided had the vessels in question been provided with electric signal lights in place of the utterly inadequate oil lanterns with which they were provided. And on the same point we added, that the futility of trusting to these and fog-bells and whistles to avoid collisions, has been demonstrated again and again; while the power of the electric light to penetrate a fog has been shown to be infinitely superior to any form of light yet devised, and its efficacy as a safeguard against this class of accidents is out of all comparison superior to anything else. The use of electric lights should, therefore, be made mandatory on all steam vessels.

We are gratified to have the opportunity at this time of presenting to our readers the illustrations and description of an electric light apparatus specially designed for marine use, and which appears to possess every necessary and desirable feature that an apparatus intended for this special service should have. The apparatus in question is the invention of Mr. Hiram S. Maxim, a well-known inventor of electrical machinery, and is manufactured by the United States Electric Lighting Company, 120 Broadway, New York.

Referring to the accompanying engravings, Fig. 1 represents the electrical generator, or dynamo-electric machine of the Maxim system, and Figs. 2 and 3 show the present form of the electric lamp used with it. The dynamo-electric machine (Fig. 1) is provided with an armature of soft iron rings, with the wire wound parallel to the axis, and so disposed as to permit of the free circulation of air through the armature. This arrangement is designed to prevent the dangerous heating of the generator, which is one of the most serious impediments to the economical use of most of the machines of this class, whether of foreign or domestic manufacture, and is affirmed to answer the purpose very satisfactorily, even with the severe test of running the machine on a short closed circuit.

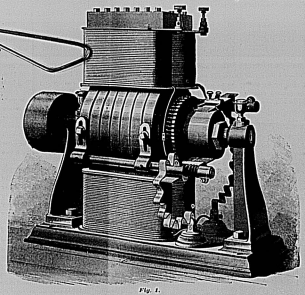


Fig. 1.

The large and heavy commutator has its sections curved in a right and left hand spiral, to avoid the occurrence of a break in the current. The machine is well built, compact and attractive in appearance, and on the score of performance and adaptability for its intended service, will compare favorably with the best machines of its class—a fact which has been amply demonstrated in competitive tests instituted for the purpose of comparing the merits of the several forms of dynamo-electric machines. The inventor has designed a small, high-speed engine for the special purpose of driving the generator directly, without the intervention of belts and pulleys; but the machine may, of course, be driven from any source of power that is available.

Referring now to the lamps, Fig. 2, represents the form of the device intended for use on land or for river steamboats. The details of its construction and operation, will be found below in connection with the description of the lamp shown in Fig. 3, which is more elaborate, and is designed for ocean steamships. In all essentials respecting its working parts, the lamp shown in Fig. 2 is substantially the same. The front, or cover-glass is in strips, to lessen the danger of cracking from the intense heat evolved from the light.

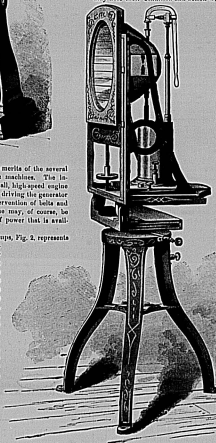


Fig. 2.

Fig. 3 shows the form of lamp designed for ocean steamships. The exterior of the lamp is formed of a strong brass case, cylindrical in shape, mounted on a substantial base piece, and supported on trunnions, so as to be capable of being moved in any direction. Within the case is a silvered reflector of parabolic form, at the focus of which the carbon poles of the electric arc are located. The mechanism of the lamp, by which the position of the carbons in the focus of the parabolic reflector is maintained as they are consumed, is substantially the same as that previously described and illustrated in our October number for 1878, and to which we, therefore, refer those of our readers who wish for details that are not shown in the accompanying engravings. It will suffice to state in this place that the regulating apparatus is perfectly automatic in action, consisting essentially of an electro-magnetic device and appropriate gearing, controlled by the current passing to the lamp. By the action of this regulator, both the carbons are kept continuously in the same place, being fed upward and downward respectively, according to the rapidity of their consumption. This regulator is likewise one of Mr. Maxim's patented inventions.

The lamp may be raised or lowered, or moved forward and backward at will, and the carbon poles may be accurately adjusted in focus by means of regulating screws provided for the purpose. A small lens placed in the side of the reflector throws an inverted image of the carbons on a ground glass screen, so that an observer may note their condition and action without exposing his eyes to their direct glare. The whole apparatus is handsomely finished, and presents a very ornamental appearance. It is enclosed in such a manner that a heavy sea will not interfere with its action. When it is desired to cut off all light in the foreground and to illuminate only distant objects, a funnel-shaped bonnet is attached in the front of the lamp, thus cutting off all light but that emanating from the center of the lamp. It is affirmed that either of these lamps will throw a beam of light strong enough to read by at a distance of five miles on a clear night, and many hundred feet in a dense fog.

The whole apparatus, generator and lamp, seems to possess every requisite and desirable quality for the purpose for which it has been devised, and we feel sufficient interest in the subject of the employment of electric lights on ships—board, to reiterate our previously expressed opinion that in one form or another its use should be insisted on for the prevention of collisions and other disasters that their employment would almost certainly prevent.

Further information respecting this apparatus may be had of the United States Electric Lighting Company, 120 Broadway, New York.

Improvement of the Gramme Magneto-Electric Machine.—Where a continuous current is required, the Gramme machine is in our view not only equal but even superior for purposes such as electric lighting to any other generator of electricity; and this development of the Paccinotti ring has appeared to be in principle and detail so perfect that no inherent defect has hitherto been pointed out. We think, however, that theory indicates a shortcoming which is stated to be of very considerable practical moment, and which will probably be remedied by an invention which will shortly be made public. The distribution of magnetism in the soft-iron ring is very far from being in the direction generally assumed, viz., in the annular direction of the ring itself, which is that in which the inductive effect would be a maximum. The ring being placed between the poles of a magnet, the normal magnetic effect tends to take place in a straight line uniting the poles; and although this direction is considerably modified by the peculiar form of the armature in this case, it is stated that experiment as well as theory indicates that the magnet produced by induction is by no means generated in a line at right angles to the general direction of the wire in the coils upon the ring. The loss of effect from this cause would appear to be considerable; and if this be the case the Gramme machine, as well as others in which a soft-iron ring is employed, may very probably be susceptible of considerable improvement.

AN IMPROVED ELECTRO-MOTOR.*

By THEODORE WIESENDANGER.

While recently many minds have been at work, with more or less of success, to produce improvements in dynamo-generators of electric energy, very few have given their special care and attention to the development of the electro-motor. Experience has taught us hitherto that the efficiencies of one and the same machine by action and reaction, or for use either as a generator, or on the inverted process as an electro-motor, stand in a certain and direct proportion to each other, or that our most efficient generators, such as the Siemens, Brush and Gramme machines prove also the most effective motors, and on the other hand that inferior dynamo-machines invariably are inferior motors. It would, however, be hazardous to conclude from these results that this rule should hold good for all future machines, and from the results of researches I have recently made, I come to the conclusion that the motors which are to supersede those now in use could not be employed as generators. Dynamo-machines, such as now constructed, only prove efficient when their field-magnets are able to retain at all times (*e. g.*, even when the machine stands at rest) a certain and very considerable amount of residual magnetism, and for that reason their cores are made of retentive material, hard cast iron, as is the case in the Brush and Gramme machines; or if the cores consist of soft iron they are attached to large masses of hard cast iron, in such a manner that the latter are inclosed in the magnetic circuit, and form part of the cores.

Generators of the same kind, when made small in size, have cores much larger and heavier in proportion, and, moreover, the baseplate, or, as in the Weston machine, a heavy encasing cylinder, is made to form a portion of the field-magnets. Not all efforts hitherto made to produce efficient small dynamo-machines with cores of soft iron only, have resulted in absolute failure, although men of the highest genius have made repeated and prolonged efforts to solve that most difficult of problems.

These curious facts conclusively prove that the theory explanatory of the action of dynamo-machines, as now universally adopted, viz., the theory of inductive action and reaction between the field-magnets and the armature, can not any longer be considered complete or satisfactory; for even wrought iron—especially when occurring in large masses, always contains an appreciable amount of residual magnetism, more especially after it has once been subjected to strong magnetizations, and if the above theory were correct and complete, then the smallest possible amount of residual magnetism, augmented by repeated action and reaction, would be sufficient for the starting of such a machine in action. This, however, experience proves *not* must be either abandoned or amended.

The inventors of the most recent electro-motive engines have sucked—perhaps unconsciously—upon the idea that the construction and action of electro-motors are based altogether upon the same laws as those of dynamo or magneto machines, and, in accordance with that assumption, the field-magnets of the Desprez motor are made to consist of large and heavy masses of magnetized steel.

Experimenters have also for a long time past clung to the idea that the efficiency of an electro-motor—or the amount of energy to be obtained from such a machine by means of a current of given strength circulating in the coils of its armature only—bears a definite and direct proportion to the magneto-inductive power of its field-magnets, and that an increase of power in the field-magnets alone must necessarily produce greater capabilities of the machine.

This, however, is a mischievous theory, because erroneous in very principle, and development would only lead to the hypothesis of perpetual motion. On the contrary, starting from the consideration of the fact that a very small magnetic needle, if acted upon by one of the poles of another and very powerful magnet, has its polarity destroyed or reversed, and that if one of its poles, say the N pole, is presented to a similar (N) pole of the large magnet, the former will instantly lose its characteristic qualities and be attracted by its overpowering opponent, we can only come to the one rational conclusion that the power of the field-magnets of an electro-motor, as compared to that of the magnet or magnets constituting its armature, should not surpass the limit of some certain ratio, to be determined yet by experiments carefully conducted, and that, if it surpasses the limit, the capabilities of the machine must be impaired. Acting on this principle, I have constructed a motor in which the power of the field magnets is as nearly as possible equal to that of an armature, the core of the former being very light and made entirely of soft iron; and the satisfactory results obtained from this machine are a sure sign that further investigation of the subject and experiments made with a view of determining the exact ratio of power between the magnets and armature will result in further improvement.

Another and very important consideration in the construction of dynamo-machines and electro-motors has not yet received that care and attention from scientific investigators which would lead to immediate progress. It is the mutual motion of the revolving armature with regard to its approaching to, or receding from the poles of the field-magnets. In nearly all the machines now constructed the pole faces of the cores of the field-magnets and those of the armature are of such a shape, and the latter is caused to revolve in such a manner, that only in a small portion of the revolution the poles either approach the poles of the field-magnets or recede from them. But the most successful production of reduced currents will be achieved, and the greatest amount of power will be derived from a motor, if attention is paid not merely to the *one* condition, that the armature should recede in the most highly concentrated magnetic field possible, but also that nearly the entire motion of the revolving armature should be either one of approach or of withdrawal. Let us first of all consider the case of a machine with two poles only of field-magnets and two poles of the revolving armature.

It is usual to give the active faces of the former such a shape that a section of the same represents a portion of a true circle. See Fig. 7.

In the ordinary machines now in use the radius of the circle described by the outline of the revolving armature, and that of the larger circle described in position by the section of the latter or active faces of the poles are nearly the same, and the two circles are concentric. (See Fig. 7.) The pole c of the armature only approaches the pole a of the field-magnets while moving from c to d, or where the intensity of the magnetic field of A is at its minimum. When continuing its motion from d to e and to f, the pole c can no longer be said to approach A, because the distance between the respective surfaces remains constant.

I therefore propose that the devices shown in Figs. 9 and 6 should be adopted. The radius of the circle, part of which is formed by the section d, e, c, is considerably larger than that of the circle described by the outline of the field of motion of the armature; d, e, c is, moreover, considerably less than the radius of a circle of the shape d, e, i, f, c, A, and that described by the outline of the field of motion of the armature are non-concentric. The pole p of the armature, when in its motion, approaches the pole, A, not only in its course from c to C, but also when in the most intense magnetic field of A, viz., whilst moving from C to e and d. Fig. 11 represents a section of the field-magnet's cores E F and G H, and pole's pieces N and S cast on two halves and mounted on a base board, to which they are fixed by the two bolts R and T. The same principles may be applied to machines with field-magnets of more than two poles (see Fig. 3); or the armature itself may be made of such a shape as to work under the conditions above stated (Fig. 4). But even if the poles of the armature and those of the field-magnets are of the ordinary shape, a machine with more magnets will be more perfect in its action than one with two poles only. Fig. 10 illustrates a machine in which the armature during nearly the whole of its motion either approaches to or recedes from

* A paper read before the British Association.

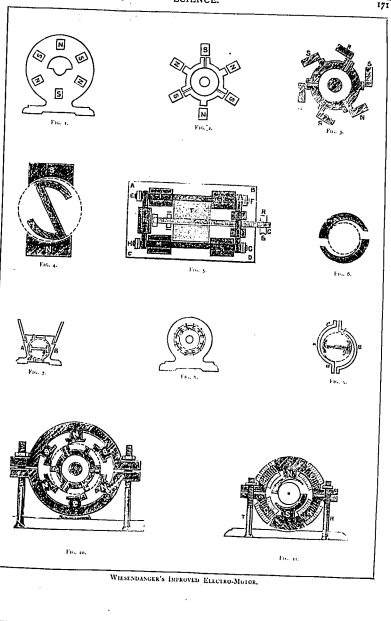


FIG. 1. FIG. 2. FIG. 3.

FIG. 4. FIG. 5. FIG. 6.

FIG. 7. FIG. 8. FIG. 9.

FIG. 10. FIG. 11.

WIESENDANGER'S IMPROVED ELECTRO-MOTOR.

The English Mechanic
AND
WORLD OF SCIENCE AND ART.

FRIDAY, SEPTEMBER 17, 1886.

ARTICLES.

DOMESTIC MOTORS.

ALTHOUGH there is a large and increasing demand for small domestic motors, and several attempts have been made to supply it, the fact remains that there is no really satisfactory device which is at once cheap, efficient, and unobjectionable. It must be confessed that the conditions necessary for success are not easily met, but the prospective reward is sufficiently ample to encourage inventors to persevere until they succeed. The demand for motive-power in small workshops is also large, and in this case, how first-cost is the primary consideration, although economy in working is not lost sight of. The tendency of the modern system is to drive workers into large factories—to bring about a centralisation in manufacturing which checks the real advancement of the industrial classes, and certainly does not assist in the development of individual skill. With small and comparatively cheap domestic motors, a great deal of work would be done at home, and there would be a fair tendency towards overcrowding, which is indeed mainly by the desire to reside near the shop; but besides the array of real industrials, there are a host of amateurs who want a small motor to drive a lathe or a fret-saw, and to supply power generally to their *ateliers*. The choice of motive power appears to lie between gas, steam, or hot-air, for electricity is at present too costly, and water is not always available. For obvious reasons, steam-engines, as usually constructed, are objectionable, for they introduce an element of danger which it is as well to avoid, and even when well attended, are accompanied by dirt and heat, the smell of oil, and the escape of steam. An electric motor must be worked by the current produced by a machine, or by that obtained from a battery. In the one case a motor for the machine would be required, and in the other the use of acids and sundry chemicals would be regarded as a nuisance, even if the expense were a matter of little importance. Where water at a high pressure can be obtained, that would appear to offer the best means of supplying a motive power, with motive power, but besides the cost of the water, there is another objection that must be considered, and that is, the effect upon the total supply of a number of small engines running water practically to waste. In London, for instance, the companies do not care about supplying water for such purposes now, and would speedily set up a non-pressure if domestic turbines or hydraulic engines became fashionable. M. Fontaine, in a paper read recently before an association of civil engineers in Paris, gave some facts which show that the use of water in that city is practically out of the question, for though the pressure is equal to a head of 40 metres near the Seine, it is only 10 metres in the higher districts. The engines, of from 1 to 3d. per cubic metre, when not more than five cubic metres per day are used, though it is as low as 2½ when the daily consumption amounts to twenty cubic metres, a fact which would indicate that there is abundance of water at Paris. Taking the pressure as equal to a head of 20 metres, and allowing the motor an efficiency of 60 per cent., the quantity of water required for a work equal to six kilogrammetres per second will be 10 cubic metres in 10 hours, and the daily expense will therefore be about three shillings. It is some towns the charge for water is much less, and it is not impossible to obtain it in places with an efficiency of 80 per cent. Engines driven by springs are not properly motors, as they must be wound up themselves, either by another engine or by muscular power; but although they may be convenient in use they cannot possibly take the place of the domestic motor, although one enthusiastic inventor spent large sums of money in fitting spring motors to a tram-car. The efficiency of springs is very low, M. Fontaine putting it at 40 kilogrammetres for each kilogramme of metal in the spring, assuming it to be of the best steel. A weight raised by smooth ropes and easy-running pulleys gives a better return for the work stored up, but is not convenient, and would scarcely be adopted for any of the purposes we suggest. There is a possibility that some fortunate inventor will hit upon a means of using hot-air for a domestic motor without over-stepping the limits of size at which can be considered allowable. We illustrated on p. 369 of our last volume a "motion" of this kind, but we are afraid that, like other hot-air engines, it will be found too cumbrous for use in private houses. The hot-air engine has, however, the great advantages that it is easily managed, is fairly economical, and certainly free from danger: its durability will depend to a great extent upon the design, as will also its first cost. Looking at the matter from all points of view, it would seem that if a domestic motor is introduced it will take the form of a gas-engine, using either the gas supplied by the companies or that made from one of the cheap hydrocarbons. It possesses all the advantages of the other motors without their disadvantages, but if constructed on any of the present models, is rather costly. In comparing it with the steam-engine, however, it is probable that the first cost would not much exceed that of a small engine and boiler combined, while it would be unquestionably more economical in working. We should estimate that the saving alone in running expenses, as compared with a steam-engine, would about pay the interest on the extra cost, and as depreciation and cost of repairs would not exceed while similar items in the case of the steam-engine, we have, so far, a decided advantage in favour of the gas-engine. The latter, too, can be placed in almost any position, and is certainly as little trouble as any device—not even excepting the water-motor; while the hot-air engine at least requires attention in the matter of firing. The one disadvantage is the necessity for cooling the cylinder, but we are inclined to think that might be accomplished in a comparatively easy manner by means of a current of air charged with moisture around the cylinder, the external design of which would present a very large cooling surface. In the gas-engine we are imagining would be on the "silent" principle, as the noise made by the other forms would be intolerable in a house, and it should also be free from smell, or so arranged that the odours produced by working could be swept into a chimney or other air-shaft. Such an engine would be available for use in the kitchen, the "workshop," or even the drawing-room, and what with sewing machines, washing machines, knife-cleaners, and sundry other domestic appliances, not to speak of lathes, the demand would undoubtedly be very extensive, provided the resulting article supplied at a moderate price. If such a motor could be easily devised, we know very well that instead of suppressing its invention we should be writing a description of it; but something approaching the idea is already in the market, and it probably requires only a little stimulus, such as might be applied by the gas companies, to bring out a number of plans which might ultimately lead to the production of the domestic motor of the future. It is not impossible, however, that before a thoroughly successful domestic motor has been invented, some one will discover a means of transmitting power to a distance, just as water and gas are laid on to our houses, and that, in all probability, will take the form of electricity, generated by dynamo-machines driven by a fall or current of water. Sir William Armstrong, it will be remembered, has adopted this plan at his seat in Northumberland, and we believe some attempts of a similar kind are to be made in the United States, where there is an abundance of power, in many cases running to waste. In this country we have few falls, and not many streams, of water that could be utilised for the purpose, and we therefore think that the most promising line for experiment is in the direction of a cheaply-constructed gas-engine, which could be used with little trouble wherever a supply of coal-gas is available.

Electrician May 25 1888

2971. **Improvements in Dynamo-Electric and Magneto-Electric Machines.** A. J. Cloud. Dated September 20th, 1882.—(*Communicated from abroad by E. Reynier, of Paris.*—Not proceeded with.)

This invention relates to improvements in the original Siemens machine, which are shortly as follows—The fixed magnets are placed at right angles or perpendicular to the plane of revolution of the coil, as is the case with it. The ends of the core of the coil are connected by thin cores of iron, and a thin iron ring may be placed on the poles of the fixed magnet or magnets. The coils may be wound on the ordinary Siemens or Gramme shuttle, and are composed of flexible segments fixed on a disc of wood or other insulator, and insulated

from one another, but close together. The figure shows the machine with two metal rings as described above.

FITZGERALD'S MAGNETO AND DYNAMO-ELECTRIC MACHINES.

The improvements in magneto and dynamo-electric machines we now illustrate deserve the most careful attention, inasmuch as they show a decided advance in the right direction. The main idea of the inventor seems to have been to aim at perfecting the Gramme machine, and so, *first and foremost*, obviating the loss of the poles of a magnet and the ordinary system, he wholly or partially surrounds the armature longitudinally and transversely, thus increasing the effective inductive action. The ring is also magnetised directly and with the least possible loss, and the direction of the inducing magnetic polarity is such that it is constituted by the ring itself, as it should be. Fig. 1 shows a transverse sectional elevation of a magneto-electric machine, Fig. 2 is an elevation partly in section looking on to the left hand side of Fig. 1 with the driving pulley removed. In Fig. 1 A is the soft iron ring carrying 50 (more or less) coils, B, of No. 16 soft iron wire, and C, C are the pole pieces which are connected to the cylinder D. The ring A with its coils, is mounted on a brass bush, F, attached by a key, E, to the shaft P, mounted on suitable bearings in the standards G G, and at one end carrying the driving pulley H. The ring A is shaped or wholly surrounded by a hollow cylindrical ring, I I F, of wrought iron, or other magnetic material, which is also largest at the top and bottom. The opposite portions of this hollow magnetic ring are so formed with coils of wire as to constitute two magnets having their flat poles opposed on the vertical plane transverse to the ring A. The reverse direction of the winding near the poles required to produce this effect is shown at Fig. 3. The coils are secured by means of a screw-nut and washer, and held in position by thin lugs, J, projecting from their cores between the coils. The lugs J are bolted to the cylinder lugs, K, cast on the frame L. The ring A has preferably a deep groove, *a*, cut in it, circumferentially as shown. The reflector, C, consists of a cylinder of wood or other non-conducting material rigidly attached to the boss E, and having let flush into its inner circumference a series of strips of conducting material, M, insulated, and in number equal to the coils on ring A. The extremities of the coils are brought to the outside of the collector, and connected so as to form a closed circuit, the points of connection between adjacent coils being severally brought into contact with the conducting pieces M as shown at *n n*. Fig. 1 shows clearly the collecting brushes, the current being taken off at the horizontal central line, or the line of greatest polarity. Fig. 4 also shows a front view of the collector C. The brushes are flat springs of copper, O', each having at one end a contact piece, O, and being attached at the other end to a round bar, P, passing through a terminal, Q, and being fixed in position by a set screw, R. The terminal Q is fastened to the end of the bar P, having an adjusting-nut, S, tapped through it, and bearing on the plate under-neath. The set screw enables any required tension to be put on to the springs O', thus regulating the contact between O and the collector C. A binding screw is attached to the terminal Q, connected by screwcap, U, to the end of the machine. The whole of the current-collecting portion of the machine is liberated by means of this screw.

Considerable modifications are made in the construction of the ring. The method of construction is shown by Fig. 5. Ordinarily, in winding a number of coils of wire upon a ring, more or less of wire be lost, the same in each layer, inductive action is left between the coils. These interspaces are filled by Mr. Fitzgerald with soft iron ridge-shaped blocks, Y. These blocks can either be made with the ridge or segment and slipped on, the ring being made in halves for convenience in winding.

Fig. 6 shows a modified form of the ring A and the encircling magnets I F I. The ring being cylindrical instead of circular, and the encircling magnets having parallel instead of circular sides. The principle is the same whichever form is used. Fig. 7 is, however, illustrates a modification in which the ring A is wholly encircled on its cross section by coils, W, of wire in lieu of the coils on the ring. The encircling coils W are supported in a suitable framing, X, and the ring A, to rotate in the middle, is mounted between the coils W. Fig. 7, by one of which (preferably the upper) it is driven by friction. Therefore, the edge of this coil or pulley being of India rubber, as seen at 1 1, Fig. 8. The extremities of the coils of ring A are carried to a commutator, which is also described to a series of strips of conducting metal, Z, let flush into an insulating cylinder, Y, or of one or more coils, A', fitted round the outside of ring A. The current is taken off at segments of the outer circumference of the coils or let left in each between these longitudinal grooves, W, on these inner surfaces, where they pass over the ring A1 on the outside of ring A. The ends of the two surfaces of the ring and encircling collecting brought into very close contact. Fig. 9 is a transverse section taken at *a b*, Fig. 8 in a sectional plan of ring A at commutator, and Fig. 10 a section of Fig. 9, taken at line *c d*, Fig. 9.

It is obvious that in the three forms of machines shown per, namely, the ring A, and those on the inducing electro-magnets I F I or the inducing coils W, may be connected in multiple arc or in series, as is well understood. The apparatus may be advantageously constructed so that the current taken from either the ring A being employed to magnetise both of the inducing electro-magnets I F I or the inducing coils W, and the current for the external circuit of the circuit being taken from the second in ring A. The coiled ring A may be enclosed in a casing of soft iron, provided with a non-interrupted slot to allow of the passage of the wires from the coils. The arrangement of the inducing magnets I F I and the coils W is applicable to ring armatures generally. The saddle-shaped armatures they are called by Mr. Fitzgerald—of double or single circumference, are applicable to a great variety of machines, and may be used for the purposes of, for dynamo or magneto-electric machines the combination with a ring or cylinder-shaped armature of permanent or electro-magnets of double curvature, such as will encircle the ring-armature both transversely and longitudinally. (2.) And of the machines the combination with a ring or cylinder-shaped armature of electro or permanently magnetic ring constituting two magnets having their similar poles in a plane transverse to the armature axis. (3.) In similar machines the combination with a revolving coiled ring or cylinder of armature inducing coils completely encircling the revolving coiled ring or cylinder. (4.) The method of connecting dynamo and magneto-electric machines as described. (5.) The construction for use in dynamo or electro-magnetic machines or in other electrical apparatus of magnets illustrated in Figs. 1 to 6 of the accompanying drawings, the essential characteristic of such magnets thereof saddle-back magnets being that they are always curved in the direction transverse to the axis of the magnet or the line joining the poles), whilst they are sometimes curved also in the direction of this axis, and in the case of electro-magnets are surrounded with coils of wire every turn of which is partly convex and partly concave.

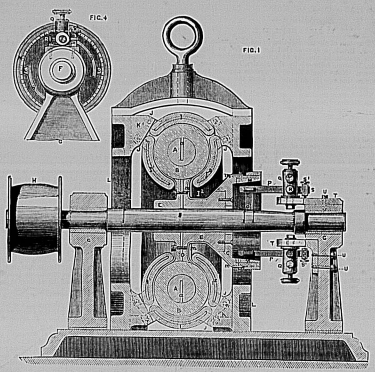


FIG. 4

FIG. 1

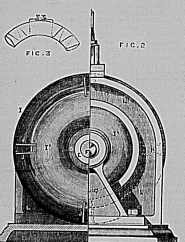


FIG. 3

FIG. 2

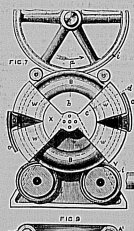


FIG. 7

FIG. 10

FIG. 5

FIG. 6

FIG. 8

The Possibilities of the Electric Railway.

The highly interesting practical experiments of Dr. Werner Siemens, of Berlin, and of Mr. Edison, in connection with operating a railway with electrical motors, have attracted universal attention by reason of the novelty of the idea in the present generation, and of the apparent success of the experiments; and much speculation has been indulged in as to the possible

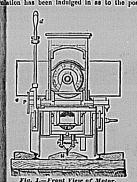


FIG. 1.—Front View of Motor.

future utility of this latest application of electricity. From the results that have been reached in the preliminary experiments of both the inventors above named, we risk very little in advancing the opinion that the practical success of the new method of propulsion has been demonstrated both from a technical and economical standpoint, and we may reasonably expect that the system extensively introduced in the near future for general purposes, and for the transmission of power for agricultural purposes, and in our cities for the delivery of parcels, the transfer of passengers and goods. For all these purposes a novel, quiet, and doubtless safer motive power than that do not see that the instant occur to us, the advantages of electricity as a motive power over steam and horses is too prominent to admit of question, and the economical method of propulsion by electricity, which we think may safely be assumed, the general introduction of the electric method of propulsion for the hauling of ores and minerals, plowing and other agricultural work, and cities for the transfer of passengers and goods for postal and freight service, is merely a question of time. We anticipate that the electric railway will very speedily into popularity on the strength of its introduction in a few prominent localities where its advantages over steam and horses in the absence of nuisance, freedom from liability to many forms of accident, and unavoidable, and from the annoyances of flying ashes, cinders, grease and other dangerous and offensive accompaniments of our present elevated steam railways, would strikingly demonstrate themselves. And while the anticipations of the advocates of the electric railway for our cities, as a substitute for the surface and elevated roads, and for the transaction of much of the

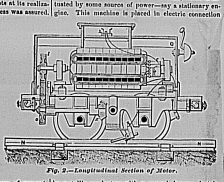


FIG. 2.—Longitudinal Section of Motor.

package and freight traffic over thoroughfares now thronged with vehicles, be realized, the single advantage that would be gained in the improvement of the sanitary condition of our cities in ridding us of the vast bodies of filth with which our streets are daily littered, can hardly be overestimated.

The history of the electrical railway resembles that of the majority of important and revolutionary inventions, in that several abortive attempts at its realization were recorded before its actual success was assured. Nearly forty years ago, the idea occurred to Prof. Page, one of the pioneers of electrical invention, and some years later Mr. Silby and Dr. Colton essayed the problem. But these early experimenters lacked the means for the economical generation of electricity with which our inventors of to-day are provided, on which account they failed. The only source of electricity available at that time, was the galvanic battery, the inconvenience, uncertainty and costliness of which was an insuperable obstacle. The development of the dynamo-electric machine within the past few years, however, has removed this serious difficulty from the path of inventors, and has given them what before was lacking, namely, a comparatively cheap means of generating and maintaining powerful electrical currents by the direct conversion of mechanical energy (no matter how generated, whether by steam, wind or water-fall) into electricity. In this form we can send our power to great distances over metallic conductors with comparatively little loss, drive electric locomotives or electric engines located at distant points, to do the work of the steam engine in our factories and workshops, or furnish light to towns and cities. Upon the development of the dynamo-electric machine, the electric railway has been made a possibility of the near future, and unless the signs of the times are most deceptive, we look for the most extensive adoption of the system in the course of the next decade.

Dr. Werner Siemens, of Berlin, whom name we mentioned at the outset of this article, is entitled to the credit of having revived in practical shape the forgotten efforts of Page and others of the past generation, by constructing and operating an experimental electrical railway in the grounds attached to the Berlin Exhibition of 1879. As this ingenious invention promises at no distant day to have a historical interest, we present herewith illustrations and a description of its operation and plans, together with some practical suggestions of the inventor that have grown out of the same.

The electric railway requires, first, a dynamo-electric machine at the terminus of the road, which is situated by some source of power—say a stationary engine. This machine is placed in electric connection by metallic conductors with a second dynamo-electric machine, which, properly mounted on a vehicle, the wheels of which are set in motion by it, constitutes the electrical locomotive. Thus we have the first dynamo-electric machine set in motion by the steam-engine at the terminus, the electricity generated by it is conveyed by the rails, or by some special conductor, to the second dynamo-electric machine, which is sets in motion, and actuates the locomotive. These are the essential parts of the electric railway. The details of Dr. Siemens' system are as follows:

Fig. 1 represents a front view of the locomotive, and Fig. 2 a longitudinal section.

The motion of the electrical machine is communicated by suitable gearing to the wheels of the vehicle on which it is mounted, and these are placed on rails of the ordinary construction. The electricity from the driving electrical machine at the station is conveyed to the locomotive through a special insulated central rail (seen in Fig. 1), the current built taken from the locomotive rail by a metallic brush, and returned to the first machine through the ordinary uninsulated rails, thus completing the circuit.

FIG. 3.—SIEMENS' ELECTRIC RAILWAY AT THE BERLIN EXHIBITION.

The stationary machine, it should have been stated, has one of its poles connected with the track rails and the other with the insulated center rail. The current, therefore, comes through the insulated center rail, traverses the metallic brushes in contact with the center rail, passes through the wires of the locomotive and returns through the wheels and track rails.

Fig. 3 shows a perspective view of the locomotive, drawing three cars, each containing six passengers. The current is thrown on or off by the driver, who sits astride of the motor and controls its motion. The performance of the locomotive here described, and which

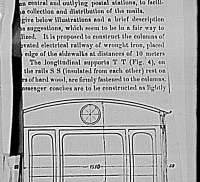


FIG. 4.—Siemens' Electrical Elevated Railway.

is capable of developing 2½ horse-power, attained a maximum of 14 miles per hour, carrying 18 passengers. Siemens' novel experiment attracted so much attention, that the suggestion was subsequently made to use the electrical elevated railway in the city of Berlin for the transfer of passengers, which, we are informed, has been received with favor by the municipal authorities. He also developed the idea of employing the system as a substitute for the pneumatic propulsion, in use in that and other European capitals, on central and outlying postal stations, to facilitate the collection and distribution of the mails. We give below illustrations and a brief description of these suggestions, which seem to be in a fair way to be realized. It is proposed to construct the columns of the elevated electrical railway of wrought iron, placed on the edge of the sidewalks at distances of 10 meters apart.

The longitudinal supports T T (Fig. 4), on the rails S S (insulated from each other) rest on the tops of the latter, and are firmly fastened to the columns. The passenger coaches are to be constructed as lightly as compatible with safety, and are designed to seat 15 persons. Each wheel is carried on an independent axle, and the axle bearers of each side are electrically connected. The two driving-wheels R R receive their motion from the dynamo-electric machine, which is placed under the bottom of the vehicle. The central rail in this plan is dispensed with, and the track itself forms the conductor, the plan being similar if not identical with that of Mr. Edison's, described in the June number of this journal.

Fig. 5 represents a special arrangement designed for the postal service, by the same inventor. The road is proposed to be carried on short iron columns S. On these rest, at suitable distances, to which are attached short metal pieces d' d', forming the side walls of an inclosed railway. Between these sheet metal strips, at suitable distances apart, are placed light wooden cross-ties, on which rest the light rails a' a'. Of these rails, one is placed at frequent intervals in electrical connection with the side sheets, which are covered above with a removable sheet-metal cover d, while the other is connected with all the iron columns. It is designed to run small four-wheeled wagons on this road by suitable electrical connections.

We are thus in a fair way to see this interesting branch of electrical invention specially developed.

à l'une de rotation et changent de polarité deux fois par tour.

Cette disposition rappelle jusqu'à un certain point la machine de M. Nimdet dans laquelle on aurait remplacé les aimants inducteurs par des électro-aimants.

L'idée neuve et personnelle de M. Cance consiste dans l'emploi de bobines spéciales, tant pour les inducteurs que pour l'induit, qui augmenteraient dans une grande proportion la puissance de la machine.

Chaque bobine se compose d'un noyau de fer formé lui-même d'une série de fils de fer très-recuits et très-doux, sur lequel on enroule deux couches de fil de cuivre isolé, puis d'une seconde enveloppe de fils de fer de mêmes dimensions placés suivant les génératrices du cylindre et maintenus par une nouvelle double couche de fil de cuivre enroulé, et

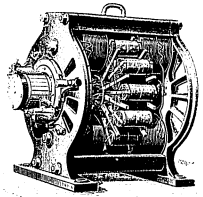


Fig. 1.

ainsi de suite, trois, quatre, cinq ou six fois suivant la puissance de la machine.

Cette disposition spéciale d'électro-aimant, qui date déjà de 1875 et que M. Cance a su si habilement appliquer à sa machine, présente plusieurs avantages.

Au point de vue des inducteurs, les spires traversées par le courant étant toujours très-rapprochées des tiges de fer qu'elles doivent magnétiser, leur action est ainsi énergique que possible; il en résulte donc que ces inducteurs constituent un champ magnétique puissant.

Au point de vue des bobines induites, ces petites tiges de fer très-recuites s'aimantent et se désaimantent avec la plus grande facilité, et comme elles sont ainsi très-rapprochées des spires à induire, et que, d'autre part, elles sont induites par leurs deux extrémités à la fois, on trouve là réunies toutes les conditions nécessaires pour donner aux courants une grande intensité, c'est-à-dire un champ magnétique puissant, des aimantations rapides et faciles, et une action inductrice produite à très-courte distance.

Pour ne pas donner trop de développement à la couronne formée par les induits, et par suite diminuer l'action de la force centrifuge, M. Cance a disposé les bobines en deux séries concentriques portant douze bobines chacune.

Dans ces conditions, la couronne extérieure, ayant une vitesse plus grande que la couronne intérieure, les actions d'induction devraient y être plus énergiques. M. Cance a paré à cet inconvénient en augmentant la surface du champ magnétique des bobines de la couronne intérieure. Par cette disposition, les courants induits sont sensiblement égaux dans les deux séries de bobines, car on compense par l'intensité du champ magnetique ce que l'on perdrait à cause de la diminution de vitesse.

Signalons encore une disposition de balais qui permet de changer instantanément leur calage suivant la vitesse, et de faire disparaître à peu près complétement les étincelles d'extra-

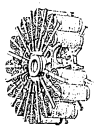


Fig. 2.

courant; le collecteur est placé à l'extérieur du bâti, il se trouve donc indépendant de tous les autres organes et peut être ainsi facilement nettoyé, démonté ou remplacé. Le même système permet de construire très-facilement des machines à courants alternatifs qui produiront des effets puissants sous un très-petit volume : c'est d'ailleurs le projet de l'inventeur.

Dans une expérience à laquelle nous avons assisté, la machine tournant à 1 100 tours a fourni un courant de 21 webers, mesurés à l'électro-dynamomètre de Siemens et Halske, à travers une résistance formée de 200 mètres de câble et un régulateur Serrin donnant un arc de 3 millimètres de longueur avec des charbons carrés de 9 millimètres de côté.

Ces chiffres représentent, à très-peu près, les résultats fournis par une machine Gramme, type d'atelier, tournant à la même vitesse.

La machine de M. Cance n'occupe pas un volume plus grand, elle emploie la même quantité de cuivre et a un poids total un peu moindre; l'enroulement des bobines, leur fixation sur l'arbre et leur remplacement s'effectuent avec la

plus grande facilité ; elle peut donc recevoir, au même titre que la machine Gramme, toutes les applications à l'éclairage, la force motrice, etc., si son inventeur veut la livrer dans des conditions satisfaisantes de bon marché, le seul facteur qui ait une influence décisive sur le développement des applications de l'électricité.

E. H.

NOUVEAU TÉLÉGRAPHE

ACOUSTIQUE, DE M. WILDE

Je ne sais trop si c'est M. Wilde lui-même qui a choisi le nom sous lequel on désigne sa nouvelle invention ; ce nom n'est pas clair, le système n'a rien de très-acoustique, si ce n'est que les dépêches ne sont pas inscrites par le récepteur,

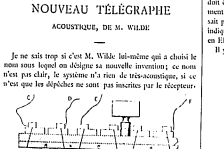


Fig. 1.

elles sont recueillies en écoutant le bruit que produit l'appareil, cela n'a rien de nouveau, tous les récepteurs actuellement en usage font assez de bruit pour qu'on puisse lire au son, comme disent les télégraphistes ; cela se fait constamment, et les Américains n'épèrent pas autrement ; leurs récepteurs sont tous des parleurs (*Sounders*).

Le système que M. Wilde vient de combiner et dont le premier spécimen a été présenté à quelques personnes, jeudi 16 septembre, dans les ateliers de la Compagnie parisienne (*l'Alliance*), est remarquable par d'autres côtés et constitue au contraire une combinaison très-nouvelle.

Le générateur d'électricité est une machine à courants alternatifs, les expériences ont été faites jeudi avec la machine de *l'Alliance*. Ceci est déjà un point nouveau ; on a, il est vrai, employé des machines à la télégraphie, et on a décrit dans ce journal (n° du 1er mars, p. 92) les procédés mis en usage pour cela en Amérique ; mais naturellement ce sont des machines à courants redressés, puisqu'on les employait simplement au lieu et place des piles.

Les courants alternatifs produits par la machine sont envoyés dans un circuit local qui forme le circuit primaire d'une série de bobines d'induction. Cette disposition est figurée dans le diagramme ci-contre figure 1. AB est le circuit en question, on voit qu'il est commun aux trois bobines M, N et P, comme à toutes les autres qui peuvent être installées. M. Wilde estime que, sur une machine ordinaire donnant six chevaux vapeur, on en pourrait placer trois ou quatre cents.

Les circuits secondaires de ces bobines sont au contraire indépendants comme cela est figuré en CD. C'est par eux que doit être fait le service télégraphique ; chacun peut généralement suffire à une ligne ; si cependant une bobine ne fournissait pas assez, on en couplerait deux ou plus, comme cela est indiqué pour les bobines N et P qui forment un seul circuit en EF.

Il y a là un mode de distribution curieux ; avec une seule

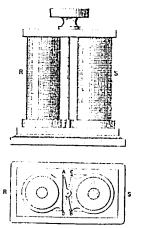


Fig. 2.

machine faire le service de plusieurs lignes séparément est un résultat qui pourra être utilisé.

Dans la construction des bobines, je signale un détail. M. Wilde les place par groupes entre deux culasses de fer doux qui rendent tous les noyaux solidaires ; cette disposition avait déjà été indiquée, mais les expériences de M. Wilde l'ont conduit à la considérer comme très-avantageuse pour la régularité de l'induction.

L'appareil que je viens de décrire sommairement met à notre disposition une série très-rapide de courants inverses ; il suffira d'interposer dans la ligne une clef Morse pour manipuler avec ces courants comme avec des continus ; la succession en est tellement rapide, qu'on ne peut frapper sur la clef le coup le plus sec sans en laisser passer plusieurs.

Il reste à voir par quel moyen on peut, au poste de réception, utiliser ces courants inverses, les appareils ordinaires n'étant pas disposés pour cela.

On the 6th of August, 1878, lightning struck the powder magazine at the Victoria Colliery, Barnsley, Yorkshire. At the time of the explosion the magazine contained about 7,000 lbs. of gunpowder. The magazine was an oblong building of brick, 9 feet long, 6 feet wide, and 6 feet high (internal dimensions), and it had a uniform thickness of three bricks. At the end was a heavy iron door, and at the other a lightning conductor, consisting of a copper wire rope seven-sixteenths of an inch in diameter. The point of the terminal rod was about 12 feet above the top of the building, and a similar length was carried into the ground, and terminated in rivery soil at a depth of three feet. The conductor was also carried a little distance along the roof at each end of the building opposite to that in which the iron door was placed. It was not observed with the iron door in any way damaged. On testing the conductivity of the copper rope it was found to be only 57·2 instead of 93 or 94 per cent. This deficiency should not have been overlooked, although the rope, when carried along the roof, down the iron door-post, and into the ground.

In January, 1879, lightning struck one of the pinnacles of the tower of Chester Cathedral, although on another pinnacle only 40 feet from it, there was a good copper conductor having a diameter of ⅜ of an inch weight. On testing the conductor by means of a galvanometer I found it and the earth connection in thorough order. In this case a point should have been placed on each of the pinnacles and joined to the main conductor.

In May, 1879, the steeple of the Church at Loughton, co. Ex-Northumberland, was struck by lightning, and damaged. The spire, 135 feet in height, had attached to it a thin rod of iron, 0·2 of an inch diameter, about 3 of an inch in external diameter, and 1 internal ; the copper being ⅛ of an inch in thickness. It was made in short lengths joined together by screws at the coupling-piece, but there was no metallic contact existing between the pieces, which were much corroded. The conductor was not in contact with the building, but was kept at a distance of 2½ inches by 21 insulators. The earth-contact was obtained by bending the tube and burying it in the ground at a depth of from 6 to 18 inches, the soil being dry loose rubbish, the earth terminal being only 3 feet. It was placed in a corner formed by a double-stem buttress, which came between the conductor and a lead-covered roof attached to the spire ; the distance between the conductor and the lead roofing being about 18 inches. The lightning appears to have come down the conductor a certain distance, and finding the road to earth bad, it passed through the buttress, dividing about two cartloads of stone, and then down the iron hinges, leaving from the lead-covered roof, and so to earth.

From the instances quoted, it is evident that it is not sufficient merely that rods of copper should be attached to a building, but it is necessary that once put up they should be regularly inspected to see if they are in good order, so as to be really efficacious. That this is rarely done is one of the main reasons why accidents by lightning occur in places nominally protected by conductors. It is, perhaps, not too much to assert that at present not one in a thousand of our public buildings in England are regularly tested.

There can be no manner of doubt that in the matter of lightning conductors they manage things better on the other side of the Channel than with us. The French Government are in the constant habit of consulting the most eminent scientific men on the subject of protecting public buildings against the destructive influence of lightning. There is scarcely an instance in which a British Government ever did such a thing. It is true the Houses of Parliament had lightning conductors erected upon them at a very great cost and under scientific advice. But all who understand the subject practically agree in saying that it is very doubtful whether the magisterial pile of buildings in which our legislators assemble is really, that is efficiently, protected. At all events, I understand the rods have never been tested since the conductors were erected in 1852. That the Victoria Tower should have been struck in June, 1858, and slightly damaged, tends to show that the conductors at that time were not in an efficient state.

From the examination I have made I am pretty correct in stating that one half of our cathedrals and three-fourths of our churches have not even nominal protection. For all that science has done, the Queen might any day be killed in her apartments at Windsor Castle, the Prince of Wales in Marlborough House, and the Prime Minister in Downing Street. To see the difference between England and France in this respect, one has but to cross the Channel between Dover and Calais. At Dover there are huge barrels of great length, on the top of high hills, exposed in the full fury of storms sweeping across the Channel, and the few conductors to be found upon them at long intervals are certainly not numerous enough for efficient protection against lightning, and their efficiency has never, so far as I can learn, been tested. The contrast in this respect on crossing the Channel is of the most striking. At Calais, the Hôtel de Ville, in the Grand Place, literally bristles with lightning conductors, and so do all the churches and chief buildings in the town. The same all over France, Germany, and Belgium. Without slavishly imitating our scientific neighbours, we might yet borrow some of the care they do upon the protection of our property as well as of our lives against the terrible effects of the electric force.

TROUVÉ'S ELECTRIC MOTOR

By M. TROUVÉ.

In the dynamic diagram of a Siemens armature is traced out, on making the armature turn a complete revolution between the magnetic poles which react upon it, it will be observed that the work is almost nil during two periods forming a considerable portion of the revolution. These two periods correspond to the times during which the cylindrical poles of the armature, having reached the poles of the magnet, move in front of them. During these two portions of the revolution, which are each about 90°, the magnetic surfaces destined to react one on the other remain at the same distance, and the armature has no motive force given it.

I have suppressed these periods of indifference and increased the useful effect of the machine, by modifying the shape of the bobbin ; the polar faces, instead of being portions of a cylinder of which the axis coincides with that of the system, are of a small form, so that on turning they gradually approach their surfaces towards those of the magnet, up to the moment when the hinder edge leaves the pole of the magnet. The action of repulsion then commences, so that the dead point is practically got rid of.

Fig. 1 shows a general perspective view of a motor constructed on these principles ; fig. 2 is a vertical section of the same, with a horizontal projection.

Fig. 1 is drawn to half size. A A C C is a fixed

ON THE BEST FORM OF MAGNET FOR MAGNETO MACHINES.

By W. LADD.

(Read before the British Association, August, 1880.)

At the British Association Meeting at Dundee, in 1867, I made some remarks upon different forms of magnets, and exhibited diagrams, showing by

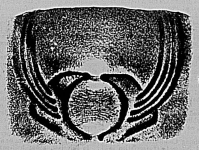


Fig. 2.

the lines of force—naturally arranged—the great superiority of the circular magnet where an armature is to be employed.

Since that time, some thousands of that form of magnet have been made for medical, mining, and other purposes.

Some months ago, in conversation with M. Breguet, of Paris, I showed him these same diagrams, and he was very much impressed with their importance; he has since then constructed a machine using the Gramme armature, and with a smaller quantity of steel in the magnets he has made a far more powerful machine than hitherto constructed with either the Jamin or the ordinary horse-shoe form. It is also more symmetrical in appearance and occupies less space.

With this machine I can heat to incandescence 10 inches of platinum wire by four turns of the handle, while to heat 11 inches of the same size

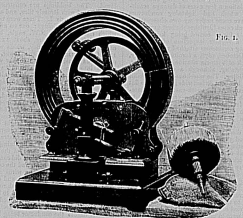


Fig. 1.

wire by a machine having a Jamin magnet, it took ten turns of the handle.

[This machine is shown by fig. 1. Fig. 3 shows the distribution of the magnetism about the field in which the armature revolves.]

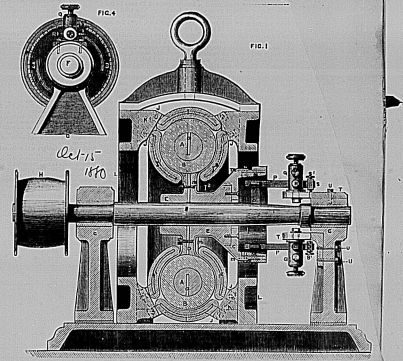
FITZGERALD'S MAGNETO AND DYNAMO-ELECTRIC MACHINES.

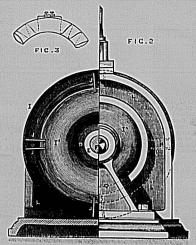
THE improvements in magneto and dynamo-electric machines we now illustrate are the invention of Mr. Desmond G. Fitzgerald, and deserve careful attention, inasmuch as they show a decided advance in one right direction. The main idea of the inventor seems to have been to aim at perfecting the Gramme machine; and so, instead of rotating the ring between the poles of a magnet on the ordinary system, he wisely or partially surrounds the ring with the magnet, and rotates the coils on the periphery of the inducing magnet. The ring is thus magnetised directly; and with the least possible loss, and the direction of the inducing magnetic polarity in the circle constituted by the ring itself, as it should be. Fig. 1 shows a transverse sectional elevation of a dynamo-electric machine; Fig. 2 is an elevation partly in section of the ring, to which the side of the coils with the end-plate and pulley removed. In Fig. 1 A is the soft iron ring carrying more or less, coils B of wire, all wound in one direction. The ends of these wires are connected to the collector C. The ring A, with its coils, is mounted on a hollow shaft D, driven by a bevel E on the shaft F, mounted in suitable bearings on the standards G G, and at one end carrying the driving pulley H. The ring A is almost wholly surrounded by a hollow electro-magnet I I, which, for convenience of manufacture, the ring I I² I³ I⁴ is divided transversely, of which the two represented by I I and I² are annular, while two are semi-annular, and make up the largest diameter I, the division between the halves being preferably at the top and bottom. The annular portions of the hollow magnetic ring are wound with coils of wire or bar constituting two magnets having their like poles opposed on the vertical plane transverse to the ring A. The reverse direction of the winding of the poles required is represented as it is shown at Fig. 3. The vertical sections of the electro-magnetic ring are united and held in position by thin lugs J projecting from their cores between the coils of wire. These lugs J are bolted to the magnetic ring by bolts K, cast on the ring I, and passing through a deep recess i cut in it circumferentially, as shown. The collector C consists of a cylinder of wood or other non-conducting material, rigidly attached to the boss E, and carrying on its outer surface the inner circumferences a series of strips of conducting material, 7 in the present instance, and in number equal to the coils on ring A. The extremities of the coils are brought to the outside of the collector, and connected, as by form a closed circuit, to the ends of connection between adjacent coils being severally brought into contact with the conducting pieces M as shown at n n. Fig. 4 shows clearly the collecting brushes, the contact being taken off at the ends of a diameter at right angles to the line of greatest regularity. Fig. 4 also shows a front view of the collector C. The brushes are flat springs of copper O, each having at one end a platinum point O¹, and being attached at the other end to a round the pillar P, passing through a key-plate Q, and being fixed in position by a set screw R. A short lever S is attached to the end of the bar P, having an adjusting screw S¹ passing through it, and bearing on the plate underneath. This screw enables any desired tension to be given to the springs O¹, thus regulating the contact frictional. The pillar P is fixed to and insulated from a plate T, connected by screws U to the end standard of the machine. The whole of these current collecting parts are thus readily liberated by means of these screws.

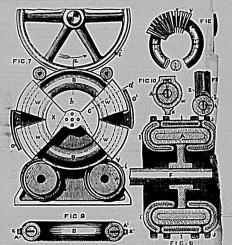
Considerable modifications are made in the construction of the ring. The method of construction is shown in fig. 5, which, similarly to fig. 1, shows a number of coils of wire upon a ring, more especially if it be of circular section and if the coils be composed of wire of the same gauge in each layer, interstices are left between the coils. These interstices are filled by Mr. Fitzgerald with wedge-shaped blocks V. These blocks may either be made with the ring, or separately and slipped on the ring being made in halves to receive them, as shown.

Fig. 6 shows a modified form of the ring A and the encircling magnet I I. Here the ring is made of a flattened band of circular section and the encircling magnets being ring-shaped to correspond. The principle is the same whichever form is adopted. In fig. 6 the interstices between the coils on the ring A, is wholly encircled on its cross section by coils W, in lieu of inducing magnets.

In figs. 7 to 10 illustrate a totally new form of machine in which the ring A is wholly encircled on its cross section by coils W, in lieu of inducing magnets. These encircling coils W are wound on to a suitable frame-work and are also wound







tinual contact, the surface of this roller or pulley being of india-rubber, as seen at i i, Fig. 8. The extremities of the coils of ring A are attached in a manner similar to that before described to a series of strips of conducting metal, Z, let flush into the surface of the roller or pulley, a double or single ring of metal round the outside of ring A. The coils are connected in succession to the outer circumference of the coils W left in such a manner as to form a set of wire. Preferably, the coils W are wound so as to leave a longitudinal groove W in their inner surface, where they pass over the ring A on the outside of ring A. The silvers of the two surfaces of the ring and encircling coils being brought into very close contact. Fig. 9 is a transverse section taken at a a, Fig. 9 shows a section of ring A at centre line, and Fig. 10 a section of coils W, taken at the line b b.

It is obvious that, in the three forms of machines shown permanent magnets may be substituted for the electro-magnets; the permanent magnets retaining substantially the same shape,

1880

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

Oct 15 1880.

VOL. VIII.—No. 185.

ELECTRIC MOTORS.

THE problem of the electrical transmission of power to a distance has given a considerable impetus to the invention of electric motors. The interchangeability of the electric generator and the electric motor is generally known to be possible; indeed, in almost all the experiments made on a large scale to show the possibility of the electric transmission of power, the motor and generator have been identical in construction. It seems to be admitted, however, that in several points the motor should differ from the generator, if the highest percentage of efficiency is to be obtained. In other words, the best generator does not necessarily form the best motor.

The tendency, in most cases, is to go back to the forms of motors which were designed plentifully many years ago. The motors of Trouvé, Wiesendanger, and others—the peculiar feature of which consists in the shaping of the armatures and inductors in such a way that the approach of the two together is gradual—were anticipated at least thirty years ago by the late Sir Charles Wheatstone, who invented and constructed several machines on the principle. These, we believe, may be seen in the museum of King's College, London, amongst the collection of that prolific inventor.

That there is a good field for invention in the direction of electric motors, can hardly admit of doubt, as their employment is likely to be considerable at no very distant date. At present the experiments made have been but fitful, though we believe that many are working quietly at the subject.

ELECTRO-MAGNETIC MACHINES.—A paper was recently read before the Academy of Sciences on the law of electro-magnetic machines, by M. Jaubert. With a given intensity of field, whatever the other conditions in which the machine works, from the moment when it gives maximum work the retardation is equal to one-eighth of the entire period; the intensity is constant and equal to the quotient by $\sqrt{2}$ of the absolute maximum of intensity; the electro-magnetic work is proportional to the velocity; and the velocity is in a constant ratio to the resistance.

CANCE'S DYNAMO-ELECTRIC MACHINE.

By E. HOSPITALIER.

Good dynamo-electric machines actually transform 80 to 90 per cent. of the power expended in driving them, into electricity. In the face of these figures

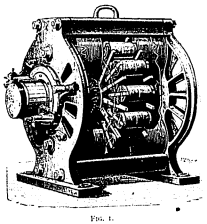


FIG. 1.

it is evident that there is but little improvement with regard to economic efficiency to be desired, but there is a good opening for improvements on the side of simplicity of construction and small first cost. It is with these objects that the machine of M. Cance has been constructed, and it appears to present certain advantages, which we will point out. The machine is composed essentially of two pairs of fixed inductors placed upon the frame, and of an inductor (represented by fig. 2) composed of 24 bobbins arranged in two series of twelve each, and connected to a Gramme commutator, seen to the left of fig. 1.

The bobbins cut the magnetic field parallel to the axis of rotation, and change their polarity twice each turn.

This arrangement is similar to a certain point with the machine of M. Niaudet (*Telegraphic Journal*, April 1st, 1876), in which the permanent inducing magnets are replaced by electro-magnets.

The novel idea of M. Cance consists in the employment of special bobbins and of special inductors, which augment in a great degree the power of the machine.

Each bobbin is composed of a bar of soft iron formed of a number of iron wires well annealed and very soft; on these are coiled two layers of insulated copper wire, and then a second wrapping of iron wires of the same dimensions as those forming the core, over these again are coiled two more layers of insulated copper wire, and so on, three, four, five, or six times, according to the power of the machine.

This arrangement of the electro-magnet, which dates from 1875, and which M. Cance has applied to his machine, presents several advantages.

As regards the inductors, the turns traversed by the current being always very near to the iron layers which they magnetise, their action is very energetic, and consequently these inductors constitute a powerful magnetic field.

As regards the induced bobbins, these little layers of well annealed iron, magnetise and demagnetise with great ease, and as they are thus very close to the inducing layers, and as, on the other hand, they are induced at their two ends at a time, they combine all the conditions necessary for giving to the induced currents a great intensity, that is to say, a powerful magnetic field, rapid and easy magnetisations, and an inductive action produced at a very short distance.

In order to avoid a too great development of the crown formed by the induced coils, and the consequent considerable action of centrifugal force, M. Cance has arranged the bobbins in two concentric series of twelve bobbins each.

Under these conditions, the outside crown having a greater velocity than the inside one, the inductive actions are more energetic in the former. M. Cance has got rid of this inconvenience by increasing the surface of the magnetic field of the inside bobbins. By this arrangement, the induced currents are velocity-equal in the two series of bobbins, for what is lost by low velocity is made up for by a more intense magnetic field.

We should point out an arrangement of the brushes which allows of the instantaneous change of their position according to the velocity, and which gets rid almost completely of the extra current sparks; the collector is placed outside the frame, it is thus independent of all the other pieces, and can be easily altered or replaced. The same system allows of the easy construction of machines with alternate currents which produce powerful effects within a very small space; this is another idea of the inventor.

In an experiment at which we assisted, the machine turning at the rate of 1,100 turns per minute, a current of 20 webers was give out, measured by a Siemens and Halske dynamometer, and through a resistance formed of 200 metres of cable and a Serrin regulator, giving an arc of 3 millimetres in length with minute carbons 9 millimetres thick.

These results represent, almost exactly, the results furnished by a Gramme machine, workshop type, turning with the same velocity.

The machine of M. Cance does not occupy a greater bulk, it employs the same quantity of copper and has a total weight a little less; the coiling of the bobbins, their fixing on the axle, and their replacement, is effected with the greatest ease; it can therefore be used in the place of the Gramme machine in all the applications of electricity, such as the electric light, the transmission of power, &c., if its inventor can bring it out at a low price, the sole factor which has any decisive influence in the development of the applications of electricity.—*La Lumière Électrique.*

Telegraph Journal Oct 15 1880

Fig 2

Nous ferons remarquer seulement qu'on peut faire rentrer dans cette catégorie d'appareils les horloges électriques, les compteurs électro-chronométriques, les régulateurs électriques d'horloges, Effectivement, dans ces appareils, un courant électrique émis à intervalles à des intervalles de temps périodiques, agit sur des électro-aimants dont le noyau produit alors un effet mécanique direct ou transformé à l'aide de bielles, manivelles, tiges guidées, cliquets et rouages...

E. MICHAUDIE.

(A suivre.)

D'ÉNERGIE

6e article (voir les 1er, 15 mai, 1er juin, 15 juillet, 15 août et 15 septembre).

2° *Mouvements longitudinaux.*

Les courants intermittents réguliers à périodes égales portent en outre produire des mouvements vibratoires longitudinaux dans les noyaux d'électro-aimants.

Le fait a été observé pour la première fois par M. Page en 1837, et étudié successivement par Delezenne, de la Rive, Beatson, Marrian et Gaugain.

De la Rive en a le premier donné l'explication par les mouvements moléculaires déterminés par l'aimantation. Le courant tend à disposer les molécules en files longitudinales, et celles-ci reviennent à leur position d'équilibre en vertu de leur élasticité.

D'après cette théorie confirmée d'ailleurs par l'expérience, les sons sont d'autant plus intenses que le fer est plus doux; les mouvements moléculaires y étant aussi d'autant plus faciles.

On comprend aussi pourquoi une tension exagérée qui diminue la mobilité des molécules, diminue l'intensité des sons, et pourquoi, lorsque le fil ou le noyau sont aimantés d'une manière continue, un courant intermittent y détermine des sons plus ou moins intenses suivant qu'il produit une diminution de sens contraire ou de même sens que l'aimantation préalable.

Les sons longitudinaux sont d'ailleurs accompagnés de sons transversaux dont les expériences de Wertheim ont donné l'explication.

Le téléphone de Reiss repose précisément sur ces faits.

C'est, en effet, un transmetteur de courants intermittents produits par une membrane animée d'un style métallique (analogue au phonautographe de Scott), qui produit les intermittences. Les courants intermittents arrivent dans un récepteur qui n'est autre qu'un fil de fer entouré d'une hélice tendue sur une caisse renforçante, et constituant ainsi une sorte d'électro-aimant particulier.

On fait ainsi reproduire au fil des sons longitudinaux identiques à ceux qui font vibrer la membrane du transmetteur.

On obtiendrait de cette manière aussi facilement des sons musicaux proprement dits, et même les sons complexes provenant de la parole articulée.

Le récepteur du téléphone de M. Ader, décrit dans ce journal (1880, p. 273), repose sur les mêmes principes, car sous l'influence des courants ondulatoires d'un transmetteur

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—NO. 186.

A NEW ERA IN PUBLIC LIGHTING.

INVENTORS are still working hard to perfect or invent dynamo machines and electric lamps, indeed it seems that at the present time this branch of electrical science is receiving more attention than all the other portions combined.

It is doubtful if much improvement is possible on the well known machines already in the market, unless, indeed, some great discoveries should indicate an entirely fresh direction to thinkers in that field of investigation, but this seems hardly possible.

A good lamp, simple yet effective, durable yet economical to manufacture, is, we believe, still a desideratum; but both machines and lamps are for most practical purposes sufficiently good for the electric light to have made much more rapid advancement than it can be said yet to have done.

Why then is the development progressing so slowly? The reason, we think, is partly, perhaps largely, to be accounted for by the fact that hitherto most individuals or firms desiring to use the electric light have found that to obtain the necessary plant entailed too extensive an addition to capital expenditure. And this, particularly as the advantage of the light, in point of *general economy*, when used on such a scale as for warerooms, &c., is still held by some to be doubtful. If an instance were wanting to prove the pecuniary advantage when the electric arc is largely used, we might quote Mr. Swan's words in speaking before the Literary and Philosophical Society at Newcastle. That gentleman said that, at the Alexandra Palace two thousand gas lights, costing twenty-six shillings per hour, had been replaced by six electric lamps, costing only six shillings per hour.

What undoubtedly is now wanted is the central system for the supply of the electric current in large or small quantities; and this supply obtainable on analogous terms to those required for a supply of gas. If every one wishing to use gas were obliged to purchase the necessary plant for so doing, and superintend the working thereof, we think his ardour in that direction would be considerably damped, and most probably some other method of lighting ultimately adopted. It is with satisfaction then that we note that the central system is engaging the attention of two or three most influential firms on this side the Atlantic, and we also read that one of the companies in America interested in the Brush light is about projecting a similar system there. When once a success is scored the adoption of the electric light will progress with more and more marked rapidity. The public will be satisfied with the increased light or greater economy, and those who invest their capital in electric light shares, will, we believe, have no reason to be dissatisfied with their profits.

HEINRICHS' NEW RING ARMATURE AND THEORY OF THE GENERATION OF ELECTRIC CURRENT IN A RING ARMATURE.

A further improvement on the Pacinotti* ring armature has been made by Mr. Charles F. Heinrichs, the inventor of the electric lamps with circular carbon pencils.† As this improvement is of an important nature, and possesses very promising features, we shall fully describe its principle and advantages.

Mr. Heinrichs was led to devise the new form of armature through a close study of those of the existing forms, and by observing the manner in which the electric currents are generated in them; by this he formed a theory as to the action which the soft iron ring takes in the generation of electric currents in its surrounding insulated conducting-wire. Of this theory we shall make use in this article, with Mr. Heinrichs' permission. We shall have to refer to other already known ring armatures which are improvements on the Pacinotti ring, and we shall have also to draw comparison between those and the new one of Mr. Heinrichs, without which we could not well describe its merits and features. Several theories have been advanced, to explain the part which the soft iron ring plays in the generation of electric currents in the armature, but we have not yet seen an entirely satisfactory explanation of the action which the soft iron ring takes when in motion.

M. Antoine Breguet explains the action of the soft iron ring in his small pamphlet, "La Machine de Gramme," and part of his explanations are confirmed by Mr. Heinrichs' theory, as we shall see later on; but we think Mr. Heinrichs has gone a good deal further, and has not only endeavoured to discover the disadvantages of the existing armatures, but also constructed a form of the latter on which he overcomes those disadvantages in a satisfactory and simple manner.

It is well known that when a piece of soft iron is brought within the sphere of the coils close to a magnet (fig. 1) this piece of soft iron will become also a magnet, and the one end nearest to the magnet acquires south polarity and the other end north polarity. In the middle of the piece of soft iron a neutral line, *l l*, will be established, and if the piece of soft iron were surrounded with insulated conducting-wire, a current would be set up or generated in the entire length of the wire *in one direction*. As is well

* See *Telegraphic Journal*, vol. vii., p. 197.
† See *Telegraphic Journal*, vol. viii., p. 321.

Journ. Tel. Oct. 16, 1880

Telegraphic Journal

Electricity from River Currents.

As inventor of this city proposes to utilize the swift current of rivers by systems of anchored floats carrying current wheels connected with electro-dynamic machines. The electricity thus generated might be conveyed to factories on the shores and set to work by means of electro-motors; or it might be used for lighting towns, or even for running trains on railways.—*Scientific American.*

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courants induits qui se développent, non plus dans les bobines, puisque celles-ci sont en circuit ouvert, mais dans les aimants et même dans les noyaux de fer eux-mêmes, une partie des masses de fer, quelque précaution que l'on ait prise pour les diviser longitudinalement comme c'est d'usage.

On peut facilement reproduire cette expérience avec l'appareil suivant : une aiguille de boussole est suspendue, par un fil non-tors, entre deux masses de fer placées chacune en regard d'un des pôles de l'aiguille. Si alors on laisse le fil se détordre, on observe que la rotation de l'aiguille est plus ou moins rapide suivant que l'on met ou que l'on retire les masses de fer.

Le fait si remarquable de la production des aimants qui a été observé dans le fonctionnement de toutes les machines dynamo-électriques, tient évidemment à ces causes.

Aussi nous avons persuadons de recommander aux constructeurs de tes sortes de machines d'employer précédemment, malgré l'usage reçu du contraire, des masses de fer doux massives, et surtout d'isoler, et autant que possible de section circulaire, pour y faciliter le développement des courants induits, les aimants soient d'abord moins puissants que sous la forme lamée, mais le pense que, par le fait de la démonstration, ils les dépasseront promptement. Les noyaux de fer des bobines, en particulier, devraient se le composer, être traversés le plus possible, car les courants induits qui s'y développeraient, feraient écran à ceux de l'hélice.

L. PALLET.

FAITS DIVERS

Le journal la *Lumière électrique* en fait un plus grand cas. Il les suivra, pleins de bienveillance, les connaîtra souvent quelques lignes, vaut pour le savoir, non pour reproduire ses sentences, soit pour les soumettre quelques années. Voici ce qu'il dit de *Physical Review* au numéro de mai 1880 :

« Nous voyons avec plaisir que notre estimé confrère la *Lumière électrique* de Paris prend sa place parmi des publications les plus diverses consacrées exclusivement ou intimement supplément, c'est une revue mensuelle scientifique, et, comme notre confrère scientifique de Londres, *Lightning review*, *The Telegraphic Journal*, elle donne aux études de ses numéros des dimensions bien suffisantes. Elle s'est donnée le rétrait pour but d'encourager à ses lecteurs, dans des articles écrits avec lucidité, et par des gravures de grand prix, tous les perfectionnements et toutes les expériences qui se rattachent à notre science particulière — bien que particulier aussi ne soit pas trop d'abord — et comme nous de la télégraphie qui se rattache intimement à nos études, elle honore ses relations réciproques de la progrès de la science électrique. »

Progrès de l'éclairage électrique.

On vient d'inaugurer à Schaerbeek l'éclairage électrique du Jardin Royal Albert. Dans la première fois, dit le *Bruxelles*, que ce système reçoit d'éclairage a été appliqué sur une aussi vaste échelle. Depuis plusieurs mois d'essais ont lieu.

Trente lampes à foyer libre, placées dans l'intérieur du jardin, à une hauteur de soixante mètres au moins du sol.

Les vingt-six lampes sont disposées par petits groupes ou statuts de globes-verres, éclairages entre elles à des distances variant entre 125 et 200 mètres.

Chaque groupe se compose de huit machines Siemens, mues par une machine Siemens de la force de 30 chevaux.

La transmission du courant est effectuée au moyen par des fils recouverts aux poteaux télégraphiques, et, en partie, par des fils souterrains. La grosseur des fils en fer oblige cette même la distance qui sépare les lampes du foyer générateur. Ils sont figés, en effet, en cuivre qui est nécessité de laisser pour toutes les lampes. Les charbons sont aussi grands pour durer une heure. Cette fragmentation générale est combinée de façon que l'on puisse, au besoin, développer la puissance éclairé dans une proportion considérable. Les groupes de générateurs pourraient atteindre à demeure 2,000 et lampes, soit en tout 500.

Le jardin Royal Albert est actuellement éclairage avec deux à Schaerbeek un grand nombre d'amateurs et de curieux. Le spectacle était magnifique. Par un temps gaster humid, qui a fait remarcir la puissance de nouvel éclairage, une brume épaisse s'est formée pendant l'illumination, et on a pu juger par là des services que la lumière électrique est capable de rendre dans les mauvais temps. Rien que soumis par le brouillard les lampes n'en ont pas

CORRESPONDENCE.

TELEDYNAMICS.

TO THE EDITOR OF THE ELECTRICIAN.,,

SIR,—I have not by me Peclet's "Traitée on Heat" by which to verify Mr. Paget Higgs's figures relating to the number of calories which an iron wire might lose when heated to a temperature of 98 degs., and submitted to an atmosphere of 18°C. I believe, however, in the first place that these figures are considerably exaggerated, and in the next, that a telegraph wire of No. 8 B.W.G. could not be practically utilised for transporting motive power to a distance, by causing it to be traversed, as indicated by Mr. Paget Higgs, by a current of 200 webers.

In fact, a current of 200 webers, traversing a wire 1,000 feet long, with a resistance of 3 ohms, will represent, per second a total expended energy which may be expressed in kilogrammetres by the formula,

$$W = \frac{Q^2 R}{2 g 1} \text{ kilogrammetres per second.}$$

$$W = \frac{(200)^2 \times 3}{2 g 1} = 37402 \text{ kilogrammetres.}$$

That is to say, an energy in *horse-power* of $\frac{37402}{75}$ or 498·5 horse-power expended in the conductor in the form of heat in order to carry the motive power 200 metres (1,000 feet in distance). Thus, whilst the wire No. 8 B.W.G. might have been traversed by a current of 200 webers, *"with perfect safety and without appreciable heating effect,"* the loss which I indicate points out sufficiently that it would be of no interest to attempt practically such a mode of transmission.—Yours, &c.,

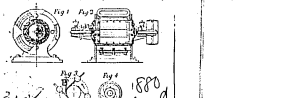
F. HOSPITALIER.

Nov. 14, 1880.

Journ. Tel. Oct. 16, 1880

LAW OF ELECTRO-MAGNETIC MACHINES.—Recent investigations by M. Joubert have shown that the retardation is equal to one-eighth of the entire period. The intensity is constant and equal to the quotient by 8/7 of the absolute maximum of intensity. The electro-magnetic work is proportional to the square of $\frac{7}{8}$. The $\frac{49}{64}$ is $\frac{3}{4}$ nearly, so the resistance $\frac{3}{4}$.

1880. Dynamo-Electric Machines: E. P. Alexander, London. (*Mech. Engineering, Architect, &c.*, 6 pp., 2 figs.) Relates to a dynamo-electric machine for producing currents of great power. For this purpose a cylindrical armature wound longitudinally is employed, and the field magnets are arranged in a star-shape electro-magnet, consisting of six bars (fig. 1) and over each one of the electro-magnets with coils of insulated wire, so as to form six poles. The armature (fig. 2) consists of a hollow cylinder, pierced with longitudinal holes, through which the wire is passed. The coils of the armature are wound in the form of rectangles lying their long sides parallel to the axis. The middle coil of each being such that the two sides are at the same time approaching and receding from the poles. The ends of the coils are connected to the commutator, in such a manner that the currents in each of the



Engineering

bars, are all in the same direction. The current is led to and from the armature by a wire wound round a cylinder of non-magnetic material. The ends are collected by brushes, which bear on the ends of the bars. In order to prevent the passage of induced currents from one bar to the other, through the iron of the armature, the latter is made in sections, these being insulated from each other by a paper wire which is extends from the iron in such a manner as to keep perpendicular against the commutator. The armature is made to revolve between the poles of the field magnets. The claim is made for the invention of a dynamo-electric machine having the new features. The patentee without further reference will show the disposition of the various parts. Drgs. 11, Desc.

autre exigence à satisfaire, surtout s'il s'agit de machines électriques.

Dans les machines électriques, où il y a de nouveaux progrès et de nouvelles dispositions réalisés tous les jours, l'expérimentateur se trouve assez souvent en présence d'un fait intéressant, de quelque chose qui, au premier coup d'œil, paraît être impossible. Alors la première question qu'il pose est toujours : N'y a-t-il pas de changements dans les instruments? Il est donc nécessaire qu'un possède des méthodes directes et simples pour vérifier les constantes de ces instruments.

Pour mesurer l'intensité du courant nous employons, dans l'établissement de Siemens et Halske, des électro-dynamomètres, dont la constante reste égale pendant des années; la vérification de cette constante n'est donc guère nécessaire. La détermination de cette constante se fait par le *poids de cuivre* déposé par le courant.

Mais, outre l'intensité du courant, il faut mesurer des tensions, comme j'ai montré dans l'article mentionné par M. Hospitalier; dans ce but nous avons construit un instrument qui indique directement les différences de tension.

Comme il y a un aimant dans cet instrument, la constante pourrait subir de légers changements, surtout si l'instrument ne se trouve pas très-loin des machines électriques; dans ce cas, on détermine la constante, il nous faut un moyen aussi simple que possible. Ce moyen consiste à relier l'instrument à une batterie de quelques éléments Daniell, lesquels avec précision; cette détermination se fait en quelques minutes.

Nachdem nun Siemens und ich auf eine solche Experiences, que si l'on procède de cette manière, la constante de l'instrument se détermine avec une exactitude de 1 pour 100, au moins, et que la force électromotrice de nos éléments Daniell est telle que le courant 1, $\frac{\text{Daniell}}{\text{U. Siemens}}$ donne 1,38 *gram. de cuivre* par heure. Comme c'est par cette *quantité de cuivre* déposée par le courant et par *l'unité Siemens* que notre « Daniell » est défini, il est facile de convertir toutes les intensités de courant en webers anglais.

De cette manière, quoique par principe nous adoptions le système des unités de la British Association, nous sommes forcé par les circonstances à employer d'autres unités en attendant le développement ultérieur du système.

C. Frolich.

Nous reconnaissons volontiers notre erreur au sujet des unités électriques, et nous sommes loin de la regretter, puisqu'elle nous a valu l'intéressante rectification qu'on vient de lire.

Cette erreur provient d'une mauvaise interprétation du texte allemand — assez confus d'ailleurs, — par notre traducteur, encore peu habitué à la terminologie scientifique.

Les conclusions de notre article du n° 14 n'en sont pas moins exactes pour cela et la confusion encore plus grande, M. Frolich reconnaît qu'il existe deux webers, un weber allemand et un weber anglais; nous prenons bonne note de cet aveu, notre article n'ayant pas eu d'autre but que de signaler cet inconvénient et de faire appel aux bons offices de la science pour le faire cesser.

M. Frolich donne pour la valeur de l'unité $\frac{\text{Daniell}}{\text{U. Siem.}}$ la valeur suivante :

$$1.\ \frac{\text{Daniell}}{\text{U. Siemens}} = 1{,}17 \text{ webers anglais.}$$

Si nous prenons la valeur de l'élément Daniell en volts et celle de l'unité Siemens en ohms, en adoptant les chiffres de M. Latimer-Clark (*Electrical tables et for*, nous trouvons que l'unité adoptée par M. Frolich a pour valeur.

$$1.\ \frac{\text{Daniell}}{\text{U. Siemens}} = \frac{1{,}079}{0{,}9176} = 1{,}113 \text{ webers anglais.}$$

Il y a donc *des centièmes* de différence entre la valeur donnée par M. Frolich et celle qui résulte des chiffres de M. Latimer-Clark.

En prenant pour la force électromotrice de l'élément Daniell la valeur donnée par sir W. Thomson (1,12 volts), on trouve 1,17 comme l'indique M. Frolich pour la valeur, en webers, de l'unité $\frac{\text{Daniell}}{\text{U. Siemens}}$.

En prenant le chiffre de M. Kohlrausch (*Annales de Poggendorf*, 1872) : Daniell = 1,138 volts, on arrive à 1,19 webers anglais.

Enfin, avec les chiffres du professeur G. C. Foster, (*Report*, page 113), 1 Daniell = 1,116, la valeur de l'unité $\frac{\text{Daniell}}{\text{U. Siemens}}$ = 1,212 webers.

L'unité adoptée est pratique par M. Frolich présente certainement de la simplicité, elle est d'une réalisation toujours facile, et les résultats sont *comparables entre eux*. Nous lui reprochons seulement d'être une unité arbitraire dont la liaison au système des unités absolues est assez mal définie, puisque la valeur de l'élément Daniell en volts varie, suivant les auteurs, entre 1,079 et 1,116, ce qui fait varier la valeur de l'unité d'intensité *pratique* entre 1,11 et 1,21 webers anglais.

Le chiffre de M. Frolich est une moyenne entre les valeurs extrêmes qui diffèrent entre elles de un *dixième* de leur valeur absolue.

Ces chiffres suffisent pour montrer combien nous avions *raison* de demander *de l'unité dans les unités*. ✱

E. Hospitalier.

LES MACHINES D'INDUCTION AMÉRICAINES

Il y a en Amérique, tout bien compté, une demi-douzaine de machines électro-dynamiques qui ont donné quelques résultats pratiques, mais deux systèmes seulement se disputent sérieusement le champ des applications à la lumière électrique; ce sont les machines Brush et Wallace-

de polarisation déterminés au sein des corps médiocrement conducteurs, et on verra combien les phénomènes ainsi produits sont curieux et variés. Ils pourront évidemment un jour contribuer puissamment à éclairer le usage obscur qui nous cache encore la nature de l'électricité.

Th. du Moncel.

(A suivre.)

DES LOCOMOTIVES ÉLECTRIQUES

2e article (voir le numéro du 15 octobre).

Les avantages du mode de traction électrique pour les tramways sur l'emploi des chevaux, sont les suivants :

1° Économie résultant de ce que les moteurs électriques atteignant facilement un rendement de 0,50 (qui est celui du travail maximum), il sera possible, en employant pour faire mouvoir les générateurs de courant, des machines économiques consommant moins de 1 kilogramme de charbon par cheval et par heure, de réduire la dépense de combustible à 9,50 par tonne brute et par kilomètre. En admettant qu'une voiture chargée pèse en moyenne 7 tonnes et fasse 100 kilomètres par jour, et que le prix du charbon soit de 35 francs par tonne, on voit que la dépense de charbon serait inférieure à 2 fr. 50 cent. par jour et par voiture, chiffre très-inférieur à celui de la nourriture des chevaux qui font le même travail. Il est à peine nécessaire de dire que je suppose le moteur électrique monté sur la voiture même, de façon à réduire le poids mort au minimum.

2° Le moteur électrique est incontestablement le plus simple de tous les moteurs connus. Il ne comporte aucun autre organe que les balais qui amènent le courant. On pourrait dire que c'est un arbre armé de la propriété de tourner quand on y lance un courant électrique. Par suite, il peut être confié au mancuvre le plus ignorant auquel il suffit d'indiquer le moyen de rompre ou de fermer le circuit.

3° Il présente tous les avantages des appareils à air comprimé, à cau chaude et à gaz d'éclairage comprimé, puisqu'il permet comme eux d'utiliser dans un locomoteur le travail développé par une machine fixe, tout en ayant sur eux une immense supériorité au point de vue du volume et de la simplicité de construction.

Ces brillantes qualités avaient, dans un avenir peu éloigné, le monopole de la traction des tramways au moteur électrique, lorsque la question de distribution du courant sera résolue, ce qui — je puis l'affirmer d'après mes recherches personnelles — ne saurait tarder beaucoup.

Application de la locomotive électrique au transport des lettres. Dans un article paru il y a quelque mois dans ce recueil, M. Hospitalier décrivait un projet de poste électrique de MM. Siemens. Or, au mois d'août de l'année dernière (1878), M. Dumpelmyer, ingénieur des lignes télégraphiques, avait conçu l'idée de substituer la traction électrique à l'emploi de l'air comprimé qui sert au transport des dépêches dans les tubes pneumatiques. Les motifs sur lesquels il s'appuyait pour proposer cette substitution découlent naturellement des recherches expérimentales qu'il a poursuivies pendant plus sieurs années sur le travail absorbé par l'exploitation des réseau de tubes pneumatiques de la ville de Paris. Il résulte de ces recherches, que, si de tous les modes de transport l'emploi des tubes pneumatiques est le plus commode, il est aussi de beaucoup le plus coûteux, sans que ce prix de revient excessif soit compensé par une rapidité exceptionnelle. La vitesse *moyenne* des petites véhicules circulant dans les tubes, n'est en effet que de 25 à 30 kilomètres à l'heure, à peine la vitesse des trains de marchandises sur les chemins de fer, et cependant l'effort exercé sur eux est égal à près de trois fois leur poids! Ce désastreux résultat est dû, comme l'a démontré M. Bontemps, à ce que presque toute la force motrice développée est employée à vaincre les frottements de la colonne d'air qui remplit les tubes, tandis que les frottements propres aux véhicules on *curseurs* qui portent les dépêches sont presque insignifiants. Cette résistance, développée par le mouvement d'une colonne d'air dans un tube, croît avec la longueur, et si cette dernière atteignait 15 à 20 kilomètres, par exemple, l'emploi de ce mode de propulsion deviendrait absolument impraticable, à moins qu'on n'employât une disposition ingénieuse dont l'idée est due aussi, je crois, à M. Bontemps et à laquelle il a donné le nom de *relais pneumatique*.

Ces considérations montrent que l'emploi d'une locomotive électrique à laquelle le courant serait fourni par une machine d'induction, présenterait pour ce genre d'application une supériorité très-considérable sur les tubes pneumatiques, même quand le rendement du moteur atteindrait à peine 0,20 à 0,25 du travail absorbé par la machine génératrice. Il faut remarquer, toutefois, que cette supériorité de la locomotive électrique consistait d'existence en détail mauvoir cette dernière dans un tube d'une section peu différente de la sienne propre, parce qu'elle aurait alors à refouler devant elle une colonne d'air qui, d'après les expériences citées plus haut, absorberait aussi très-considérable. Aussi, dans l'opinion de M. Bontemps, les petits chemins de fer destinés à la circulation des locomotives électriques devraient-ils être installés dans les galeries d'égout.

Supposons maintenant qu'une locomotive électrique pèse 15 kilogrammes avec ses dépêches, et qu'elle marche à la vitesse de 6 mètres par seconde sur une voie dont l'inclinaison ne dépasse pas 0,03, et que sur un réseau de 70 kilomètres de développement, tel que celui de Paris, on lance un véhicule toutes les cinq minutes : le nombre total de véhicules en mouvement, à un instant donné, sera de : $\frac{70000}{5 \times 60 \times 1} = 39$, ou environ 40. Le travail absorbé par chacun d'eux sera (en admettant que le coefficient de traction sur niveau égal à $\frac{1}{100}$,1 par seconde, *en remontant la rampe de 0,030*, et le travail total développé par les 40 véhicules sera de 216 km par seconde, soit moins de 3 chevaux. Il sera même certainement moindre,

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Journal Telegraphique

The problem of the electrical transmission of power to a distance has given a considerable impetus to the invention of electric motors. The interchangeability of the electric generator and the electric motor is generally known to be important. Indeed, in almost all the experiments made on a large scale to utilize the principle of the electric transmission of power, the motor and generator have been identical in construction. It seems to be admitted, however, that in several points the motor should differ from the generator, if the highest percentage of efficiency is to be obtained. In other words, the best generator does not necessarily form the best motor.

The tendency in most cases is to go back to the form of motors which were designed scientifically many years ago. The motors of Trouve, Wiesenhanger and others—the peculiar feature of which consists in the shaping of the armatures and inductors in such a way that the approach of the two together is gradual—were anticipated at least thirty years ago by the late Sir Charles Wheatstone, who invented and constructed several machines on this principle. Those we believe may be seen in the museum of Kings College, London, amongst the collection of that prolific inventor.

That there is a good field for invention in the direction of electric motors can hardly admit of doubt, as their employment is likely to be considerable at no very distant date. At present the experimental models have been but fitful, though we believe that many are working quietly at the subject.—*The Telegraphic Journal.*

Engineering, Nov. 25, 1881.

ELECTRIC POWER.

The electric tramway which Dr. Werner Siemens has constructed in Berlin, between the suburb of Lichterfelde and the Lichterfelde station, is now regularly opened for passengers, and is giving great satisfaction. The rails are of the common railway pattern, but the gauge is only 3 ft. 3 in. A single car is propelled by the current at an average speed of nine miles an hour, though this rate can be doubled if necessary. A similar line has been erected at the Crystal Palace, Sydenham, as an attraction for visitors, but it is probable that electric tramways will be practically introduced into this country before many years are past. Velocipedes are now so common that it is not surprising to find that electricity has been applied to their propulsion. M. Trouvé, the well known French electrician, recently drove an English tricycle through the streets of Paris by means of electricity. In a Plantè secondary battery and a pair of Dupuy electric motors. The tricycle with its companion apparatus weighed 4 cwt., and went at the speed of an ordinary cab; but with some modification of the apparatus, M. Trouvé hopes to attain a rate of 12 or 15 miles an hour. The new accumulator battery of M. Faure will also help his purpose, and we may anticipate that velocipedes driven by electric power will by and by prove useful to the invalided or weakly. In Paris, too, electricity has been applied to work an air compressor at the top balloon factory of M. M. Chanchard et Cie, behind the Hotel du Louvre. The spare steam power of the engines has been utilized by two Gramme machines, one of which generates the current and the other transfers it into mechanical work. The energy thus transmitted is about a horse-power per minute.—*Engineering.*

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Journ. Tel. Jour. 1, 1881

Electro-Dynamic Paradox.

M. GERARD-LESCUYER has discovered a novel phenomenon, by so doing the current produced by a dynamo-electric machine into a magneto-electric machine. As soon as the current is closed the magneto-electric machine begins to move; it tends to take a velocity proportioned to the intensity of the originating currents, but it soon moves more slowly, stops, and turns in the opposite direction, going through a similar series of changes and returning to the first direction. This regular alternation of movement continues as long as the originating current is in action. In trying the experiments a Siemens' dynamo-electric machine, with continuous currents was used as the generator. The receiver was a small Jaboulay Gramme machine, with an ordinary permanent magnet, constructed by M. Breguet.—*Comptes Rendus.*

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1880.

1383. "Dynamo or magneto-electric machines and electric motors." THOMAS ALVA EDISON. Dated April 5. 6d. Relates to the rotating armatures, the arrangement of the commutator brushes or contacts, and the shaft of the rotating armature and commutator, which are applicable to both dynamo or magneto-electric machines and to electric motors. Fourteen figures illustrated. The armature core is built up of rings slightly conical in form, each ring being insulated from each other. The brushes or springs are set at an angle of about 45° to the axis of the commutator. When a brush or contact current is required it is done at several points simultaneously, so that the spark at the rupture is spread over several points, and does not burn up the contacts.

SUR LES ÉLECTRO-AIMANTS

CONSIDÉRÉS COMME ORGANES DE TRANSFORMATION D'ÉNERGIE

Par M. [illegible]

III

TRANSFORMATION ÉLECTRIQUE, PAR L'INTERMÉDIAIRE DU CHAMP MAGNÉTIQUE, D'UNE FORCE MÉCANIQUE EN ÉNERGIE ÉLECTRIQUE.

L'emploi des électro-aimants pour produire cette transformation, est un des plus remarquables qui puissent être imaginés: elle est caractérisée par la présence d'un champ magnétique dans lequel se meuvent les organes de transformation.

Ce champ peut être produit de deux façons; par des aimants ou par des électro-aimants, d'où résultent deux catégories d'appareils et une division toute naturelle de ce nouveau chapitre de notre classification.

Quoi qu'il en soit, l'énergie électrique produite se manifeste toujours sous la forme à laquelle on donne le nom de

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courants induits, dont la constitution intime est encore inconnue, mais qui présentent cet caractère général de n'exister que pendant un temps extrêmement court, avec une intensité rapidement variable, et de changer de sens suivant le sens de la variation du mouvement des organes de transformation de l'énergie mécanique employée.

Deux cas. — *Champ magnétique produit par des aimants permanents, fixes ou mobiles.*

[A]. — *Production de courants intermittents ou oblitérés.*

Les appareils qui servent à produire des courants interrompus ou continus par transformation de mouvements produits dans un champ magnétique d'aimants permanents sont tellement connus des lecteurs de ce journal, qu'il me suffira de signaler les plus remarquables.

En effet, c'est la catégorie d'instruments dans lesquels les machines de Pixii, de Saxton, de Clarke, de Nollet et de l'*Alliance*, les premières machines magnéto-électriques de Wilde, de Gramme, de Siemens proprement dites ou modifiées récemment par M. Deprez... etc.

On les appelle ordinairement machines *magnéto-électriques*, mais il est certain que le mot *électrique* est inutile, étant entendu que ces machines sont des appareils destinés à produire de l'électricité. Le mot *magnétique* caractérisera la nature de l'inducteur.

On sait que ces machines, qui ont toutes été décrites dans ce Journal, produisent en général des courants électriques intermittents de sens contraire ou *alternés*, mais qu'on peut *redresser* ou rendre *continus* à l'aide de commutateurs dont la forme est bien connue. La machine Gramme produit en réalité directement à l'aide de ses collecteurs de courant plusieurs courants continus.

[B]. — *Production de courants des oscillations électriques d'intensité périodiquement variable.*

Les appareils destinés à produire cette trans-formation ne sont pas moins connus que les précédents.

Ce sont, par exemple, les transmetteurs téléphoniques...pile Graham Bell, etc., dont les plaques vibrantes sont mises en vibration à l'aides de sons musicaux ou des ondes aériennes complexes qui caractérisent la parole humaine.

Il est bien entendu que je n'ai pas à les décrire ici.

Je me contente de faire remarquer le rapprochement des instruments de ce genre des machines précédentes. Effectivement, *au fond*, ils ne diffèrent les uns des autres que par le mode de mouvement des organes, vibratoire pour ces derniers, circulaire pour les autres.

Il en résulte que dans l'essai de classification rationnelle que je donnerai plus loin comme résumé de ce chapitre, les téléphones G. Bell, Gower,... doivent être rapprochés des machines qu'on nomme aujourd'hui magnéto-électriques.

DEUXIÈME CAS. — *Champ magnétique produit par des électro-aimants, fixes ou mobiles.*

Les appareils qui produisent la transformation d'énergie mécanique en électricité sous l'influence d'un *électro-aimant inducteur* sont représentés par les transmetteurs téléphoniques sans pile dont je viens de parler, par les machines très-importantes, et dont le nombre s'accroît tous les jours, de façon qu'un essai de classification, permettant de reconnaître dans ces variétés d'une même famille, ne paraît pas inutile.

On a donné à ces machines le nom de *dynamo-électriques*... Ce nom ne me paraît pas bien choisi, et, avant que l'usage ne s'en répande tout à fait, peut être vaudrait-il mieux le changer.

Le premier mérite d'un nom, en effet, lorsqu'il sert de base à une classification scientifique, n'est-il pas de représenter *exactement* la chose qu'il sert à nommer? Or le mot dynamo-électrique ne peut pas désigner clairement un appareil destiné à transformer l'énergie mécanique du mouvement en électricité; car le mot grec *dunamis* signifie *force* et non mouvement. Mieux vaut évidemment employer un mot dérivé de *kinema*, qui signifie mouvement, et d'un Ampère à dire *électrocinétique* et M. Thomson *électrique*, mots universellement employés aujourd'hui.

Je proposerais donc de substituer au nom de dynamo-électrique celui de *cinéto-électrique*, et d'appeler *transformateurs cinéto-électriques* tout instrument, appareil, ou machine, quels que soient ses organes mécaniques, susceptible de transformer de l'énergie mécanique en électricité.

Mais alors on a ainsi une dénomination très-générale qui s'applique à plusieurs groupes d'appareils ou de machines, on plutôt à plusieurs modes de transformation, et qui ne peut *caractériser* avec une précision suffisante des machines particulières comme celles dont nous parlons et qu'on nomme actuellement dynamo-électriques.

Effectivement, dans une classification complète, que je donnerai plus tard, je montrerai que les transformateurs *cinéto-électriques* forment 2 familles d'après la 1re ou la transformation *directe* et dont je n'ai pas à parler aujourd'hui, la 2e ou la transformation ne peut s'opérer que par l'intermédiaire d'une induction, d'un *champ d'induction*, qui peut d'ailleurs être produit : 1° par une masse d'électricité à l'état statique ou potentiel; 2° par un courant électrique constant ou continu; 3° par un aimant permanent (c'est le cas des machines dites actuellement magnéto-électriques); 4° par un électro-aimant (c'est le cas des machines dites actuellement dynamo-électriques).

De là 4 classes d'appareils caractérisés par la nature de l'inducteur ; mais je n'indiquerai dans le tableau ci-après que la classification relative aux deux dernières, les seules qui se rapportent au sujet général qui nous occupe en ce moment, c'est-à-dire l'utilisation des électro-aimants.

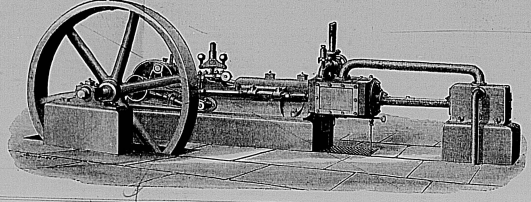
Dans cette manière de voir, une machine de Clarke serait une machine *cinéto-électrique* de 3e classe ou à *inducteur magnétique*, ou, en abrégeant, une machine *cinéto-électrique* : les nouvelles machines de Gramme à lumière seraient des machines *cinéto-électriques* de 4e classe ou *électro-magnétiques*. D'ailleurs, dans l'usage courant, on pourrait supprimer le mot cinéto-électrique et n'employer que les mots *magnétique* ou *électro-magnétique*.

Voici maintenant les bases de la classification dont le tableau synoptique est donné ci-après pour les transformateurs de 3e et de 4e classe.

HORIZONTAL CONDENSING ENGINE.

USED FOR DRIVING THE ELECTRIC LIGHTING MACHINERY AT THE ROYAL ALBERT DOCK.

BY MESSRS. MARSHALL, SONS AND CO.



passengers at 5.30 p.m. Steam of 150 lb. pressure and 150 revolutions per minute were steadily maintained all day, and, beyond the bearings requiring adjustment, the boat and machinery are, as we have said, none the worse for the four months' cruise. The directors of the Peninsula Company, preferring to leave the machinery in the exact condition in which it arrived in England, no attempt whatever was made to remove any of the evidences of wear and tear, thus giving those present the opportunity of judging for themselves of the practicability of working very highly pressure steam with economy. The *Andromache* is not only the smallest steamer that has ever steamed across the Atlantic, but is probably the only one of her size in England capable of performing such a feat. Her captain and crew are so satisfied with the working of the little vessel that they have expressed their willingness to take the *Andromache* either back again to America or to the most distant part of the world. When it is considered that the vessel is only 32 tons register, 70 tons gross, it must be admitted that she is a very extraordinary little craft, and has accomplished a remarkable feat in ocean steam navigation.

(To be continued from page 222.)

ENGINE FOR DRIVING ELECTRIC LIGHTING MACHINERY.

ON another page we have described the general arrangements for lighting the Royal Albert Dock by electricity, as carried out by Messrs. Siemens Bros. To drive the current-generating machinery there is in each of the four stations a horizontal condensing engine, with Cornish boiler, which were all supplied by Messrs. Marshall, Sons and Co., of Gainsborough. The accompanying engraving represents one of these four engines, which are all of the same type. They are of 30 horse-power nominal each, with 14-inch cylinders, and 24-inch stroke, running at 70 revolutions per minute. The flywheel is 14 feet in diameter, and the cylinders are steam-jacketed. Each engine is fitted with Messrs. Marshall's automatic expansion valve gear and jet condenser. The expansion gear consists of a sensitive and powerful governor, of novel construction, acting through a link and die on to an expansion cut-off valve working at the back of the main slide valve. The ordinary throttle valve is dispensed with, and the speed of the engine is controlled by means of the expansion valve, which regulates the admission of steam into the cylinder exactly in proportion to the duty performed by the engine. This gear is very simple and reliable in its action, automatically regulating the speed with very rapid fluctuations, and is adapted either for heavy or light work. The condensers are of improved construction, adapted for high speeds, the valves and seats are of brass, with Harbutt's india-rubber valves. The air-pump is connected direct to the tail end of the piston rods, and a distance piece is introduced between cylinder and condenser, ensuring speedy and accurate relative adjustment of these parts in erecting the engines. The arrangement of the foundations for the engines also reduces the work to the simplest character. The boilers are Cornish, multitubular type, each 15 feet 6 inches long, and 7 feet 8 inches in diameter, fitted with thirty-two tubes, each 4 inches in diameter. We need hardly say that the design and workmanship throughout are excellent, and that the engines

SPONTANEOUS COMBUSTION IN COAL CARGOES.

THREE weeks ago we considered it our duty to direct attention to some recent cases of spontaneous combustion in coal cargoes, and to offer a few remarks on the liability of coal cargoes in general, and Scotch coal cargoes in particular, to ignite without any apparent cause. We urged that greater precautions should be used in the shipment of these cargoes, in the interests not only of exporters and underwriters, but of our merchant service, whose lives are needlessly endangered. The subject having attracted considerable attention, and called forth the letter which appeared in our last issue from Professor Abel, one of the ablest and most active of the Royal Commissioners appointed in 1875 to inquire into the spontaneous combustion of coal in ships, we need not offer any apology for so soon returning to the subject, and for printing it in a more exhaustive manner. There is the less need for this, inasmuch as since our article appeared several fresh cases of spontaneous combustion have been reported, chiefly again in Scotch coal cargoes, thus adding force to our previous argument that the coal shipped north of the Tweed either contains so much more sulphur than other kinds, that it is more liable to generate combustion, or that less care is exercised than at the southern ports in its shipment.

In order to render clear our subsequent observations, we would in the first place remind our readers that five years ago, the present subject was attracting considerable attention, and a Royal Commission was moved for and appointed to inquire into the matter. The Commissioners consisted of the Right Hon. H. C. E. Childers (chairman); Sir George Elliot, Bart., Mr. H. H. Vivian, M.P.; Professor Abel, Dr. Percy, and Messrs. Richard Cory, George Duncan, John Fenwick, John Ferguson, Charles Healy, and Wm. Young. With the selection of these gentlemen we have no fault to find, but at the same time it will doubtless occur to those of our readers who are familiar with the subject, as it has occurred to us to say that the practical experience and knowledge, and the shrewd common sense of the popular member for the Cardigan Boroughs would have proved invaluable in the deliberations of the Commission. Be that as it may, the Commissioners duly met, patiently waded through a mass of written evidence, protests of captains, underwriters, and others to the communications or queries, reports, recommendations, and such-like; and carefully examined a large number of witnesses of greater or less experience. Copies of the papers, and of the evidence of the witnesses, along with the recommendations of the Commissioners, were published the following year, 1876, and although the evidence as reported contains a large proportion of what may be called table-talk,—several of the witnesses availing themselves of the opportunity to air coalfacts and even to cry up or damage the reputation of particular descriptions of coal,—there is no doubt the ponderous volume of 373 pages is well worth perusal, as it contains a vast amount of most useful and interesting information connected with the question under discussion.

The number of witnesses examined being over thirty, it would be impossible within the limits of an article to wholly separate the wheat from the chaff, or to review the evidence in full. We shall therefore content ourselves by directing attention to the evidence given by one of the most important witnesses, and then pass on to consider the Commissioners' report. Mr. Henry Johnson, McCulloch, consulting coal engineer to the Admiralty, stated that he had been connected with the coal trade for more than thirty years, and had had six or seven years' experience in shipping coal for the Government. In the course of his examination, after recommending a system sometimes practised in the north of England, and always at Cardiff at the commencement of the loading of each large vessel, namely, that of lowering coals into the holds of ships, to prevent unnecessary breakage; and also the use of smaller screens than was customary, with the same view, he said—

"The larger the coals the greater the value and the less danger there is from fire." He said he would not like to ship bituminous coal in the dry state, therefore more capable of excluding anything like air. The smaller coals are left between the pieces of coal, the better it is, and the more opportunity there is for the air to circulate round the coal. Of course it is the want of air, in my opinion, that causes the combustion."

He then gives evidence on the question of moisture, and its effect upon the coal:—

"Very often," he says, "I have seen coals put on board ship in a most slobbery way; that is to say, I have known the sides of the ship to be wet and damp, and sometimes I have known even water to be in the ship, quite apart from any moisture in the coals themselves; and my experience teaches me this, that if coals are even moist, much less damp, the bi-sulphide in the coals (because all coals have it, seeing perhaps the best part of South Wales, at the throttle coal) except that coal I know of no coal that is free from sulphur) becomes, through its oxidisation, turned into sulphide of iron by a natural process, and during that time, naturally, sufficient caloric is generated to cause combustion in the carbon of the coal."

Then with regard to ventilation, Mr. McCulloch said he did not think there were any ships that were ventilated, or, if there were, they were so badly ventilated that the ventilation was not worth speaking about. Lastly, as to the practice of double-screening, alongside ship, this witness says:—"I think it is obsolete." At least, I hope it is. It is obsolete as far as the Admiralty is concerned. I tried to stop that waste of coal (besides the cost of it, more per ton) very soon after I took office . . . It makes the coal worse and is expensive." Upon the foregoing we would remark that Mr. McCulloch's evidence appears to us to be of very great value, and worthy of the utmost attention, as does the question of coal being shipped as large and as free from moisture as possible, and the urgent necessity of having cutters properly ventilated." At the same time, we cannot but think his remark as to the "obsolete," or worthlessness, of ventilation in the vessels which came under his notice rather sweeping; for we know, and the appendix to the Commissioners' report proves, that many shipowners and masters have for a long time given this matter their most serious and anxious attention. Then, on the question of double screening, Mr. McCulloch, in our opinion, is mistaken, both in theory and fact, and it is hard to reconcile his remarks on that subject with his previous evidence as quoted by us. Moreover, we must express our extreme disappointment that this very important and well-known method of getting rid of the small coal did not receive from the Commissioners the attention it deserved. In fact, although they hovered round and round about it they appear to have practically

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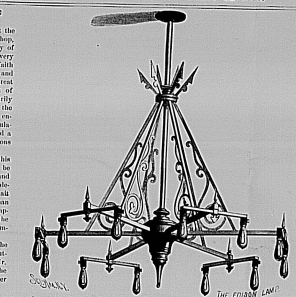
EDISON'S NEW DYNAMO-ELECTRIC MACHINE.

The remarkable activity prevailing at the Menlo Park laboratory and machine shop, and the evidences of the enormous outlay of capital which one sees at these works on every hand, are convincing proofs of the good faith and thorough earnestness of Mr. Edison and his co-laborers and supporters. The great work of perfecting a complete system of electric lighting in all its details is necessarily a very slow operation, for much more work may be urged, as time-tests of the endurance of lamps, perfection of the insulation of the underground conductors, and a hundred other time-consuming operations must, of necessity, be gone through with.

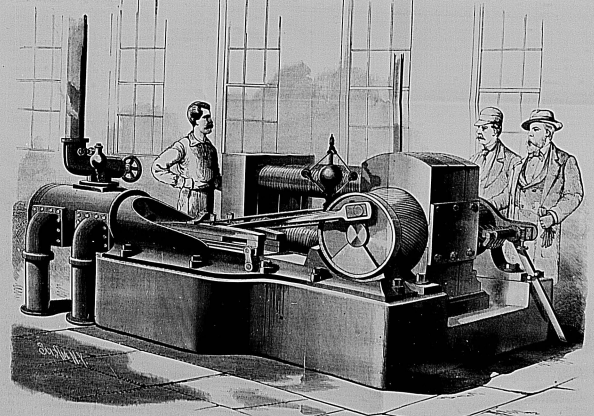
As it is Mr. Edison's determination that his system of electric illumination shall not be presented to the public until it is complete and commercially practicable to the smallest detail, he would be sorry, we can afford to wait patiently for the perfected thing, rather than be subjected to the trouble and possible disappointments attending the perfecting of the system while it is in public use, as is commonly the case with great inventions.

Besides carrying to a successful issue the grand experiment of illuminating a large out-of-door area with incandescent lamps, Mr. Edison has practically demonstrated that the highest economy in the conversion of power into electricity can be reached only by the use of very large machines, and by the direct application of the power to the armature without the intervention of belts or other means of transferring power.

Our engraving represents a gigantic dynamo electric machine approaching completion at Mr. Edison's machine shop, and designed to replace sixteen of the largest machines of this kind previously made. They name and the driving engine are both mounted on a massive cast-iron bed, 8½ by 7 feet and 2 feet deep, very heavy and strongly ribbed, the entire machine weighing 8 tons. Near the middle of the bed is mounted the dynamo electric machine, which, we believe, is the largest ever constructed. Its field magnets, three in number, are 6½ feet long. The armature is 2 feet 6 inches in diameter and 28 inches long, and weighs 1½ tons. The engine is 100 horse power, of the Porter-Allen type, built especially for this purpose at the Southwark Foundry, Philadelphia. Its stroke is 16 inches. The internal diameter of its cylinder is 9 inches. The crank disk is placed on the end of the armature shaft. Steam pressure, 120 lb. per square inch. The engine cuts off at one-fifth of the stroke and makes 600 revolutions per minute. The working pressure of the dynamo is 140 volts; the resistance of the armature is one two-hundredth of an ohm.



THE EDISON LAMP.



EDISON'S STEAM DYNAMO-ELECTRIC MACHINE.

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ntion that the Royal Albert Dock is an ex- of the Royal Victoria Dock at Canning Town, sists of an entrance dock at Galleons Reach, hed from the river between two open timber The entrance lock is 700 feet in length, and to a tidal basin, having a water area of 12 This basin again opens into the main basin, 6500 feet in length, 500 feet in width, and ter area of 72 acres. Attached to the main its western end and on its southern side are ving docks, one 410 feet and the other in length. The whole of this extensive area, about a mile and three-quarters in length, electrically lighted by 26 lamps on the system, the contract for the light- ng been entrusted to and carried out srs. Siemens Brothers. The lighting ment consists of four stations at which the current is generated, one station being n the north and another on the south side of basin, near its junction with the tidal basin, more in similar positions at the western end in basin. In each of these stations is a 20 wer (nominal) horizontal condensing engine, th its boiler has been supplied by Messrs. , Sons and Company, of Gainsborough. ine will be found described and illustrated her page.

paratus at each of the stations for generat- electric current consists of seven Siemens machines, which act as light-producers, and machine of the same kind, which is used citor. There are also the commutators and ppliances for measuring the currents. stations conductors are led to the 26 lamps, hich is placed on a latticed iron standard gh, and from which a very powerful light is The leading wires from the stations to the partly carried on telegraph poles and onveyed underground in the form of The distances between the lamps and the s vary from 120 to 1100 yards, and the of the leads has been selected with a view nsate as much as possible for this difference, to equalise the intensity of the lights. The have been arranged with a view to the tension of the light space, power being for supplying a total number of 24 lights station, or 192 lights in all. The lamps Siemens' regulators enclosed in weather- terns surmounted by circular white re- hich diffuse the rays of light well around. ons used are of sufficient length to give a 6 consecutive hours. Of the 26 lights two at the pier-heads, two on either side of ice lock, three around the tidal basin, while e distributed along the quays on either side n basin and between the graving docks. light will eventually be placed at the nd of the basin above a clock tower, which be erected. The lamps are so distributed re the best illumination at the dock gates bridges, and they afford sufficient light for the proper carrying on of the traffic quays and on the railways which traverse

the external lighting, an example of in- mination by electricity was also afforded ting of one of the sheds on the north side k by eight small lamps. These, with two ps in the Station No. 3, which is adjacent d, were supplied with the current from a ernative current machine and a small hich were placed in Station No. 3 and the engine there. This shed is 300 feet 120 feet wide, and was abundantly illumi- he eight lamps. It was to this shed that s were first conducted on alighting from in the docks, and there they found the and luggage from the *Garonne*, a fine elonging to the Orient line of steamers, had just arrived, and was the first vessel the aid of the electric light, her docking en successfully performed. The visitors

SING ENGINE.

INERY AT THE ROYAL ALBERT DOCK.

ONS AND CO.

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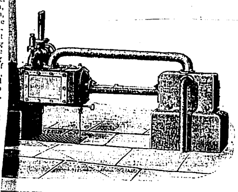

TION IN COAL

dered it our duty to ent cases of spon- goes, and to offer a of coal cargoes in es in particular, to . We urged that ed in the shipment not only of exporters merchant seamen, ered. The subject tention, and called out last issue from and most active of ed in 1875 to inquire of coal in ships,

or to review the evidence in full. We shall therefore content ourselves by directing attention to the evidence given by one of the most important witnesses, and then pass on to consider the Commissioners' report. Mr. Henry Johnson McCulloch, consulting coal engineer to the Admiralty, stated that he had been connected with the coal trade for more than thirty years, and had had six or seven years' experience in shipping coal for the Government. In the course of his examination, after recommending a system sometimes practised in the north of England, and always at Cardiff at the commencement of the loading of each large vessel, namely, that of lowering coals into the holds of ships, to prevent unnecessary breakagb; and also the use of smaller waggons than was customary, with the same view, he said—

"The larger the coals the greater ...

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SCI[ENCE]

A WEEKLY JOURNAL

Vol. XLIV.—No. 4. [NEW SERIES.]

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EDISON'S NEW DYNAMO-EL[ECTRIC] MACHINE.

The remarkable activity prev[ailing at] Menlo Park laboratory and m[...] and the evidences of the enormo[us] capital which one sees at these wo[rks] hand, are convincing proofs of th[e] and thorough earnestness of Mr. [Edison,] his co-laborers and supporters. [The] work of perfecting a complete [system of] electric lighting in all its details is a very slow operation, howeve[r] work may be urged, as time-test[s] durance of lamps, perfection of tion of the underground condu[ctors] hundred other time-consuming must, of necessity, be gone throu[gh].

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Besides carrying to a success[ful] grand experiment of illuminating of-door area with incandescent Edison has practically demonstra[ted] highest economy in the conver[sion]

The current is taken from the commutator cylinder by twelve brushes, six on either side, either one of which may be removed without disturbing the others. These brushes are supported by an arm capable of being rotated on an axis coincident with the axis of the armature, so that they may be made to approach or recede from the neutral point, and in this manner control the current.

This machine will furnish a current to eight hundred incandescent lamps. According to the most recent estimates as to economy, as obtained by indicating his present engine with 500 lamps, three and a half pounds of coal burned under the boiler per hour will generate a nett current sufficient for 8½ incandescent lamps of 16 candles each, or 16 lights of 8 candles each.

IMPROVEMENTS IN THE SILVERING OF MIRRORS.

Astronomers, and all who are interested in the production of mirror surfaces for optical purposes by the deposition of silver upon glass, will learn with pleasure that this subject has been receiving practical attention at the hands of a painstaking experimentalist, Professor Piazzi Smyth, the Astronomer Royal for Scotland. Convinced of the great value of reflecting over achromatic telescopes for certain phases of astronomical research, Professor Smyth has lately been directing his attention to the eliminating from the film of deposited silver certain objectionable features which marred its usefulness when applied to the reflector or glass mirror of large reflecting telescopes.

Subject to slight improvements to be afterward mentioned, the quickest, best, and most reliable method of depositing silver on glass, and that by which large glass specula as well as flat reflectors for a heliostat have been prepared by this astronomer, is the following:

Solution A.—175 grains nitrate of silver dissolved in 10 ounces of distilled water.

Solution B.—262 grains of nitrate of ammonia dissolved in 10 ounces distilled water.

Solution C.—1 ounce of caustic potash, purified by alcohol, in 10 ounces distilled water.

Solution D.—Half an ounce of sugar candy and 32 grains tartaric dissolved and boiled for ten minutes or so in 5 ounces distilled water. When cold add 1 ounce of alcohol, and make up to 10 ounces with water.

To Mix.—Put one-quarter of A into a glass beaker, add one-quarter of B, and then, gradually, one-quarter of C. Stop if it gets cloudy and add a drop or two of B, and continue with one-quarter of C until it is all got in. Then add a drop or two of A till the mixture has a slight brown color that will not dissolve in a couple of minutes; let it settle, or filter through cotton wool. To this add one-quarter of D, when the glass is ready to put on.

The quantity of the whole should be such that when the glass is placed on the fluid there should be about a depth of three-quarters of an inch below it. If everything is right, the mixture will turn first a pale sherry color, and then an inky black. In ten minutes in hot weather, or twenty minutes in winter, deposition will be completed, after which the mirror is then removed, washed, dried, and polished with a rouged pad.

From an observation of the fact that the silver formed much more readily on glass lying on the top of the solution than that which lay in the bottom of the vessel, a little going downward, but by far the greater portion ascending, Prof. Smyth reasoned that the so-called silver could not be pure silver after all, but must be combined with some substance that has altered its specific gravity. To that substance, which he concludes is potash in some form, he attributes the further fact that a damp warm thaw coming on after cold will sometimes cause the polished film to leave the glass and rise up in blisters. By what means, therefore, was this hygroscopic element to be eliminated? All difficulties are overcome by lifting the mirror from the silvering bath, and after allowing some of the solution to drip off, transferring it to a bath of alcohol, into which it is allowed to remain, with gentle agitation, till no more coloring matter is given off. A great advantage is also found in the substitution of soda for the potash in solution C, using much less of it. The effect of the alcoholic bath is noteworthy and valuable. A more perfect adhesion to the glass, with consequent freedom from the blisters mentioned, added to the greater smoothness and amenability to the action of the rouge polishing pad, are among these advantages.

An effective way of cleaning the surface of the glass previous to its being silvered consists in rubbing it with nitric acid, which must then be wiped off with a cloth, followed by an application of powdered Spanish whiting, to which is added enough distilled water to make a paste. This is rubbed over the surface and allowed to become quite dry, when, by rubbing with cotton wool, it is all removed. On being seen to be dry and clean the plate is gently lowered, face downward, into the solution, taking care not to sink it so low as to allow the back to get wetted. The film thus obtained possesses great body, solidity, and luster after being rubbed with the rouge pad, these qualities being very apparent when compared with a film obtained by the older processes.

[illegible] bales of silkworms' eggs, consigned to [illegible] valued at \$1,[illegible], arrived in this city [illegible] on Wednesday [illegible], January 5, by the [illegible] put on board the [illegible] came from China, [illegible] the 28th [illegible]

means a circuit or circuits are closed. Wires lead from the protruded conductor to any point on the line,

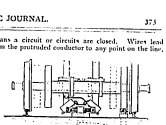


FIG. 2.

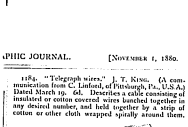
and are caused through suitable mechanism to make or break a circuit there also when required.

1156. "Magneto and dynamo-electric machines." J. H. JOHNSON. (A communication from A. de Mérites, of Paris.) Dated March 16, 48. Consists in enabling these machines to furnish an alternate current without the employment of an exciting machine. The inductors are magnetized by the alternate current itself without the necessity for changing its direction by means of a commutator or collector. Taking the machine known as De Méritens as an example, the coils of the ring are wound in such a manner that the exit wire from one coil is soldered to the exit wire of the next coil, and the extremity of the entering wire of one coil is soldered to the entering wire of the next coil. Hence it results that there are two entering or two exit wires leading to the binding screws where the current from the machine is collected. It also results that all the coils of the ring are traversed by one current, which changes its direction during each revolution as many times as there are coils in the ring. (*Provisional only.*)

1351. "Micro-telephonic apparatus." R. H. CUTLER-NEVAY. Dated March 17, 48. An iron or steel ribbon or core, with a soft iron on the base is, after being polished with a resisting medium, coiled with a number of lengths of wire insulated and connected by one end of each length to the bobbin. The bobbin is connected with a pendulum or spring of any suitable metals, either in the form of spiral or flat springs, coated with a resisting medium, the intention being to obtain delicate vibratory motion with the object of getting telephonic effects with less resistance as compared with carbon as generally used. (*Provisional only.*)

1478. "Dynamo-electric machine." JOHN PERRY. Dated March 28, 48. The object of this invention is to get a very intense magnetic field, and at the same time to have the currents generated to be continuous. In the machines of Gramme, Siemens, &c., the winding of the wire bobbins takes place, as nearly as possible, in the plane containing the axis of rotation. In the new invention each winding of wire on the rotating part of the machine makes a decided angle with the axis of rotation. Fig. 1 is the vertical elevation of the machine; *e f* is a shaft made to rotate; *a b* is a ring of phosphor bronze on which a great number of thin wedge-shaped coils (*c*, fig. 2) are packed so as to form an annular armature whose section is shown at *k*, fig. 3. The plane of each winding of this armature makes an angle of 30 degrees with the direction of motion when turning with the shaft. The armature is firmly fixed to the shaft, and is kept from changing its shape during rotation by means of the wooden discs, *i*, *i*, which embrace the coils on the inner parts of the ring, and which are bolted together and fastened to the shaft by the screws and collar shown in the figure, and by means of the outer rings of wood and metal, *l*, *l*, *l*, which are bolted together, embracing the outside of the

1189. "Telegraph wires." J. T. KING. (A communication from C. Linford, of Pittsburgh, Pa., U.S.A.) Dated March 19, 68. Describes a cable consisting of insulated or cotton covered wires bunched together in any desired number, and held together by a strip of cotton or other cloth wrapped spirally around them.



The interstices are filled with melted paraffin, coal tar, or similar material, or the wires are immersed in melted paraffin, coal tar, or similar material, as or before they are bunched. The cloth wrapper is then coated externally with coal tar, asphaltum, rubber, cement, or other elastic impervious material. Then, if desired, another strip of cloth may be wound on it spirally in the opposite direction, and coated in like manner. The fig. shows a container having a box or bed, which may be of cast iron or other suitable material, preferably protected by tarring or otherwise coating its exterior. Its interior is fluted or grooved, as indicated at *b*, to form receptacles for the wire, and whole interior surface is coated with porcelain enamel, as at *c*. Upon the bed is a cover, *d*, adapted to fit within the flanges, *e*, and rest upon the shoulders, *f*.

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Why then is the development progressing so slowly? The reason, we think, is partly, perhaps largely, to be accounted for by the fact that hitherto most individuals or firms desiring to use the electric light have found that to obtain the necessary plant entailed too extensive an addition to capital expenditure. And this, particularly as the advantage of the light, in point of *general economy*, when used on such a scale as for warerooms, &c., is still held by some to be doubtful. If an instance were wanting to prove the pecuniary advantage when the electric are is largely used, we might quote Mr. Swan's words in speaking before the Literary and Philosophical Society at Newcastle. That gentleman said that, at the Alexandra Palace two thousand gas lights, costing twenty-six shillings per hour, had been replaced by six electric lamps, costing only six shillings per hour.

What undoubtedly is now wanted is the central system for the supply of the electric current in large or small quantities; and this supply obtainable on analogous terms to those required for a supply of gas. If every one wishing to use gas were obliged to purchase the necessary plant for so doing, and superintend the working thereof, we think his ardour in that direction would be considerably damped, and most probably some other method of lighting ultimately adopted. It is with satisfaction then that we note that the central system is engaging the attention of two or three most influential firms on this side the Atlantic, and we also read that one of the companies in America interested in the Brush light is about projecting a similar system there. When once a success is scored the adoption of the electric light will progress with more and more marked rapidity. The public will be satisfied with the increased light or greater economy, and those who invest their capital in electric light shares, will, we believe, have no reason to be dissatisfied with their profits.

HEINRICHS' NEW RING ARMATURE AND THEORY OF THE GENERATION OF ELECTRIC CURRENT IN A RING ARMATURE.

A FURTHER improvement on the Pacinotti* ring armature has been made by Mr. Charles F. Heinrichs, the inventor of the electric lamps with circular carbon pencils.† As this improvement is of an important nature, and possesses very promising features, we shall fully describe its principle and advantages.

Mr. Heinrichs was led to devise the new form of armature through a close study of those of the existing forms, and by observing the manner in which the electric currents are generated in them; by this he formed a theory as to the action which the soft iron ring takes in the generation of electric currents in its surrounding insulated conducting-wire. Of this theory we shall make use in this article, with Mr. Heinrichs' permission. We shall have to refer to other already known ring armatures which are improvements on the Pacinotti ring, and we shall have also to draw comparison between those and the new one of Mr. Heinrichs, without which we could not well describe its novelty and features. Several theories have been advanced to explain the part which the soft iron ring plays in the generation of electric currents in the armature, but we have not yet seen an entirely satisfactory explanation of the action which the soft iron ring takes when in motion.

M. Antoine Breguet explains the action of the soft iron ring in his small pamphlet, "La Machine de Gramme," and part of his explanations are confirmed by Mr. Heinrichs' theories, as we shall see later on; but we think Mr. Heinrichs has gone a good deal further, and has not only endeavoured to discover the disadvantages of the existing armatures, but also constructed a form of the latter in which he overcomes those disadvantages in a satisfactory and simple manner.

It is well known that when a piece of soft iron is brought with one of its ends close to a magnet (fig. 1) this piece of soft iron will become also a magnet, and the one end nearest to the magnet acquires south polarity and the other end north polarity. In the middle of the piece of soft iron a neutral line, *l l*, will be established, and if the piece of soft iron were surrounded with insulated conducting-wire, a current would be set up or generated in the same length of the wire *in one direction*. As is well

* See *Telegraphic Journal*, vol. vii., p. 117.
† See *Telegraphic Journal*, vol. viii., p. 311.

means a circuit or circuits are closed. Wires lead from the protruded conductor to any point on the line.

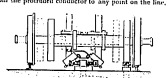

FIG. 2.

and are caused through suitable mechanism to make or break a circuit there also when required.

1156. "Magneto and dynamo-electric machines." J. H. JOHNSON. (A communication from A. de Méritens, of Paris.) Dated March 16. 4d. Consists in enabling these machines to furnish an alternate current without the employment of an exciting machine. The inductors are magnetised by the alternate current itself without the necessity for changing its direction by means of a commutator or collector. Taking the machine known as De Méritens as an example, all the coils of the ring are wound in such a manner that the exit wire from one coil is soldered to the exit wire of the next coil, and the extremity of the entering wire of one coil is soldered to the entering wire of the next coil. Hence it results that there are two entering or two exit wires leading to the binding screws where the current from the machine is collected. It also results that all the coils of the ring are traversed by one current, which changes its direction during each revolution as many times as there are coils in the ring. (*Provisional only.*)

1251. "Micro-telephonic apparatus." R. H. CUNNINGHAM. Dated March 17. 2d. An iron or steel bobbin or core, with a soft iron on the base is, after being polished with a resisting medium, coiled with a number of lengths of wire insulated and connected by one end of each length to the bobbin. The bobbin is connected with a pendulum or spring of any suitable metals, either in the form of spiral or flat springs, coated with a resisting medium, the intention being to obtain delicate vibratory motion with the object of getting electric effects with less resistance as compared with carbon as generally used. (*Provisional only.*)

1278. "Dynamo-electric machine." JOHN PEARS. Dated March 18. 6d. The object of this invention is to get a very intense magnetic field, and at the same time to have the currents generated to be continuous. In the machines of Gramme, Siemens, &c., the winding of the wire holders takes place, as nearly as possible, in the plane containing the axis of rotation. In the new invention each winding of wire on the rotating part of the machine makes a decided angle with the axis of rotation. Fig. 1 is the sectional elevation of the machine; *e f* is a shaft made to rotate; *a b* is a ring of phosphor bronze on which a great number of thin wedge-shaped coils (*c*, fig. 2) are packed so as to form an annular armature whose section is shown at *k*, fig. 2. The plane of each winding of this armature makes an angle of 30 degrees with the direction of motion when turning with the shaft. The armature is firmly fixed to the shaft, and is kept from changing its shape during rotation by means of the wooden discs, *i*, *i*, which embrace the coils on the inner parts of the ring, and which are bolted together and fastened to the shaft by the screws and collar shown in the figure, and by means of the outer rings of wood and metal, *l l*, *l l*, which are bolted together, embracing the outside of the

1284. "Telegraph wires." J. T. KING. (A communication from C. Imbard, of Pittsburgh, Pa., U.S.A.) Dated March 19. 6d. Describes a cable consisting of insulated or cotton covered wires bunched together in any desired number, and held together by a strip of cotton or other cloth wrapped spirally around them.

The interstices are filled with melted paraffin, coal tar, or similar material, or the wires are immersed in melted paraffin, coal tar, or similar material, as or before they are bunched. The cloth wrapper is then coated externally with coal tar, asphaltum, rubber, cement, or other elastic impervious material. Then, if desired, another strip of cloth may be wound on it spirally in the opposite direction, and coated in like manner. The fig. shows a cushioned bearing a box or bed, which may be of cast iron or other suitable material, preferably protected by tarring or otherwise coating the exterior. Its interior is fitted or grooved, as indicated at *b*, to form receptacles for the wire, and whole interior surface is coated with porcelain enamel, as at *c*. Upon the bed is a cover, *d*, adapted to fit within the flanges, *e*, and rest upon the shoulders, *f*.

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* *See Telegraphic Journal*, vol. vii., p. 219.
† *See Telegraphic Journal*, vol. vii., p. 311.

the ends of the cylinder is still not very satisfactory, the accumulation of heat on this part of the armature cannot be prevented, as all the wires of the armature cross each other at the two ends of the cylinder; and if the generator is made of a large size the length of the wire over the ends of the cylinder is increased considerably without a corresponding advantage. Mr. Heinrichs having satisfied himself on all these points, has adopted the channelled ring armature, shown by figs. 9, 10, and 11, the insulated conducting-wire being wound on the outer surface of the ring armature, lly crossing the channel with the insulated conducting-wire the inner surface of the ring is not made use of at all. This armature will give good results if made out of solid iron, or a bundle of very thick iron wire, which assists greatly in the generation of currents. This armature can be made in any size without altering its advantageous principle. It has, besides, one very great point in its favour, that is, it prevents the accumulation of the heat which is naturally produced in the insulated conducting-wires when they are traversed by powerful currents; this takes place also in all armatures through *the quick changes and* enforced demagnetisation of the iron. In Mr. Heinrichs' ring, the insulated conducting-wire which crosses the channel is freely exposed to the air, both inside and outside. This also tends to keep the iron ring cool and to maintain the efficiency of the armature. This is a point we miss in all other armatures.

In the early part of last year Mr. Heinrichs had occasion to rewind a bobbin of the multiple current generator of a London machine, and he informs us that he found the insulation of those four layers of copper wire which were nearest to the iron core totally burnt; this is prevented in Mr. Heinrichs' new armature, where the wire which is the nearest to the core has a considerable portion of its surface exposed to the air, *i.e.*, where the insulated conducting-wire crosses the channel. In fig. 10 we see this ring armature in section, made in horseshoe or channel form, the inducing magnets, n and s, surrounding the entire outer surface of the horseshoe ring in the section. Mr. Heinrichs claims as his invention the ring armature made in channel form, over which the inducing magnets, n and s, are so arranged as to surround the entire outer surface of the ring. The insulated conducting-wire in which the currents are to be generated overlies the iron ring only where the ring is directly under the influence of the inducing magnets, thus, that portion of the insulated conducting-wire which crosses the channel, and which is not under the influence of the inducing magnet, is also not under the influence of the soft iron ring. It will be seen that the length of the insulated conducting-wire which is under the influence of the inducing magnet and iron ring is much longer than the wire which crosses the channel.

It is obvious that the best results will be obtained with those armatures in which the largest portion can be brought directly under the inductive influence of the inducing magnets. Thus, if the Gramme ring (fig. 7) is made 5 inches wide it will have only 5 inches of insulated conducting-wire under the inductive influence of the inducing magnet (those which overlie the outer surface of the ring), against 1 inches of insulated conducting-wire, screened by the iron ring from the influence of the inducing magnets, as shown in fig. 5, and where no currents are generated. In the Hefner v. Alteneck armature a cylinder is 10 inches long and has a diameter of 5 inches; thus we find there are 10 inches of insulated conducting-wire for current generating against 7 inches of wire which do not generate any current; this shows favourably against the Gramme ring. In Heinrichs' horseshoe ring the proportions are 8 inches of insulated conducting-wire for current producing against 4 inches of wire which are not current producing, and these figures are arranged so as to help to keep the whole insulated conducting-wire cool. These figures show the advantage of Heinrichs' armature. In fig. 11 we show a further modification of Mr. Heinrichs' channelled ring, which we here nearly round in section, as in the original Pacinotti ring, but in which his principle of having a channel and employing surrounding inducing magnets is adopted. In another article we hope to describe the generator and the results obtained with it.

As we have shown the most developed Siemens ring armature in this article we have yet to draw attention briefly to two more modifications of *the arrangement, namely*, where the ring has been made in a flat narrow ring, and the inducing magnets arranged on both sides of the ring. The priority of this idea belongs to Mr. Schuckert,* as it was introduced in his generator over five years ago. Several of his machines have been in use in this country. The soft iron ring is made out of thin sheet iron plates which acquire little magnetism and act chiefly as a screen, as in the Gramme ring. The demagnetisation of the iron ring is much assisted by having inducing magnets arranged on both sides of the ring, but it will produce great heat in the armature.

In the Hiorth generator† the armature is also a flat narrow but solid iron ring, recessed on its circumference for the reception of the insulated conducting-wire, as in the Pacinotti ring. The position of the inducing magnets, relative to the ring, are the same as in the Schuckert generator. The ring being of solid iron, bears a great part in the generation of the currents. The enforced demagnetisation of the solid iron ring produces heat in the armature. This is to some extent overcome by a number of holes on the circumference of the ring which allow the air to circulate for cooling purposes, but produce noise when in motion.

Mr. Heinrichs' new means and apparatus for generating electric current were patented in England and abroad in November, 1879.

* See *Telegraphic Journal*, vol. viii., p. 121.
† See *Telegraphic Journal*, vol. viii., p. 121.

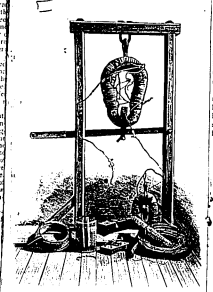
JOEL'S IMPROVED INCANDESCENT ELECTRIC LIGHT LAMP.

FIGS. 1 and 2 show an improved form and arrangement of electric light lamp recently patented by Mr. Henry V. Joel, A. M., Inst. C. E. Fig. 1 is a complete lamp suitable for lighting interiors, and fig. 2 is an enlarged section.

The improvements made in this form of electric light are mostly mechanical details, and make the

PROFESSOR HENRY'S BIG MAGNET.

In the course of his pioneer work in the investigation of electro-magnetic action, William Sturgeon, of London, discovered in 1823 that soft iron could be rendered temporarily magnetic by surrounding it with a coil of conducting wire connected with a battery. As the result of this discovery he made the first step toward the construction of an electro-magnet. He bent a piece of iron wire into the form of a horseshoe, lu-sulated it by a coating of varnish, and then



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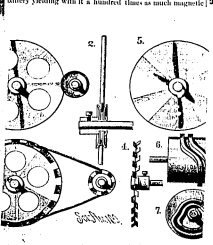
wound it with copper wire spirally, the spirals being widely separated, so that the current would be compelled to pass round and round the iron core. When the current was on the wire the core was found to be magnetic; when off, the core was not magnetic.

Professor Henry took up the discovery at this point and carried it an important step further. He wound the copper wire with insulating silk, making it possible to cover the core of the magnet with a much greater length of wire in closely wound coils, and also to lay on coil above coil. The compound helix so made developed great power, the same battery yielding with it a hundred times as much magnetic power as could be obtained with Sturgeon's arrangement. The first magnet for this principle was used by Professor Henry in 1828. It consisted of an iron bar two inches square and twenty inches long, bent, of course, into the form of a U or horseshoe, and wound with full foot of insulated copper wire in nine coils. The keeper weighed seven pounds, the core twenty-one pounds, and its lifting power was 750 pounds.

This magnet was used at Albany. In 1830 Professor Henry was called to the chair of Natural Philosophy in the College of New Jersey, at Princeton. Here he made two larger magnets for use in his investigations. One weighing 59½ pounds, and capable of sustaining 2,063 pounds, is now in the cabinet of Yale College. The other, made in 1833, weighed 100 pounds, and could support 3,600 pounds. It was many years before any magnet approaching this in power was constructed.

Through the courtesy of Mr. R. H. Rowe, photographer at Princeton, and by permission of Professor Schanck, of the College of New Jersey, we are enabled to present an exact likeness of this historic instrument, as long in the frame by which the forearm tested its strength. The magnet is deposited in the hall of the School of Science, one of the college buildings erected by the munificence of the late John C. Green. The coil at the right of the engraving represents the original silk-covered ribbon coil used by Professor Henry in his experiments on induction. The wire and battery at the left are modern, to show by contrast the improvement since made in the means for electrical investigation.

In the middle of the foreground is one of the pole changers made and used by the professor. He was accustomed to delight himself and his classes with this by changing the polarity of the big magnet so quickly that a twenty-eight pound armature could not fall off, but was freed and reattracted to its place with a sharp snap.



TRANSMITTING AND CONVERTING MOTION.

The English Mechanic
AND
WORLD OF SCIENCE AND ART.

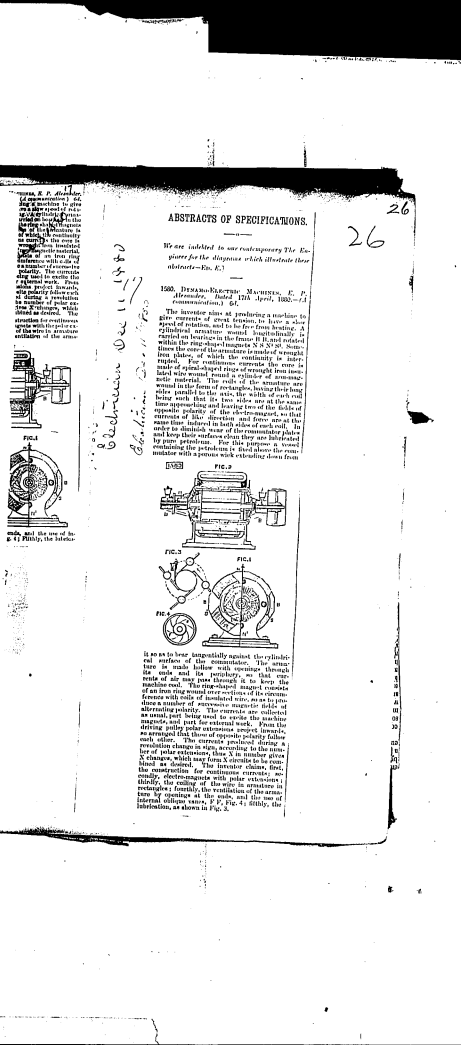
FRIDAY, DECEMBER 31, 1880.

ARTICLES.

THE NEW ELECTRIC MOTOR.

A DESCRIPTION of the new electric motor about which we have heard rumours for some time, has been published at last by the inventor, in the shape of a paper read before the Franklin Institute, and illustrated by a working model, which, in the opinion of experts, clearly demonstrated its utility. This model, which weighed only 23lbs., was connected with a sewing-machine, which did both light and heavy work, the speed being quite under control, with a current estimated at two Webers per second, the power generated being 1,000 foot-pounds. The battery used was a comparatively simple one of six cells, each containing a zinc plate 6in. long by 2in. wide; but at present we have no account of the consumption of zinc and chemicals, which, however, must be obviously more expensive than a steam or gas engine in producing current, though the batteries have the great merit of convenience and adaptability to household requirements. One of the earliest inventors of a really practical electric motor was Prof. Jacobi, of St. Petersburg, who, in 1835, at the expense of the Czar Nicholas, constructed an electric engine. For four years Jacobi experimented with his engine, and at last he succeeded in driving a large-sized boat (an ordinary 12-seater) at a speed against the swift current of the Neva, at the rate of three miles an hour. To accomplish this feat, however, he employed a battery of 64 cells, which contained many square feet of platinum, and Jacobi was characterised by the meagre results of his labours, although, as we know now, he was on the threshold of an important discovery. His engine was excellently designed, and was possibly as good as any that followed it, until Gramme in 1870 discovered that his dynamo machine could be made to act as a motor. Writing then to Faraday in 1839, Jacobi said that the most important object in the application of electro-magnetic machines had always been the management of the battery, but that obstacle "existed no longer," for he hoped within a year to have an electro-magnetic engine of from 40 to 50-h.p. Jacobi had at this time discovered that his form of platinum-coated cell was of 50 square feet of platinum surface to obtain one h.p., but he suffice in future. Jacobi was disappointed it is needless to say, as were those who followed in his footsteps, and when Joule demonstrated the principle of the conservation of energy, and it was found that the consumption of zinc in the battery was nine times as costly as the consumption of coal in the furnace, the idea of making electricity commercially available for industrial purposes was temporarily abandoned. Innumerable engineers and other sanguine inventors, according to Mr. Grisom, those who forthwith tried to produce an electric motor brought to the consideration of their work a wealth of ingenuity and all the learning of all the sciences save one, electro-magnetic induction,—and like other inventors who have gone before him, he indulges in some chirrup cheers at the scientific men who con-

tended that electricity produced by the consumption of zinc could never compete with steam. The purpose of his paper, he tells us, is to collect facts which will show that this conclusion is erroneous; but, as will have been expected, he fails to prove anything of the kind: for he steers wide of the question by attempting to show that if manual power is 100 times as costly as steam, it is at least eleven times as costly as electricity, and because manual power is preferred for certain work to steam, so he thinks electricity will supersede steam eg. in the case of sewing-machines. Of the two classes of electric motors, those which utilise the attraction of an armature to an electro-magnet, are wasteful of electric energy, because the residual magnetism retards the backward movement of the armature; but those which utilise the attraction and repulsion of two or more magnets, convert a portion of the retarding influence, of the residual magnetism, into a useful force. To test, says Mr. Grisom, all dynamo-electric engines, when used as motors, convert all magnetic resistances to motion into a counter electromotive force. It appears that this counter force retards the consumption of zinc in the battery, and tends to depolarise the negative plate. Counter electromotive force is usually regarded as increased resistance, says Mr. Grisom, but an experiment with one of his motors demonstrated the error of that view; for, after being held unmoved, while a sufficiently powerful current was passed through its coils, and the deflection of a tangent galvanometer carefully noted, it was found, on allowing the motor armature full speed, that the galvanometer indicated about a fourth of the original amount of current. The electro-motive force of the battery was practically reduced when the speed of rotation was diminished by a brake, the needle immediately indicated a greater current. Unfortunately, no illustrations and very meagre details of this motor accompany the paper, though a small one, as mentioned above, was shown at work. It is an efficient dynamo-electric machine, as well as motor, and its essential advantage over the older forms is in the field-magnets, which are of so peculiar a shape, that all the magnetic lines of force are brought into the best possible position for effecting the revolution of the magnetic armature. According to Mr. Grisom, the secret of his motor lies in the following:—Mr. Ladd, he says, claims to have discovered the great advantage possessed by the lines of force of a helically circular magnet over those in the usual "bow-shape form;" but does not appear to have attempted to utilise the lines of force which fill the interior of a curved magnet, from the neutral to the polar points. If a bar of soft iron is pivoted at one end, so as to move in a horizontal plane, and a semicircular magnet is placed concentrically with the circle which the bar can describe, it is found that a given force is exerted upon the bar, at a much greater distance from the poles, when the latter is within the semicircle, than when it is without. I believe that no field magnets on this principle have ever been constructed, and herein is the secret of the power of this little motor, which weighs about 23lbs., and which compares favourably with those of the old forms of 15 times its weight." An electric motor would, however, find a scant welcome in a house, unless the motor is free from odour, trouble, and noise. Grisom's is, it appears, inclosed in a waterproof box, does not require commutated acid, gives out no odour, does not exhaust itself, and requires removing only when the fluid is used up by actual work. It requires absolutely no attention until the reservoir is exhausted by actual work. A great deal of unscientific "mystery," or obscurities of explanation, surrounds the whole invention at present; but it is clear that the battery is simply made up of six very deep bichromate cells, in which the deposits of salts set up currents, which constantly bring fresh liquid to the plates. In answer to questions, Mr. Grisom said that of the zinc plates were 6in. by 2in., with two carbons to each zinc, and each cell held about a gallon of solution, so that if the motor is small, and "can be really considered," the battery would make quite an article of furniture. Upon a point in connection with the machine was specially mentioned by the inventor, and that was the fact that pressure is applied equally to both sides of the shaft at once, thus reducing wear to a minimum, the weight of the armature and the tension of the belt being the only causes of friction. The bearing is four diameters of the shaft, and no amount of wear can bring the poles of the armature and magnets into contact. The motor is about 9in. long by 2in. or 3in. in diameter, and as shown, was carried on an iron fork, attached to the back of the table of the sewing-machine. The latter was run at a speed of 800 stitches per minute, but by pressing on the treadle of the machine, the plates are raised in the battery, and the speed can be controlled down to 20 stitches per minute, while the power is sufficient to sew through leather, or as many folds of linen as will go beneath the foot of the machine. The motor is not yet ready for the market, which may possibly account for the meagreness of the information—somewhat in a scientific paper—but we have the principles on which the machine is constructed, and must wait for further details, as also for some data as to its running cost, for it may be doubted whether six plates of zinc 1in. by 2in., will "suffice for the sewing of a small family, for one year," especially if they have much leather work. It will be understood, however, in what way the new motor competes with steam—way a motor for a sewing-machine in places where no sensible power would have a steam-engine and its boiler. As so small a motor will run a sewing-machine, one a little larger will run a lathe, and soon; hence there will be a considerable demand, if only the motor is cheap, and Otto little to work.



Engraved by Messrs. Bagshaw, Bentley Street, Shadwell, London, from whose block this illustration is printed.

ABSTRACTS OF SPECIFICATIONS.

We are indebted to our contemporary The Engineer for the diagrams which illustrate these abstracts—Ed. E.M.

1560. DYNAMO-ELECTRIC MACHINES. *E. P. Alexander, Dated 17th April, 1880.—1 communication.* 6d.

The inventor aims at producing a machine to give currents of great tension, to have a slow speed of rotation, and to be free from heating. A cylindrical armature wound longitudinally is carried on bearings in the frame B B, and rotated between the poles of field magnets N S N S. Sometimes the armature-armature is made of wrought iron plates, of which the quantity is determined. For continuous currents the core is made of spiral-shaped rings of soft iron, and insulated wire wound round a cylinder of annealed iron material. The coils of the armature are wound in the form of a bangle, having their long sides parallel to the axis, the width of each coil being equal to the distance between the centres of two opposite and adjacent poles, leaving two of the coils of opposite polarity of the field magnets, so that the currents of like direction and passing at the same time induced in both sides of each coil, may unite in the middle near one of the commutator plates and keep their surfaces clean as they are lubricated by the oil-cups. For this purpose a vessel containing the petroleum is fixed above the commutator with a pipe and screwing down from

it so as to bear tangentially against the cylindrical surface of the commutator. The armature is made hollow with openings through its ends and its periphery, so that current of air may be forced through it by keep the machine cool. The wire-shaped magnet consists of an iron ring wound with insulated wire, in connection with coils of insulated wire, so arranged as to produce a number of successive magnetic fields of alternately opposite polarity. Coils are collected as usual, part being used to excite the machine and the other part for external work. From the driving pulley polar extensions project inwards, so arranged that the magnetic polarity follows each other. The current produced during a revolution change in sign, according to the number of polar extensions; thus X in number gives X changes, which may have X circuits to be used as desired, each having the armature coils, the commutation for continuous currents; so-called "multiple arc" coils, with polar extensions; thirdly, the coiling of the wire in armature in rectangles; fourthly, the variation of the armatures by openings at the ends, and the use of internal oblique vanes. F F, Fig. 1, shows the lubrication, as shown in Fig. 2.

Engraved by Messrs. Bagshaw, Bentley Street, Shadwell, London, from whose block this illustration is printed.

up by the chain, C, allows the carbon to drop on the lower rest, thus making full contact; when the keeper is again attracted, and pulls the lever and holder up again, the small weighted lever and rests descending and holding the carbon tight.

The lower and negative carbon is held in an upright tube, having a spiral spring, H, which propels the carbon upward. The spiral spring is held down by a chain, H, which is attached to R; the other end being wound on a barrel to which an escape wheel, J, is fixed, and which is released tooth by tooth by the lever, K, and pallets, K', carry line; the keeper attached to the lever, K, moves up and down. N is a rod to convey the current to the lower carbon. N N are the binding screws or connections. It will be seen that this lamp preserves the focus of light always at one point.

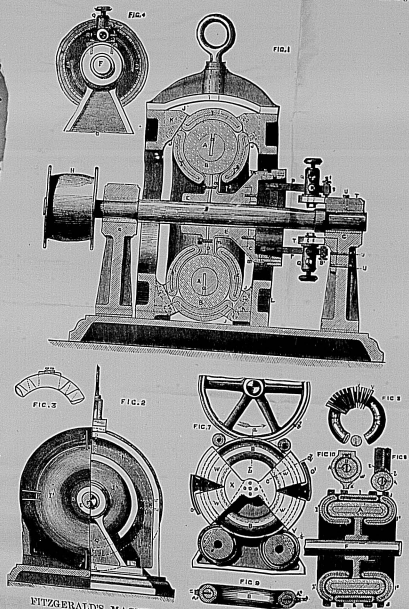
The lamp as shown is calculated to burn five hours, and gives the light of 1,000, with about 4-horse engine power.

FITZGERALD'S MAGNETO AND DYNAMO ELECTRIC MACHINES.

THE improvements in magneto and dynamo electric machines to my illustrate are the invention of Mr. Desmond G. FITZGERALD, and deserve careful attention, inasmuch as they show a decided advance in the right direction. The main idea of the inventor seems to have been to aim at perfecting the Gramme machine, and so, instead of making the ring between the poles of a magnet on the ordinary system, he wholly or partially surrounds the ring both longitudinally and transversely, that is, in two different inductive sections. The ring is thus magnetized directly and with the least possible loss, and the direction of the inducing magnetic polarity is in the circle constituted by the ring itself, as it should be.

Fig. 1 shows a transverse sectional elevation of a dynamo-electric machine, Fig. 2 is an elevation partly in section looking on to the left-hand side of Fig. 1, with the driving pulley removed. In Fig. 1 A is the soft iron ring carrying the coils, more or less, each, B, of insulated wire, all wound in one direction. The ends of these wires are all wound in one coil, C, on the boss, D, of the ring, A, with its coils, connected to the suitable bindings on a boss, E, to the commutator, F, mounted on a ring, the driving pulley, H. The standards, G, G, and at one end carry the bearings for the shaft, I, which, at one end carries the commutator, F, and at the other end the driving pulley, H. The commutator, F, is shown in Fig. 3, and consists of insulated steatite segments, A, in which are fixed the metal portions, of which the ring, I I, is composed, and B B are the brushes, of which two pairs are used—one pair of the largest diameter, I, the division between the halves being preferably at the top and bottom. The separate portions of this brush are insulated from each other, and the ends of wire are so connected two magnets are wound with coils opposed as the vertical plane traverses the ring, A. The reverse direction of the winding near the poles required to produce this effect is shown at Fig. 3. The various sections of the electro-magnetic ring are united and held in position by thin lugs, J, projecting from their cores between the coils of wire. These lugs, J, are bolted to other lugs, K, cast on the frame, L. The ring, A, has preferably a deep recess, a, cut in it circumferentially, as shown. The collector, C, consists of a cylinder of wood or other non-conducting material rightly attached to the boss, E, and having let into its inner circumference a series of strips of conducting material, M, insulated, and in number equal to the coils of ring, A. The extremities of the coils are brought to the outside of the collector, and connected so as to form a closed circuit, the points of connection between adjacent coils being severally brought into contact with the conducting pieces, M, as shown at m m. Fig. 4 shows clearly the collecting brushes, the current being taken off at the horizontal neutral line, or the line of greatest polarity. Fig. 4 also shows a front view of the collector, C. The brushes are flat springs, one, O, each having at one end a contact piece, O, and being attached at the other end to a screw, P, passing through a terminal, Q, and being fixed in position by a set screw, R. A short lever, S, is fastened to the end of the bar, P, having an adjusting screw, S', jumped through it, and bearing on the plate underneath. This screw enables any required tension to be put on the springs, O', thus regulating the contact friction. The terminal, Q, is fixed to and insulated from the standard, G, and connected to the binding screw, T, of the machine. The weight of the current collecting portion of the machine is liberated by means of these springs.

Considerable modifications are made in the construction of the ring. The method of construction is shown by Fig. 5. Ordinarily, in winding a number of coils of wire upon a ring, more especially if it be of circular section and if the



FITZGERALD'S MAGNETO AND DYNAMO ELECTRIC MACHINES.

up by the cleats, G, allow
one, thus making full con
inserted, and pulls the leve
weighted lever and cam d
right.

The lower and negative
having a spiral surface,
ward. The spiral spri
which is attached to it, th
ed to which an escape wi
leased tooth by touch by t
time the keeper attaches
down. M is a rod to con
ban. N N are the blades
be seen that this lamp pre
one point.

number of turns of wire be the same in each layer, inter
stices are left between the coils. The interstices are filled
by Mr. Fitzgerald with soft iron wedge-shaped blocks, V.
These blocks can either be made with the ring, or separately
and slipped on, the ring being made in halves to receive
them, as shown.

Fig. 6 shows a modified form of the ring, A, and the en-
circling magnets, I P P, the ring being cylindrical instead
of circular, and the encircling magnets also being modified
shapes to correspond. The principle is the same whichever
form is used. Figs. 7 to 10, however, illustrate a modifica-
tion in which the ring, A, is wholly encircled on its cross
section by coils, W, in lieu of inducing magnets.

Fig. 7 is to illustrate a totally new form of machine in
which the ring, A, is wholly encircled on its cross section by
coils, W, and, also, in lieu of inducing magnets. These en-
circling coils, W, are supported in a suitable framing, X, and
the ring, A, is made to rotate through them, is mounted between
three or more rollers, Y, by one of which—preferably the
upper—it is driven by frictional contact, the surface of the
The extremities of the coils of ring, A, are attached in a
manner similar to that before described to a series of strips
on cheeks or wooden ring, A², let them into the external surface of
ring, A. The current is taken off as an apparatus on the
outer circumference of the coils, W, left in such a way as the
the coils of wire Preferably, the coils, W, left in such a way
to leave a longitudinal groove, W, on the inner surfaces,
where they pass over the ring, A, on the outside of ring, A.
This shows of the two surfaces of the ring and encircling
coils being brought into very close contact. Fig. 8 is a
transverse section taken at e f, Fig. 9 is a vertical plan of
ring, A, at center line, and Fig. 10 is a section of coils, W,
taken at line, e f, Fig. 7.

It is obvious that in the three forms of machines shown
permanent magnets may be substituted for the electro-
magnets, the permanent magnets rotating substantially the
same as the electro-magnets, but being necessarily divided at the polar-
ities. Their similar poles are connected.

Both the ring, A, and the coils on the inducing electro-
magnets, I P P, or the inducing coils, W, left in such a way
that one or more in series, as is well understood. The ap-
paratus may be advantageously constructed in duplicate, the
halves of the hollow electro magnets, I P P, being employed to ang-
ize both sides of the ring, A, before employed to ang-
ize for the external portion of the circuit being taken
off the several rings, A. The coils being taken
divided in a ring of soft iron provided with a circum-
ferential slot to allow of the passage of the wires. Such
coils, W, is applicable to the electro-magnets, I P P.
Fitzgerald—of double or single curvature, as may be called for.
The subject suggests—Scientific American.

HORTICULTURAL NOTES.

LIQUID MANURE FOR GRAPES.—The *Rural World* de-
scribes a small vineyard belonging to Mr. Peschel of Her-
man, Mo., consisting of an acre and a half of vines, mostly
Elvira and Norton's Virginia, with fewer Delaware and
Ohland. He feeds these vines heavily with liquid manure
dited in the season about the blooming period and again
when the stoning process commences. Small furrows are
made above the vine, into which the manure passed about
the furrows covered as soon as the soil has absorbed it. The
editor states that "he has astonishing results, for four years
having an annual return of about $700 from this small piece
of ground, and his crop was really wonderful this year." No
estimate is given of the cost of cultivation.

MARKETING FRUIT.—The *Rural Home* says that most of
the money paid for fruit by consumers in Rochester goes to
the middleman. Concord grapes have been sold by the
growers at one and a half to two cents per pound. The grower

The Tradesman, Oct. 15, 1881.

28

Edison's New Machine.

Mr. Edison has just completed a very powerful dynamo machine, which was tested recently with satisfactory results. It is 180 horse power, and consumes 400 pounds of coal an hour, at an aver-age cost of $2.50 a ton, screenings being used, making the cost of running it about fifty cents an hour for 1,200 lamps. The armature is made of copper bars, one-half inch thick, instead of small wire as usual. The maximum of illuminating capacity is equal to 537,000 candles. The cost was $60,000. The largest machine previously built by Mr. Edison was an eight-horse power ma-chine of sixty lights, with two magnets weighing 300 pounds each. There are twelve magnets in the new machine, weighing 685 pounds each. It is de-signed for a station at Charing Cross, London, where a number of houses are to be wired for lighting by this means. Mr. Edison intends to build twenty-four machines of 250-horse power each, twelve of which will be placed in the Pearl street station, to light a district wherein 7,000 lamps have been wired, which will be lighted by 15,000 lamps.

De cette façon on pourra envoyer régulièrement un courant à chacune des oscillations de celui-ci, et obtenir les mêmes effets que M. Voûté a si bien réalisés.

Dès lors, l'horloge-type synchronisera le pendule conique par le procédé ordinaire, et celui-ci, l'horloge à régler, par un supplément de rouages.

G. TRUCK ET ROBIN.

L'ÉLECTRICITÉ
ET LA LOCOMOTION

La traction des véhicules par l'électricité constitue, suivant le point de vue auquel on l'examine, une application d'une immense avenir ou une réelle utopie, dans l'état actuel de nos connaissances.

Nous avons parlé à plusieurs reprises dans ce Journal de l'application de l'électricité à la traction des petits chemins de fer dans les villes, soit par voies aériennes, soit par voies souterraines. Ce système de traction dont les avantages sont connus, recevra sous peu son application en Amérique, en Allemagne et en France; le question est étudiée de tous côtés et avance à grands pas vers sa réalisation pratique.

Il s'agit seulement, dans l'espèce, d'une transmission de force à distance, cette force étant produite d'abord par des moteurs à vapeur fixes et restituée ensuite avec un rendement relativement élevé, tel le producteur d'électricité est fixe et le moteur seul, le récupérateur est mobile, ce qui diminue dans une certaine proportion le poids mort transporté et le rend, pour des petites forces, bien inférieur à celui de locomotives à vapeur qui, pour de grandes puissances, remorquent tous leurs avantages au point de vue de la légèreté. C'est donc, comme l'a démontré M. Marcel Deprez ici même, aux petits chemins de fer, aux tramways et au service du transport des dépêches qu'il faut réserver l'emploi de l'électricité.

Si, au contraire, il s'agit d'employer l'électricité à la traction des tramways ou des voitures particulières en transportant avec soi le générateur électrique, l'idée devient manifestement irréalisable, et nous nous proposons de le démontrer par quelques chiffres. On doit, en effet, s'adresser dans ce cas aux piles à liquides; nous ne citons que pour mémoire les piles thermo-électriques qui, jusqu'à présent, n'ont fourni que des quantités d'électricité hors de proportion avec leur poids et leur volume.

Ce que nous nous proposons d'établir ici paraîtra bien évident à la plupart de nos lecteurs, mais n'est pas absolument prouvé pour tous, et nous pourrions citer telle personne qui cherche actuellement les moyens d'appliquer la pile de M.... — notre discrétion nous empêcher de le nommer, — à la traction des tramways.

Quelques chiffres vont nous montrer toute l'impossibilité de cette application.

Supposons un tramway pesant, voitures, piles, moteur et poids utile, cent-kilos voyageurs, tout compris, 4000 kilogrammes. L'effort de traction sur un tramway, en palier, dans les conditions ordinaires, est de 10 kilogrammes par tonne, soit 40 kilogrammes pour le poids total. A une vitesse de 2m,50 par seconde, c'est un travail de 100 kilogrammètres que doit fournir le moteur. Avec une rampe de un centimètre par mètre, le travail se trouve doublé, soit 200 kilogrammètres par seconde.

C'est ce dernier chiffre que doit pouvoir fournir le moteur en pratique pour que, s'il se présente une rampe plus forte, 2 centimètres, par exemple, il puisse fournir un travail suffisant en ralentissant sa vitesse.

La pile électrique la plus puissante actuellement connue, eu égard à son poids, son volume et la somme de travail disponible, est la pile Bunsen, modèle Ruhmkorff.

En admettant pour le modèle en question un poids de 3 kilogrammes, une force électro-motrice de 1, 8 volts et une résistance intérieure de 0,06 ohms, on trouve que le travail extérieur total représente 1,128 kilogrammètres par seconde.

Mais il ne faut pas perdre de vue que la moitié seulement de ce travail extérieur total peut se convertir en travail utile. Chaque élément pesant 3 kilogrammes, pour donc fournir un travail théorique maximum de :

$$\frac{1,128}{2} = 0,564 \text{ kilogrammètres.}$$

Il suffirait donc, d'après ces chiffres, de placer sur le véhicule 200 éléments Bunsen plats, modèle Ruhmkorff, pour fournir l'électricité suffisante à la mise en marche du tramway de 4000 kilogrammes.

En pratique, les frottements propres du moteur, des transmissions, les mauvais contacts, la polarisation des piles, les résistances des conducteurs, etc., augmenteraient ce chiffre dans de très-grandes proportions, et l'on arriverait, pour pouvoir marcher sûrement à ces vitesses, au chiffre de 500 éléments.

Ces éléments à 3 kilogr. représentent déjà un poids de 2500 kilogr. sans les accessoires. Il ne reste donc plus que 1500 kilogrammes pour le véhicule, la machine motrice, les transmissions et le poids utile!

Avec d'autres piles, telles que la pile Reynier, par exemple, dont le travail disponible est environ moitié moindre, on arrive au chiffre de 1000 éléments pour produire la progression du tramway de 4000 kilogr. à la vitesse indiquée ci-dessus, et le travail utile reste nul.

L'un pourra, il est vrai, diminuer la vitesse et par suite le travail dépensé, mais au-dessous de la vitesse indiquée, — 2m,50 par seconde, — ce qui, avec les arrêts obligés, ne représente pas plus de 6 kilomètres par heure, le tramway ne peut plus rendre aucun service. On ne trouve donc entre deux alternatives également insolubles avec les piles connues qui, en outre de leurs inconvénients personnels, tels que dégagement de vapeurs nuisibles, prix énorme du zinc qui sert de combustible, etc., sont encore beaucoup trop lourdes et trop encombrantes eu égard à la somme d'énergie qu'elles mettent en jeu dans un temps donné.

de la lumière électrique, a montré tout le parti qu'on pouvait tirer de ces sortes de piles, jusque-là affectées seulement aux expériences de physique.

Ce court résumé des travaux effectués en France depuis une trentaine d'années montre que nous nous sommes toujours non-seulement maintenus à la hauteur des progrès qui se sont accomplis dans les applications de la science électriques, mais encore que nous avons une très-large part dans ces progrès eux-mêmes.

THÉ. DU MONCEL.

ÉTUDE
SUR LES ÉLECTRO-AIMANTS
CONSIDÉRÉS COMME ORGANES DE TRANSFORMATION D'ÉNERGIE

3e article (voir les nos des 15 mai, 15 juin, 15 juillet, 15 août, 15 septembre, 1er octobre et 1er novembre).

L'examen du tableau qui, dans notre dernier article, renferme une classification rationnelle des transformateurs électro-électriques par induction, donne lieu aux observations suivantes.

Nous avons déjà indiqué comment les transmetteurs téléphoniques sans pile devraient être partie de ce tableau. Il est à remarquer de plus qu'ils doivent être rapprochés des machines telles que celles de Page, Breton... etc., car dans ces machines l'inducteur est réellement l'aimant dont une armature en fer doux en mouvement fait varier le magnétisme, et l'induit est la bobine qui recouvre les pôles de l'aimant.

Enfin, il est à remarquer aussi que le tableau précité est encore incomplet, il y a de nombreuses variétés possibles qui n'existent pas encore : ce sont des vides à combler ; il y remédier, soit en produisant de nouvelles machines, soit en transformant les anciennes.

IV

TRANSFORMATION INDIRECTE, PAR L'INTERMÉDIAIRE D'UN CHAMP MAGNÉTIQUE, D'ÉNERGIE ÉLECTRIQUE EN ÉNERGIE MÉCANIQUE.

Nous arrivons à un dernier emploi des électro-aimants qui n'est pas le moins important, et qui est, ou peut le dire, actuellement à l'ordre du jour. Il s'agit de la transformation, inverse de la précédente, d'énergie électrique en énergie mécanique.

Nous avons donné dans nos articles précédents de nombreux exemples de transformations directes de ce genre obtenues en se servant de courants intermittents quelconques ou de courants ondulatoires. On peut faire ici une subdivision analogue, et ranger les appareils ou machines dont nous nous occupons en ce moment dans deux catégories : l'une où l'on utilise des courants quelconques, la seconde où l'on emploie des courants intermittents très-égaliers dits *ondulatoires*.

PREMIER CAS. — *Utilisation de courants quelconques.*

[A]. — *Production de mouvements continus.*

Les machines susceptibles de produire ce résultat sont bien connues de nos lecteurs. Ce sont principalement les machines électro-électriques par induction transformées en moteurs en vertu de leur réversibilité. Tout le monde sait que dans une machine telle que celles de Gramme ou de Siemens, à travers laquelle on fait passer un courant, la partie mobile se met immédiatement en mouvement et l'on conçoit sans difficulté que ce mouvement puisse être transformé en force à l'aide des mécanismes ordinaires, ou transmis au loin par intermédiaire de câbles, de courroies... etc. De là les applications remarquables qui sont tentées en ce moment : labourage par l'électricité, machines-outils mues par elle, chemins de fer électriques... etc., etc. Ces essais ont été et sont tous les jours dirigés dans ce Journal, témoin les articles de M. M. Deprez sur les locomotives électriques ; il est inutile de parler ici de ces différentes applications, il suffit de constater que la plupart des machines électro-électriques par induction peuvent être, au moins théoriquement, transformées en moteurs, et c'est à la pratique de déterminer celles qui peuvent être le mieux appropriées aux usages particuliers qu'on en veut faire ; car il est infiniment probable qu'un type de machine unique ne pourrait satisfaire en même temps à ces usages divers.

En tout cas, il est certain que les moteurs électriques ont devant eux un avenir assuré, et l'on peut bien affirmer, sans être taxé de témérité, que dans peu de temps ils entreront dans la pratique industrielle : on conçoit donc l'intérêt qui s'attache à cette récente application des électro-aimants.

[B]. — *Production de mouvements alternatifs.*

En dehors des moteurs électriques proprement dits dans lesquels la constante du mouvement est en général une condition essentielle, on peut concevoir qu'un puisse, en se servant de courants électriques intermittents alternativement de sens contraires, produire dans un champ magnétique invariable, des mouvements alternatifs identiques.

L'action d'un champ magnétique sur un courant dépend en effet du sens de ce courant, et l'on peut combiner la nature du champ et le sens du courant de façon à obtenir le mouvement que l'on désire.

Je ne citerai qu'un exemple remarquable de ce genre de transformation : celui qu'offre le relais de M. Hughes.

Ce relais a été imaginé pour pouvoir transmettre des signaux télégraphiques à l'aide de courants extrêmement faibles, tels que ceux qu'on peut faire passer par exemple à travers un câble sous-marin présentant un grave défaut.

Il se compose d'un gros électro-aimant, semblable à celui de Faraday pour l'étude de la polarisation rotatoire magnétique, animé par un courant, et dont les pôles très-rapprochés forment un champ magnétique très-condensé. Dans le plan vertical des pôles, aussi près d'eux que possible, une lame d'or très-mince est suspendue dans une petite cage de verre, entre deux tiges métalliques. Il est facile de voir que si

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 189.

THE PHOTOPHONE.

THE discussion on the paper read on the 8th instant before the Society of *Telegraph Engineers* has gone far to confirm an opinion we expressed in our leading article published in our issue of the 1st November. We there stated that we doubted the accuracy of the conclusions drawn by Professor Bell with reference to the action of light upon matter; and the experiments made by Professor Tyndall seem to have conclusively proved that the effects observed are due to heat and not to light. We do not in the least desire to depreciate the work of Professor Bell; the experiments he has made are in the highest degree interesting and worthy of praise, though the cause of the effects produced may have been misapprehended.

According to Professor Tyndall the sounds produced are probably due to the alternate expansion and contraction of the particles of which the matter is composed under the influence of heat. The experiments are valuable in that they show with what great rapidity changes of temperature may be effected. In the case of the telephone it is shown with what great rapidity magnetic changes can take place.

It is well known that an ordinary electro-magnet takes a comparatively considerable time to become thoroughly magnetised, and an equally long time to become completely demagnetised. Similarly, any kind of matter takes a considerable time to become sensibly heated, and the heat is lost equally slowly. In the two cases we have referred to we have the changes taking place with great and unexpected rapidity. Where the changes are minute the rate of action is correspondingly rapid, and it seems probable that this is so in every physical action; in the case of the action of light upon selenium we have these rapid changes taking place. These facts seem not unlikely to have a considerable bearing upon the question of fast speed working on submarine cables; possibly by signalling by very minute changes in a current a corresponding high speed of transmission may be attained. We do not suggest any means of effecting the object, but we think that there is a field for inquiry in this direction.

MAXIM'S DYNAMO ELECTRIC MACHINE ARMATURE.

THE armature, the invention of Mr. Hiram Stevens Maxim, of Brooklyn, America, is shown by figs. 1 to 5.

The body of the armature is constructed of thin plates of iron of the form shown in fig. 1, and at A', in fig. 2.

These plates should be of the best annealed iron, and are provided with a series of "radial" projections which serve as pole extensions. Part of the plates of the armature are made of the form shown in fig. 1, and at n^1, in fig. 2. These are provided with longer projections corresponding to the "radial" projections of the other plates, and also with additional projections both on the outside and on the inside for the purpose of holding the wire of the coils in position. An armature is constructed by placing a sufficient number of plates alongside of each other, and fastening them together by means of pins or rods, n^2, n^3, made of some diamagnetic material passing through all the plates, as shown in fig. 2. The plates, however, are not placed directly in contact with each other, but are separated by washers upon the rods, n^2, n^3, of about the thickness of the plates, and interposed between them, or between pairs of them, so as to leave air spaces between the plates. Where the tension of the current is very great, as in machines for supplying electric lamps, the larger plates are made of some strong insulating material, a few of them, say, one to each end, and one in the middle being used, and they are made to project so as to keep the wire at some little distance from the iron and prevent all danger of a short circuit.

Where a current of low tension is required, all the rings are made of metal, and it is advantageous under some circumstances to use more of the larger or even to construct the whole armature of them. The manner of winding the coils is shown in figs. 1 and 2, where c^1, c^2, represent the coils wound upon the armature and held in position by the projections on the large plates, n^1, so as to leave air passages between the coils, both upon the inside and upon the outside. The armature is attached to its shaft by means of a hub and is made to fit into the rings, or by any other suitable device. It is important, however, that the space between the armature and its shaft should be left substantially open, so as to permit the free passage of air. A sufficient number of the plates shown at n^1, having the larger exterior and interior projections, should be used to keep the coils separated throughout their entire course, so as to leave no close passage for air between them. In order to secure the greatest advantages from this construction, the plates composing the armature should be made thin, and a considerable number of them used.

To obviate a sharp bend at the end of the coil, and the consequent injury to the insulation and increase of resistance, the end rings of the cylinder are constructed of half-round iron; this presents an easy curve for the wire at all points.

In other respects than those mentioned, the armature is similar in construction and operation to those which are now well known and in common use.

NEW ELECTRIC MOTOR.*

BY WILLIAM WOODNUTT GRISCOM.

(CONTINUED FROM PAGE 93.)

By way of illustration, the application of human energy to the sewing machine is not only a false economy, but has proved the cause of many new and painful diseases in female operators, which annihilate their lives and affect the physique of their offspring. If any motor can be substituted for human energy in this field, there can be no greater or more convincing consideration offered to invite attention to it.

The sewing machine is in almost every home, and the needs of these discuss are spread in every class of society. The comedy, as before mentioned, is a home-held motor, and it was natural to suggest a small steam engine for this purpose; but steam is unsuited to this end, because—

1st. It requires time and trouble to start it to work, and a busy housekeeper, who may need, perhaps, to do five minutes of sewing, has no time to waste.

2nd. It is always liable to explode, or to burn out the boiler, or get various portions of its complex mechanism out of order, so as to require an experienced engine driver to repair it.

3rd. It emits an offensive odour of lubricating oil, and vitiates the atmosphere with the products of combustion.

4th. It is really much more expensive than these steam engines from which our calculations were made. If gas is consumed for a household engine the fuel amounts to from twelve to twenty-five feet of gas per hour, costing for a motor giving one thirty-third of a horse-power as much as the fuel of a six or twelve horse-power steam engine.

This last consideration would not weigh with the actual sufferers of the acute forms of disease, but the other objections are serious, and apply to all heat-motors, such as gas, steam, and caloric engines.

Other motors are before the public—the various hydraulic motors which require the special introduction of water-pipes and waste-pipe, and entail yearly visits from those friends of humanity, the plumber and the tax-collector. Then there is the spring motor, which you wind up every quarter of an hour or so, (depending, of course, much more power is the winding than you get out of it in work, and which has an unhappy habit of bursting its bonds occasionally, and wasting its short store of energy where it is least needed. Then there is the curious clock-work motor, mechanism is connected with the seat of the motor, whose various levers, cogs, cams and chicks to the top of the chair, and by the rest of the chair gradually winds up the strong spring, thereby the weight of the operator, driving the sewing machine the meanwhile. The operator then runs the sewing machine for and the performance is renewed. A very good speed can be attained by rising and sinking forty times per minute.

It is now fair to examine the theoretical and practical objections to electric motors, first with batteries. They may be divided into two classes—those which utilise the attraction only of the clock in the institute library, and those which utilise the attraction and repulsion of magnetic systems, and these which utilise the former act by intermittent attraction only, and are wasteful of electric energy, because the residual magnetism, during the interruption of the current, retards the passage of the armature away from the pole which had just attracted it.

Those of the latter type, however, recover a portion of the retarding influence of the residual magnetism into a useful force; in fact, all dynamo-electric generators when used as motors consume little magnetic resistance to motion into a counter electromotive force. At first glance it seems strange to consider a consumption of zinc in the battery and leads to be dependent on the negative plate. It has been usual to regard this counter electromotive force as an economy, but in point of fact it retards the motive force as increased resistance, but a simple experiment will show the error of this view, and will at the same time demonstrate that economical motors must also be the same dynamo-electric machine in order to recover this force, which would otherwise be lost. A small motor of the form, which is was held motionless while a sufficiently powerful type before you any of four velocity per second—viz., a current—and a galvanometer was also in circuit, whose deflections was carefully observed. Then, without changing the connections, the motor was allowed to run at full speed, when the galvanometer indicated about one-fourth of the original amount of current. The electromotive force of the battery was practically constant, and, therefore, according to the formula

$$\text{Electromotive force} = \text{Resistance} \times \text{Current}$$

the galvanometer should have indicated the same current as at

* Paper read before the Franklin Institute Nov. 17th, 1880.

first, unless the resistance had been changed or a counter electromotive force produced. The speed of rotation was then diminished by a brake, and the needle immediately indicated a greater current. This is in direct conformity with the well-known law that the electromotive force of a dynamo-electric machine varies with the speed of rotation, whereas the resistance of a coil is not affected by mere motion.

A still more striking proof that the "back-pull" of residual magnetism may be converted usefully into electricity is exemplified in a motor constructed more than a year ago by the writer on the same principle as this one, save that the fields are free, but connected with the armature. The current of the battery is sent through the armature, which revolved with considerable rapidity. If the free ends of the fields are now connected the speed is immensely increased, and if the ends are separated as literally it ran away. Of course there is a limit to this, and it has led to the wasting of a great deal of energy wasted in retarding the armature is not recovered, but nevertheless the increase of power due to this one economy is very astonishing.

The little motor exhibited this evening is also an efficient dynamo-electric machine. The most essential advantage which it possesses over the older forms is in the field magnets. Their peculiar shape is such that all the magnetic lines of force, including those near the neutral line, are brought into the best possible position for effecting the revolution of the magnetic armature. I believe that the distinguished inventor, Mr. Ledd, in England, claims, in an article which appeared lately in one of the journals, to have discovered the great advantage possessed by the lines of force of a nearly circular magnet over those in the usual horse shoe form magnet, but he does not appear to have applied the principle to utilise the lines of force which fill the interior of a curved magnet from the neutral to the polar points. If a bar of soft iron is pivoted at one end, so as to move in a horizontal plane, and a semi-circular magnet is placed concentrically with the circle which the bar can describe, it is found that a given force is exerted upon the bar, at a much greater distance than if a given force is exerted upon the bar, at a much greater distance than if a given force is exerted upon the bar, at a much greater distance than when the latter is within the semicircle than when it is without. I believe that no field magnets of this peculiar shape have ever been made, and herein is the secret of the power of this little motor, which weighs about 22 pounds, and which runs up to fairly with the—of the old forms of fifteen times its weight. The inductive actions which are produced in these field magnets at each revolution of the armature are exceedingly complex, and I shall not trouble further on your attention, except to give a brief resume of the practical defects of electric motors, and how they have been overcome by the investigation of which this motor is the result.

The great disadvantage of those who have used electric motors has been the battery. It gave forth offensive and poisonous fumes, it required almost constant attention, it was concentrated acids, and it became rapidly exhausted whether it was used or not.

All these objections are now done away with. The present battery is cheap, it is a strong one-fluid one, does not use concentrated acids, gives out no odour, does not require attention, is working only after the fluid has been used up by actual work, will last months or years if left to itself, and can be set in order in the briefest time. It requires absolutely no attention until the receptacle is exhausted by constant work, and it is ready without a moment's warning at all times and seasons, small though for one year. A professional seamstress would exhaust it more rapidly, but still not in a time which the exact terp places the speed of the motor under complete control without effort on the part of the operator.

The attention of mechanicians is invited to the fact that the form of motor, owing to the force being applied equally to both sides of the shaft at once, entails absolutely no wear on the journals except from the weight of the armatures so wear on the light, and from the tension of the belt, which is very small in view of the bearing is four times the diameter of the shaft, and the design of the motor is such that no strain is put upon the cross the poles of the armature and magnets to come in contact, which was a frequent source of annoyance to those in contact, the motor is attached to the machine, and is of such dimensions as to be readily concealed from view if preferred. There is also a device for readily changing the tension of the belt.

The power of the motor is sufficient to sew heavily woven linen as can be put under the presser. With twenty to two thousand stitches per minute. The speed with to the skill of the operator. A safe working speed for constant is considerably faster than is ever attained by professional sewing women, while others seldom sew more than three hundred stitches per minute.

[ELECTRO-DYNAMIC MACHINES.]

[M. McClintock says about a birth, cause he his writings. I shall not myself to do, but shall content myself with a few remarks on the statement of Mr. Kennedy's advice before spending the money, or they will probably find themselves in the position of Angles-Saxon, that "Angles" is supreme himself in the world, and that the people of the centre of the earth are "Angles" unless to reserve the middlest theories of the universe, and that he is the only Angle worthy to say "Signes." It quite accords to say "Signes" is quite wrong, but to say "Signes" is quite correct, may be just where we are then; but it is certain that the "Sol of force is the same throughout, and it is spreading in all directions, and there is but little difference in its value in the principles involved, whether it is in the form of the magnetic lines of force, or in the form of the electric lines of force, as you cannot substitute, except by actual experiment, the greatest field of force will be the strongest, we feld back the iron upon the field iron is pivoted at one end, so as to move in a horizontal plane, and a semi-circular magnet is placed concentrically with the circle which the bar can describe, it is found that a given force is exerted upon the bar, at a much greater distance when the latter is within the semicircle than when it is without. I believe that no field magnets of this peculiar shape have ever been made, and herein is the secret of the power of this little motor, which weighs about 22 pounds, and which runs up to fairly with the—of the old forms of fifteen times its weight. The inductive actions which are produced in these field magnets at each revolution of the armature are exceedingly complex, and I shall not trouble further on your attention, except to give a brief resume of the practical defects of electric motors, and how they have been overcome by the investigation of which this motor is the result.

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The Scientific American.

LA BIBLIOTHÈQUE DE LA NATURE

M. G. Masson, l'éditeur du journal *la Nature*, a bien voulu nous confier la direction d'une Bibliothèque nouvelle, que nous appelons la *Bibliothèque de la Nature*, et qui, destinée à comprendre un grand nombre de volumes, sera le complément de la Revue des sciences, d'où elle tire son origine.

Dans les livraisons de *la Nature*, le lecteur suit les développements successifs de la découverte qui vient de naître, au fur et à mesure qu'ils se produisent. Nous avons pensé que les notices écrites sur un même sujet, et quelquefois séparées dans nos volumes par un espace assez considérable, pouvaient devenir le canevas de livres excellents, où les questions seraient présentées sous une forme nouvelle et avec des développements considérables, de manière à servir au spécialiste et à tous ceux qui veulent étudier particulièrement telle ou telle branche de la science. Il est d'autre part, des questions qui ne sauraient entrer dans le cadre d'un

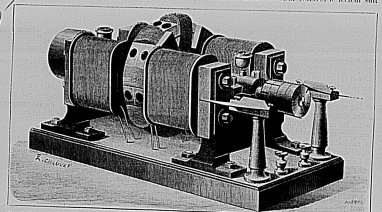

Fig. 1. Machine magnéto-électrique de M. Ruhmkorff (gravure extraite des *Principales applications de l'électricité*, par M. E. Hospitalier).

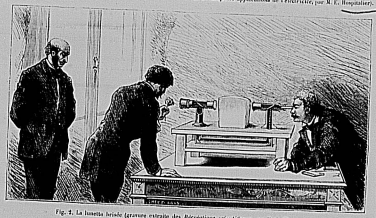

Fig. 2. La lunette brisée (gravure extraite des *Récréations scientifiques*, par M. G. Tissandier).

qui voulu que tous les jeux que nous indiquons, tous les passe-temps et les récréations dont nous donnons l'exposé, soient au contraire rigoureusement basés sur la méthode scientifique et puissent être considérés comme de véritables exercices de physique, de chimie, de mécanique ou de sciences naturelles. Il nous a semblé qu'il n'était pas bon d'enseigner à tromper, même en jouant.

La science en plein air, en plein champ, en plein soleil, est ce que nous voulons développer. Nous montrons comment on peut à la campagne, occuper et charmer ses loisirs, en observant la nature, en cherchant des insectes, en étudiant aquatiques, en observant l'atmosphère et les phénomènes célestes.

Nous enregistrons ensuite à faire un cours de physique complet sans appareil, et à étudier soi-même les différents phénomènes de la pesanteur, de la chaleur, de l'électricité et de l'électricité au moyen de simples verres à boire, de cartes, d'un bâton de cire à cacheter et de menus objets que tout le monde a sous la main. Une série d'expériences de chimie exécutées au moyen de quelques flacons de produits peu coûteux, complètent cette partie du livre établi aux sciences physiques.

Un autre genre de récréation, utile et intelligent, consiste à construire les appareils ingénieux qui composent une science. Nous donnons donc les moyens d'exécuter les appareils nécessaires, et à s'exercer à faire fonctionner ces appareils. Dans des chapitres intitulés : le Maison d'un amateur de sciences, le Laboratoire d'un amateur de sciences, nous avons réuni un certain nombre de renseignements pratiques, dont toutes les personnes ingénieuses et adroites, désireuses à se monter quelques appareils habiles, sauront à se monter quelques appareils qui permettent d'étudier ou le grand nombre des questions d'actualité ou à un grand nombre des phénomènes qui tentent de reproduire à un degré suffisant de perfection. Nous donnons ensuite, etc., jusqu'à la description de plus complexes, mais nous nous proposons d'exposer plus simples, tels que ceux qui servent à fabriquer la glace, etc.

Après avoir décrit des jeux scientifiques pour la jeunesse, nous avons voulu en indiquer d'autres pour l'âge mûr; nous avons groupé dans une seconde partie très spécial les curieux usages, si répandus aux États-Unis et en Angleterre, et si peu connus chez nous; bateaux à glace, patins, voitures à voile, courses à bicyclettes, appareils de sauvetage, etc.

Un mot que le présent ouvrage n'est pas seulement écrit pour les jeunes gens; tout le monde, nous l'espérons, trouvera quelque intérêt, quelque profit même quelque gaieté, à se mêler à notre conversation, à notre enseignement, tout en amusant les autres, à apprendre soi-même en s'amusant, tout en amusant les autres, à apprendre à tout le monde, qui est partout, sait aussi quand elle est bien comprise, procurer aux récréations et aux jeux.

Outre les gravures empruntées à *la Nature*, il y a un certain nombre d'inédites qui complètent les sujets traités, la figure ci-contre est de celle-ci; elle se trouve accompagnée, dans le livre, des lignes suivantes :

« Parmi les illusions d'optique les plus curieuses, il en est un grand nombre que l'on peut produire à l'aide de miroirs. La gravure ci-contre en est un exemple. Cet appareil, monté sur un pied fermant, permet de voir en apparence, comme le représente la gravure, un coq sortir de la bouteille et s'envoler. Le coq est en réalité placé derrière la bouteille, dans la partie inférieure. La bouteille est ouverte, et l'observateur, regardant l'image de l'objet exposé à sa droite, aperçoit nettement l'image de l'objet exposé en regard de l'objectif; cette image est reflétée par quatre lots avant d'arriver à son œil, au moyen de quatre miroirs disposés dans l'instrument. Le pied se ferme et est fermé de toutes parts et l'illusion est complète. »

Nous ajouterons que la Bibliothèque de la Nature s'accroît d'année en année, nous promettant un grand nombre de nouveautés, de nouveaux volumes de cuisine, d'ameublement, de mécanique, etc., et nous espérons que bon nombre de nos lecteurs, de plus en plus nombreux, voudront bien contribuer à ces ouvrages, destinés à répandre le goût de l'étude et l'amour du travail, du travail qu'ils font et ne cessé de faire à la publication qui en est la source.

GASTON TISSANDIER.

LE GRISOLMÈTRE ÉLECTRIQUE

La *Nature* a donné, dans le numéro du 5 mars 1877, la description d'un appareil inventé par M. Coquillon, et qui permet, au moyen d'un dosage calorimétrique assez simple, de déterminer la proportion de grisou contenue dans l'atmosphère des galeries de mines. Le grisoumètre de M. Coquillon est aujourd'hui entre les mains de tous les ingénieurs, et il a donné des résultats très satisfaisants.

Cependant, il présente l'inconvénient d'exiger l'emploi d'une galerie de mines, ou tout au moins d'une atmosphère confinée, pour opérer. Or, il est souvent très important de connaître, sur un point donné, la proportion de grisou contenue dans l'atmosphère d'une galerie de mines. Le grisoumètre de M. Coquillon ne peut donner que des résultats approximatifs, et il est d'ailleurs très délicat à manier. Il est donc très désirable d'avoir un appareil qui permette de déterminer avec exactitude la proportion de grisou contenue dans l'atmosphère d'une galerie de mines, et qui puisse être manié par des personnes peu habituées à faire des expériences de physique.

Le grisoumètre électrique de M. Le Chatelier, dont nous allons donner la description, paraît répondre à ces conditions. Il est fondé sur ce fait, que la vitesse de propagation d'une explosion dans un mélange gazeux est d'autant plus grande que le mélange est plus explosif. Si donc on détermine la vitesse de propagation d'une explosion dans un mélange d'air et de grisou, on pourra, en comparant cette vitesse à celle qui a été déterminée dans des mélanges d'air et de grisou de titres connus, déterminer le titre du mélange gazeux dans lequel on a opéré.

Pour mesurer la vitesse de propagation d'une explosion, on emploie un fil métallique très fin, qui traverse le mélange gazeux dans lequel on veut produire l'explosion. Ce fil est parcouru par un courant électrique, et il est rompu par l'explosion elle-même. Si l'explosion se propage avec une vitesse déterminée, elle rompra le fil au bout d'un temps déterminé, et si on connaît la longueur du fil, on connaîtra la vitesse de propagation de l'explosion.

Pour mesurer le temps qui s'écoule entre le moment où le courant est lancé dans le fil et celui où il est rompu par l'explosion, on emploie un appareil très simple, qui est représenté dans la figure ci-contre. Il se compose d'un électro-aimant, dont l'armature est maintenue par un ressort à boudin. Cette armature porte un levier, qui, lorsque l'électro-aimant est excité, est attiré par lui, et vient frapper contre un timbre. Le courant qui excite l'électro-aimant est lancé dans le fil métallique qui traverse le mélange explosif, et il est rompu par l'explosion elle-même. Le levier est alors ramené par le ressort à boudin, et il vient frapper contre un second timbre. Le temps qui s'écoule entre le moment où le courant est lancé dans le fil et celui où il est rompu par l'explosion est donc mesuré par l'intervalle qui sépare les deux coups de timbre.

Pour mesurer cet intervalle, on emploie un chronographe, qui est représenté dans la figure ci-contre. Il se compose d'un cylindre, qui est mis en mouvement par un mouvement d'horlogerie, et qui tourne avec une vitesse connue. Sur ce cylindre, on fixe une feuille de papier, et on trace sur cette feuille, au moyen d'un crayon, une ligne droite, pendant que le cylindre tourne. Cette ligne droite est interrompue par des dents, dont le nombre est connu, et qui sont produites par le passage d'un ressort, qui est mis en mouvement par l'électro-aimant. Lorsque le courant est lancé dans le fil métallique, l'électro-aimant attire son armature, et le ressort qui est fixé à cette armature vient frapper contre le cylindre. Lorsque le courant est rompu par l'explosion, l'électro-aimant cesse d'agir, et le ressort revient frapper contre le cylindre. Il y a donc deux dents sur la ligne droite, et l'intervalle qui les sépare correspond au temps qui s'est écoulé entre le moment où le courant a été lancé dans le fil et celui où il a été rompu par l'explosion.

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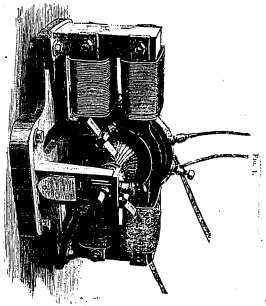
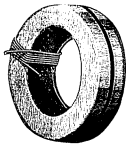
HEINRICHS' DYNAMO MACHINE AND ELECTRIC LAMP.

A GLANCE down the lists issued by the Patent Office will show that inventors are by no means satisfied with the dynamo-machines at present in use, excellent though they may be, and some of the more recent devices having undergone a preliminary trial are about to enter into competition with the Gramme, the Siemens, the Brush, and the Siemens. Amongst these is the machine invented by Mr. Heinrichs of which we give illustrations, and which has already been exhibited at work in the shops of Messrs. Perrin and Andrew, Deptford, South-London. It is rather remarkable that the most successful dynamo-machines in existence are all based on the principle of the annular armature first discovered by Dr. Antonio Pacinotti of Florence, Italy, and that of Mr. Heinrichs is no exception. By using a chamelled ring armature, however, a form suggested by the theory he has worked out, he has, it is believed, avoided all the disadvantages of the other ring forms, has utilised the greatest possible length of the insulated conducting wire for the generation of current. The result is that M. Heinrichs obtains from his lights from a machine little if anything larger than the single-light generators with which the public are now familiar. In Fig. 1, we have a perspective of the machine (one-eighth the full size); but the difference in construction will not be apparent from that. In Fig. 2, a cross section, the channelled ring armature is clearly seen. The channelled ring core

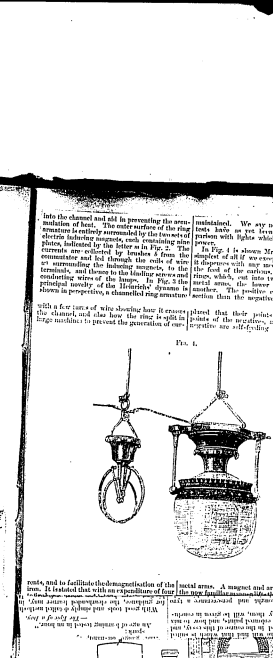


is made out of a bundle of thick iron wire formed upon a metal casing p. Around the core c is wound the insulated conducting wire w in 36 sections. These overlie the outer surface of the core entirely, and by crossing the channel of the core the inner leaves of the latter, when becoming magnetised, have no influences whatever upon that very short and nearly useless portion of the conducting wire which crosses the channel. The 36 sections are connected with each other consecutively by 36 commutator plates c^1 c^2, in a

Fig. 3.



manner similar to that adopted by Pacinotti. On the shaft s is a boss b, with six sets of spokes and held securely by metal bolsters. Wire coils which rest upon the spokes, but are cast into the channel and aid in preventing the accumulation of heat. The outer surface of the ring armature is entirely surrounded by the twenty-six electric fostering magnets, each containing nine plates, indicated by the letter a in Fig. 2. The currents are collected by brushes b from the commutator and led through the coils of wire on surrounding the fostering magnets, to the terminals, and thence to the positive screws and conducting wires of the lamps. In Fig. 3 the principal novelty of the Heinrichs' dynamo is shown in perspective, a channelled ring armature with a few turns of wire showing how it crosses the channel, and also how the ring is split in large sections to prevent the generation of cur-



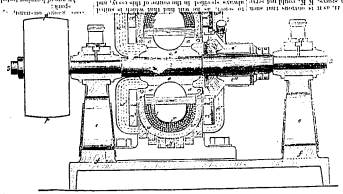
rents, and to facilitate the demagnetisation of the iron. It is stated that with an expenditure of four

maintained. We say nominally, because the tests have as yet been made only by comparison with lights which are sold to have that power.

In Fig. 4 is shown Mr. Heinrichs' lamp, the simplest of all if we except the Jablochkoff, for it dispenses with any mechanism for regulating the feed of the carbons. These are made in rings, which, cut into two pieces, are held by metal arms, the lower points touching one another. The positive carbons are of larger section than the negative carbons, and are so placed that their points are just above the points of the negatives, so that both positive and negative are self-feeding by the weight of the

Fig. 4.

sucial arms. A magnet and armature applied in the way familiar to many will be found to



the whole arrangement, prevents all shadow. It will be really understood that this lamp is not only the simplest yet invented, but the carbons being in the annular form, occupy less room for a given length than the straight ones. There are no wheels, chains, or racks, liable to get out of order, the feeding arrangement being simply the action of gravity. Some little difficulty has hitherto been found in getting suitable carbons made, but Mr. Heinrichs has devised an ingenious die which will enable a pressure of 100 tons to be brought to bear, and under that compression the circular carbons will no doubt be equal to the best of the ordinary form. As exhibited, the machine was supplying three lights which, as we have mentioned above, were of the nominal power of 2,000 candles.

whom a claim was being brought for 38,000*l*. He advised voluntary liquidation, and moved a resolution to that effect, which, after considerable discussion, was agreed to. The chairman stated that there was a proposal to form a new organization, which would be brought forward at the proper time. A committee of five gentlemen to co-operate with a similar number appointed by the creditors was agreed to, who should confer with the liquidator as to the course to be adopted. It was decided that Mr. Watchouse should be liquidator, conjointly with Mr. W. S. Peat, of Middlesborough.

THE ELECTRIC LIGHT.

SECOND ARTICLE.

(SPECIAL.)

THE SIEMENS SYSTEM.

THE principal electric lighting system of this country is that of Messrs. Siemens Brothers, Charlton. It has been introduced on an extended scale to light the promenade of Blackpool, a watering-place in Lancashire, and the Albert Docks, London, while its successful introduction into the great Reading-room of the British Museum, the *Telegraph* steamer, and elsewhere has brought it into note for lighting ships and buildings. It is also about to compete with other systems in illuminating the London Bridge district of the City, and the result of the trial will be awaited with interest.

In the Siemens system there are two classes of machines and lamps; one class designed for producing powerful single lights, and another for producing several lights of less power, all fed by the same current, and distributed so as to form a uniform illumination over a considerable area. The first are serviceable for the head lights of locomotives or steamships, for lighthouses and torpedo-work, while the latter are useful for street, hall, and factory lighting.

The dynamo-electric machines of the first class generate continuous currents. Assuming the current to exist in a coil or rather series of coils, of wire revolving in the magnetic space or "field" between the poles of very strong electro-magnets.

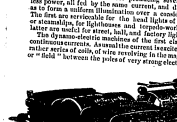


Fig. 1.

These coils are wound on an iron cylinder, mounted on an axle, carrying the driving-pulley, which holds the running belt from the engine or motor supplying the moving power. In the dynamo machine the axle is wound across the iron cylinder as the coil, but in the Siemens it is wound on Gramme-fashion round the cylinder, which here also serves for the coils a horizontal one. Sixteen machines with both of this construction, two on a table, enclosing the revolving coil or armature is that the pins of wire cross to the poles magnets, "at right angles, thereby getting the full effect of their power to excite a current. Each opposite pair of electro-magnets consists of a set of iron bars placed side by side, to form a kind of plate, and curved in the middle, as shown, to make room for the revolving coil.

These bars are wound at their flat parts with insulated wire, in such a way as to produce a strong magnetic pole at the middle or arched portion of the bars when a current is sent through the wire. In this way two opposite magnetic poles are formed, one above and one under the revolving coil, in which a current, or rather series of currents, is generated as it revolves past the poles. The series of currents follow each other so rapidly as to merge into a continuous current, and they are tapped from the coil by a double pair of straight copper combs, rubbing across the ends of the wire on the cylinder as it revolves.

In first starting the machine the current obtained is weak, and owes its existence to the "residual" magnetism or traces of magnetism left in the poles of the electro-magnets from the last time of use. But this weak current is allowed to flow through the wires of these electro-magnets in order to strengthen them when a powerful current is obtained from the revolving coil. A very short time suffices for this process, and the current can then be used for lighting purposes, as well as keeping up the strength of the electro-magnets.

Messrs. Siemens manufacture six different sizes of these machines, some of which are made with their magnets placed vertical instead of being laid horizontal as in fig. 1, D, the largest size, is capable of yielding an "arc" light of 12,000 candles, and requires about 7-horse power. It is 42 inches long by 31 inches wide, and 24 inches high; weighs about 19 cwt., and costs 175*l*. D² machine yields a light of 2,000 candles, and requires 2½-horse power. It is 29 inches long by 23 inches wide, and 19 inches high; it weighs 2 cwt. 3 qrs., and costs 80*l*. D³, the smallest size, yields a light of 200 candles, and absorbs about ½-horse power. It is 21 inches long by 11 inches wide, and 18 inches high; weighs about 1 cwt. 1 qr., and costs 32*l*. These machines can, of course, also be used for producing incandescent as well as "arc" lights, but in this case the yield of illuminating power would be considerably less than the above estimates, as it would be if more than one lamp were placed in the circuit of the current.

For several lamps in circuit, that is, for "dividing" the electric light, the most economical machine is that rendering up alternate currents. Fig. 3 represents the "Siemens" alternating current machine. It consists of two circular iron frames, bored with an even number of electro-magnets, or "bobbins," placed face to face, but separated by a narrow space in which revolves a number of coils of copper wire. In these coils the alternating currents are generated by their revolutions between the poles of the magnets. The latter are excited or made magnetic by the continuous current from a small machine of the continuous-current type for exciting. The alternating currents thus produced are led away by metal cords and conducting wires to the lamps, from about forty to forty of which may be placed in the same circuit, according to the power of the machine, and each giving a light of 20 candles or 100 candles. Four different sizes of this machine are made: W, the largest, giving from 20 to 40 lights, measures 37 inches by 37 inches across about the horse power, and costs 175*l*, or, with its exciter, 225*l*.; W, the smallest size, measures 19 inches by 17 inches high, and costs 50*l*.

Fig. 2.

The lamp used with the first or continuous current type of machine is illustrated in fig. 2. In it the lower carbon-holder is a fixture, and the upper carbon-holder is in the form of a rack, which, in sinking down under its own weight, turns a pinion or toothed wheel. In order to moderate the speed at which the rack descends, or, in other words, the feed of the upper carbon to the arc, a common clockwork escapement-wheel with its pendulum is fixed on the same axle with the pinion gearing with the rack. This escapement, which can be lifted up by the electric current (on solenoid or spiral of wire, attracting an iron core) connected to the frame. During the ordinary burning of the lamp a small lever fixed to the movable frame catches the upper carbon-holder at a standstill; but when the arc becomes too large, or the current is otherwise weakened, the attract the iron core strongly enough, and therefore lets the frame drop a certain distance, when the free end of the little lever is arrested by a projection of the lamp-casing.

Fig. 3.

and the pendulum is free to move. The upper carbon at once begins to descend, but as soon as the distance between the two carbons is diminished the strength of current increases, the solenoid again lifts the frame, and the lever again stops the descent of the upper carbon.

When it is desired to keep the arc of light in precisely the same position or "focus" the lower carbon is encircled by a copper ring, through which it is pressed upward, in order as it wastes away, by means of weights or a spring. These, according to sort, burn from 6 to 10 or 10 hours continuously without change of carbons, and they range in price from 16*l*. to 25*l*. When fitted with alarum regulator and time-keeping hole the price ranges up to 26*l*. The hanging-pendulum lamp (non-focusing), shown in figure 2, costs 12*l*.

It will be readily seen that, owing to the way the strength of current regulates the distance between the carbons in these lamps, that they ought not to be more than one lamp in circuit, for two lamps would interfere with the regulation of each other's light. The lamp of Messrs. Siemens, intended for burning along with others in the same circuit, or, in other words, for use with the alternating-current machine (fig. 3), is shown in fig. 4. It differs from the lamp just described in having coil of wire instead of one, and the frame carries two cores actuated by the solenoid. The added solenoid serves as a shunt, or by-path, to the current, and forms a high-resistance or main solenoid and the carbons, while part flows through the high-resistance. One solenoid tends to move the movable frame in one direction, while the other tends to move it in the other, and as its ordinary position depends on the *resistance* in solenoids, not the strength of current, any variation in their resistance causes the frame to move, and with it the upper carbon, until the normal resistance has been re-established.

Fig. 4.

These lamps cost somewhat less than the others, the pendent form shown above being quite low priced. It is enclosed in an opal globe, 20 inches in diameter, and carries an inverted umbrella reflector, 4 feet in diameter, to shed down the light upon the space below.

(To be continued.)

Electrician
Mch. 19 1881

THE CONSERVATION OF ENERGY.—In the *Proceedings of the American Academy of Arts and Sciences*, vol. xv., part 2, 1879-80, Mr. John Trowbridge illustrates the conservation of energy as follows:—Let an induction coil be set in action. In the circuit of the secondary coil place another coil of fine wire. Adjust the terminals of the induction coil so that the spark just passes, then place a core of iron or a bundle of iron wire in the coil which has been included in the secondary circuit. The spark instantly ceases to jump. A portion of the energy of the current in the secondary circuit has been consumed in magnetizing and demagnetizing the iron introduced into the additional coil. The work done in this way is capable of being measured. It is also evident that, when a number of telephones are in the same circuit, a part of the energy of the human voice is consumed at each telephone in heating the magnetic cores. In the same paper Mr. Trowbridge alludes to his researches as to how much of the work employed in driving dynamo-electric machines is consumed in heating the iron cores of the generator of electrical currents, and whether this loss of work should turn our attention to forms of generators in which this loss is obviated.

IRON.

THE FARCOT DYNAMOMETER.

It is highly important to be able to measure the power absorbed by a machine, especially for determining the horse-power of the motor intended to drive it and the strength of material required for the transmitting gear. Notwithstanding the many appliances invented for this purpose, almost the only one in general use depends upon a style which traces the varying strains on a band of paper moving at a uniform speed; but this machine possesses the great disadvantage of not enabling an immediate indication of the power that is being absorbed, and of rendering necessary much subsequent calculation, so that considerable time must elapse before the desired result is arrived at. M. E. D. Farcot, mechanical engineer, of Paris, has lately turned his attention to the improvement of pressure and exhaust fink. In testing them with an ordinary dynamometer, he was so struck with the evidently erroneous results obtained, that he set to work to devise a trustworthy instrument from which a reading might be taken at any moment. The principle of his dynamometer consists in measuring, by weighing, the strain transmitted by the leading side of a belt passing over the pulleys of two shafts, the driving and the driven, with the intervention of tension pulleys hung on swing beams.

In the opposite engravings, fig. 1 shows a perspective view, and fig. 2 a diagram, of the Farcot dynamometer, while figs. 3 and 4 are end and side elevations respectively. The frames, AA, are provided with bearings in which revolve the two shafts, *a* and *d*. On the former is keyed the pulley, D, driven by a belt from any motor; and on the latter the pulley, D, driven. Independent of the shafts are the pulleys E and *f*, connected by the belt, C, which also passes over the two tension pulleys, *e'* and *f'*, revolving loose on their axes, *b* and *c* respectively, in the swing frames, whose points of suspension are *e* and *f*. From the points B and H, equidistant from the centres, are suspended equal weights, *β* and *β'*, just sufficient to prevent the belt from slipping. It is between the power and the resistance, and may be regarded as the measure of the latter, and may be readily found. When the belts C and C' are subjected to the dynamometer set in motion, without, for the present, being connected with anything, the pressure of the tension pulleys on the belt C, due to the weights adjusted, is counterbalanced, and weights must be added to the plate until it is restored. This is the "tare," which must be deducted from the total weight on making an experiment; but practically it is found more convenient to construct a table of "tares" for different velocities. The dynamometer is now connected by a belt with the machine to be tested, when the equilibrium is again destroyed; and more weights must be added until it is again restored. The doubling of the belt, in passing over the tension pulleys, is exactly compensated by the latter being hung

midway in the swing frames, so that the weight on the plate multiplied by the circumferential velocity of the driven pulley gives the work or resistance in kilogrammetres or foot-pounds, as the case may be. The speed at the circumference of the driven pulley, *e'*, or revolution indicator, *l*, connected by a strap with the pulley, *f*, on the driven shaft, *d*. As the machine is arranged in the diagram, it is true that, for very exact results, there is a slight correction to be made for the angle formed by the belt, *c*, with the vertical, but a constant is readily found to meet the case. Each revolution of the driven pulley corresponds to 1·57 metre, which, at the rate of 10 revolutions a second, gives a speed of 15 min. 7 sec.; therefore each kilogramme added to the weight plate represents a work of 157 kilogrammetres, or, rather, 150 with the correction. So sensitive is the apparatus, that the motor must be provided with a heavy fly-wheel, or each stroke is manifested by a vibration of the swing-frames; and it is a curious fact that a mere drop of oil given to the bearings is equal to about a pound removed from the weight plate. Provision is K, carrying a Salter's balance, *g*, and a small grooved pulley, *h*. A cord with weight, *β'*, at the end, passes from the balance round the grooved pulley, *h*, on the driven shaft, and over the small pulley, *h'*, thus constituting a Prony brake.

Some experiments made with a dynamometer on this system having a driven pulley 80 centimetres (2·3 inches) in diameter, were made on a 120 centimetre (5·9 inches) Farcot pressure fan, with a blast orifice of 24 centimetres (9 inches), with the following result. With a speed of 500 revolutions per minute of the fan and 181 of the dynamometer, the pressure was equal to 12 centimetres (4·9 inches of water, with a volume of 6·198 cubic metres (219 cubic feet). With 530 revolutions per minute of the fan and 166 of the dynamometer, the pressure was equal to 16 centimetres (5·9 inches) of water, with a volume of 5·987 cubic metres (205 cubic feet). M. Farcot's new fan, as he terms it, permits of their being calculated in a more simple manner than usual, by taking, as the basis the speed corresponding to the pressure desired, and providing a chamber reduced to the minimum of the sectional area necessary to give the volume required at the given pressure. The "turbine," or revolving portion, differs from others in the curvature of the blades, thus increasing the centrifugal force, because the air, instead of following the radius, escapes in the direction of a line more inclined than the radius itself. The result is that the air circulates through the turbine in the smallest possible time, so as to cause a minimum of friction and, therefore, of vibration. The air thus moves with a uniform speed equal to that of the turbine. The "fly-wheel" of air, arranged around the turbine between two cheeks, plays a large part in preventing the vibrations and rendering the delivery uniform. The annular chamber is arranged spirally so as to assist all the useful effect. This arrangement permits light substances from reaching corn and other matters to be conveyed with a single fan, When a cone cannot conveniently be added to obtain a progressive exit and increase the arrangement of double suction ventilator; but in this case the speed must be greater.

(81, *a*) It will be perceived that there is given a difference of only one line between the Front-Pitch and the Concave-Parallel Pitches. The really correct addition, for Concavity, is a Board of such Compass as the present, is 2 lines; but the 1 line is more perfectly because among other reasons, given with *Double* Front-Pitch, as the exact area of the Concave Pitch Board is—for the sake of uniformity—adopted also for the Flat-Front Pitch. Which double obligation, when a short-front is preferred, it is usually out of question to have the said Cutting made wider than the Pedal-Frame is at the front glove—for otherwise an unsightly gap will be visible after the Pedal-board has been pushed back into its place. In all instruments, therefore, which possess a complete Fronted Plinth, the Checks of a *Sunken* Pedal-board (whether Concave or not) will never extend beyond the distance already given. (If there be *Composition Pedals* under the provision for the Bearings of which the chief object of this elongation of the Cheeks is to secure a sufficient length of Bearing for the Pedal-Key, whenever the Pedal-board is a *Detachable*, a *Falling*, or a *Sliding* one.) In some instruments the entire Pedal-Frame itself may have to enter the Plinth one inch (see Head of Post, in Report, of Front-fronts), but the resultant gap of no small a dimension is to be of practical service.

2. It is now necessary to consider the Concave Pitch of the Manual with the Pedal-board. Hitherto it is has been assumed that both Manual and Pedal Keys are Flat—that is, that the Front, respects right and left, of the Case, and yet a Board of the Clavier be allowed to Concavity, is not so in fact, for it has been found that the Pedal-board of such Concave Pitch is not always by any means that a given Pedal Key must always be set—exactly with the corresponding Key beneath a Manual Key,—whatever be the Compass of either the latter Pedal-board or the Manual.

3. This matter also is fully gone into under the head of Point in Report of Front-boards. It will be sufficient to say here that the Point of Centre for Concavity always set at the exact right and left Centre of the Manual Board, and that with a Pedal-board either the CC or the C-sharp Pedal Key (preferably the latter) will be found to be directly beneath the Middle C of the Manual.

4. In order to add to the utmost the correct Sufficiency of the Pedal-board, the Front of the Keys, for Concavity, from the Front of the Case as a whole—here considered—is to be set back to the Front of the Pedal-board, and the consequent slight discrepancies will have to be met by the Pedal-Frame, or Pedal-Fronts, upon which shall exist between the Front Projections of the Plinth. The Manual is in all cases assumed to be made to Normal Scale (see Report of Manuals).

5. With the Position and Scale of the Pedalboard as already understood and—and with the Concave Pitch of the Keys of Board adopted, the dedications of the Pedal Clavier will be as follows:—

If, With the Pedals placed C under C, and the Manual extending from CC to F' (Two Oct. and a Fourth), the Pedal-board will be (in. for *Low Set*). This will manifestly ensure that the space between the Plinth-Projections be extended to Sixteen Inches (in. as a gap of 2in. will appear on the *right* of the Pedal-Frame.

If, The Pedal-board C be added to the top of the Manual, the latter, and of course the Pedals and the left Front-Projection of the Plinth with it, will be driven one half of a Manual-Natural Key-distance still *further* to the left; and this will necessarily involve the setting of the *right*-hand Plinth-Projection at a half of such Key-distance to the *right*. Thus the dimension of 2in.—full note that—to be added to the dimension, making the clear length-distance between the Plinth-Projections to be 17in.—full more than is required for the actual entry of the Pedal-Frame, and involving a gap of the said 2in.—full at the right hand of the said Frame.

If, If the Pedals be placed C sharp under C, the left-hand Plinth-Projection will obviously be driven 11in. yet more to the left; and the right-hand Projection must consequently be set the same amount to the right. Thus there is then involved an addition of 22in. to either of the two previously given dimensions for C under C.

I. With the Scale of the Pedals set as already understood in Report, and their Clavier made to extend the full amount of Two Oct. and a Fourth (C to F'.—Vide Report of the Board below, remember, still *Essential*—the dedications of the Clavier will be as follows:—

II. With the Pedals placed C sharp under C, and the Manual reaching from CC to F' (Two Oct. and a Fifth), the Pedal-board will be 23in. full for far to the *right* than given at page 50—full at the *left* of the Pedal-Frame.

(*To be continued.*)

THE DEVELOPMENT OF THE PACINOTTI RING.

IN our last number we had the pleasure of bringing before our readers Heinrichs' new dynamo-magnet generator, in which he employs the now classical Pacinotti armature, and, as we said on that occasion, it is rather remarkable that the most successful dynamo machines at present in use are all based on the principle of the annular armature first applied by the Abbé Pacinotti, of Florence, in 1860, which was first described in *Il Nuovo Cimento*, which can be seen at the British Museum Library. We shall now, in this article, show the most important forms of ring armatures in use, and also Mr. Heinrichs' theory of the generation of electric current in a ring armature. This theory differs from others in very important respects, in his always been understood that the soft iron ring-core, when in action, acquires a magnetic polarity dependent on the electric action of the core, but Mr. Heinrichs shows that when the coil-wire and the inducing magnets fields, the ring-core, when in action, will acquire hardly any magnetism, and electric currents are generated in the insulated conducting wire surrounding the core by the influence of the inducing magnets only; and when the inducing magnets are removed, the ring-core will not retain any magnetism, it will acquire on the inner surface a reversed magnetic polarity to the outer surface.

In the former case (the small ring), the entire conducting wire surrounding the outer surface of the ring will be useless for the production of currents, while in the latter case the inner reversed magnetic polarity will give an impulse to the generation of currents in the insulated conducting wires surrounding the inner surface of the ring-core in an opposite direction to the current generated on the outer surface of the ring-core, as we shall see later on.

We shall show now, firstly, how currents are generated on a bar-magnet and on a ring-magnet. It is well known that when a piece of soft iron is brought with one of its ends close to a magnet (Fig. 1) this piece of soft iron will

Fig. 1.

become also a magnet, and the one end nearest to the magnet acquires south polarity and the other end south polarity. In the middle of the piece of soft iron a neutral line, *t t*, will be established, and if the piece of soft iron were surrounded with insulated conducting-wire, a current would be set up or generated in the entire length of the wire in *one direction*. As is well known, this is the principle on which all so-called magneto-electric currents are generated. If now we change the inducing magnet to the

A NEW CONTINUOUS CURRENT DYNAMO-ELECTRIC MACHINE.

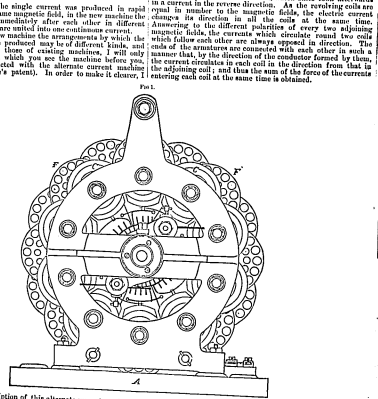
By F. von Hefner-Alteneck. (Translated from *Elect. Zeit.*)

The growing importance of the supply of electric currents by means of machinery, induces me to direct your attention to a new dynamo-electric machine, by means of which the combination of a single induction current with continuous action is brought about in a manner different from that of any former machines.

Whilst in these the single current was produced in rapid sequence from the same magnetic field, in the new machine the currents produced immediately after each other in different parts of the machine are united into one continuous current.

Although in the new machine the arrangements by which the separate currents are produced may be of different kinds, and may be copied from those of existing machines, I will only describe the form in which you see the machine before you, in which it is connected with the alternate current machine (Siemens and Halske's patent). In order to make it clearer, I

Fig. 1.



must give a short description of this alternate current machine, although I have already done so on a former occasion.

Fig. 3 shows a part of the cross section of the machine, and Fig. 1 will at the same time refer to Fig. 2, although this is a longitudinal section of the new continuous current machine.

On the base plate A, Fig. 2, are fixed two iron supports B, B, of the form of which is shown by the drawing. On the inner side of each of these supports are fixed an equal number of electromagnets, C, C, the poles of which, facing each other, are spread out into suitably shaped plates, N.S., N.S. The polarity of these electro-magnets is so managed that each one has the opposite polarity of the one facing it, and of those on the same side right and left of it.

From this arrangement it results that the pole plates of the pairs of electro-magnets opposite to each other form powerful magnetic fields, of which each has the opposite polarity to the plate next to it.

Through the magnetic fields runs induction coils which have a wooden core, and are connected with the axle A, filling up as far as possible the space between the magnetic fields. For the sake of distinctness, only two of these coils are shown in Fig. 3, and these with half of the coil a.

is between the point next to it. Thus, in the one half of the coil an upward current is induced, and a downward one in the other half, which currents mutually strengthen each other. When the coil is between the two magnetic fields there arise induced currents in the two halves of the coil, which unite soon afterwards in a current in the reverse direction. As the revolving coils are equal in number to the magnetic fields, the electric current changes its direction in all the coils at the same time. Answering to the different polarities of every two adjoining magnetic fields, the currents which circulate round two coils which follow each other are always opposed in direction. The ends of the armatures are connected with each other in such a manner that, by the direction of the conductor formed by them, the current circulates in each coil in the direction from that in the adjoining coil; and thus the sum of the force of the currents entering each coil at the same time is obtained.

In Figs. 4 and 5, for the sake of clearness, the coils introduced into the circuit are distinguished to the eye, those in which the current flows in one direction being coloured black, while those in which its course is opposite are left white. The alternate polarity of the magnetic fields is shown in the same way. For the same reason, the coils and the magnetic fields are shown concentrically to each other, the diagram only representing with accuracy their relative angular position. With reference to these illustrations, the following must also be borne in mind. Each white coil which approaches a white magnetic field, and each black coil approaching a black one, develops a current in the preceding a black field, or vice versâ, on the contrary, develops a current whose motion is opposed to that of the machine. To put it more simply, coils approaching fields of the same colour induce the opposite colour, they induce a current in the reverse direction. It will be seen from Fig. 4 that at the moment of the revolution which it represents, the coils are approaching magnetic fields of the same colour, whilst in the eighth of a revolution more the reverse will be the case. Hence, in consequence of their [illegible] to my preceding [illegible] coils is united to produce a [illegible], while, by the continued revolution

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N.Y. Tribune, Sept. 23rd, 1881.

THE ELECTRIC EXHIBITION.

THE CLAIMS OF GRAMME AND PACINOTTI.

A LETTER FROM PROFESSOR CARHOLL ON THE RIVAL CLAIMS TO THE INVENTION OF THE DYNAMO-GENERATOR—TESTIMONY OF PROFESSOR WHEATSTONE—DESCRIPTION OF THE TWO MACHINES.

To the Editor of the Tribune.

SIR: In my correspondence with you on the Electric Exhibition, I had made mention of the little machine on view in the Italian Department, known as the Pacinotti dynamo-generator. Its presence at the Exhibition has excited general interest and discussion from the fact that it seems to prefigure a later invention, the Gramme armature, which has carried magneto-electricity from its former state of an experimental science into the ranks of the practical arts. At the suggestion of friends I was induced to suppress the paragraph, as likely to lead to unfair conclusions respecting the merits of the later inventor, M. Gramme. At the same suggestion I beg to refer to your indulgence a brief summary of the main points in the discussion:

Up to about 1860 the machine now known as the dynamo-electric generator had not advanced beyond the point of perfection of the old "Alliance" machines, in which a series of spools of wire, enfolding each its separate core of soft iron, were set around the rim of a circular disc, and by its revolution brought into rapidly successive contact with the poles of the so called field magnets. In this form of armature the cores, it will be observed, were perpendicular to the plane of the wheel, while the wire coils, naturally, were wrapped parallel to this plane. In 1860 Professor Pacinotti, of Pisa, invented a new armature, first officially made known some years after. In this form the soft iron core is continuous, a bar of solid metal bent into a ring, and wrapped at intervals with spools or bobbins of wire in folds perpendicular to the plane of motion, and so presented to the magnetic poles in a position at right angles with that of the old machines. Scientists recognized in this new form a marked advance in magneto-electric science; the machine was examined, discussed, used for experiment, and finally—as I am rightly informed—relegated to the shelves of the physical cabinet, if not actually dismounted.

Some years later, M. Gramme, then a plain, thoughtful, practical mechanician in Paris, ruffled of all knowledge of Italian or Italian scientific reports, struck out his own form of magneto-electric wired, which under the name of the Gramme armature is now known to all enlightened countries, and lies at the bottom of all present devices for producing magneto electricity. His armature presents striking features of resemblance with the Pacinotti, in the essential idea, while it combines elements of mechanical detail which immensely increase its effect, and render it practically available for commercial production. His continuous circular core is itself a bundle of wires, not a solid bar, and his enveloping wire coil is continuous, not broken into separate sections. Instead of two extremities of a horseshoe bar magnet, he surrounds his armature the same reason, the coils and the magnetic fields are shown concentrically to each other, the diagram only representing with accuracy their relative angular position. With reference to these illustrations, the following must also be borne in mind. Each white coil which approaches a white magnetic field, and each black coil approaching a black one, develops a current in the preceding a black field, or vice versâ, on the contrary, develops a current whose motion is opposed to that of the machine. To put it more simply, coils approaching fields of the same colour induce the opposite colour, they induce a current in the reverse direction. It will be seen from Fig. 4 that at the moment of the revolution which it represents, the coils are approaching magnetic fields of the same colour, whilst in the eighth of a revolution more the reverse will be the case. Hence, in consequence of their [illegible] to my preceding [illegible] coils is united to produce a [illegible], while, by the continued revolution

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N.Y. Tribune, Sept. 23rd, 1881.

On the 17th of July 1871, Professor Zenobi Pacinotti [illegible] from the French Academy of Sciences the description of a machine invented by M. Gramme." On the 25th of August, 1871, Professor Fabrizio Meucci wrote a letter to the Secretaries Perpetual of the French Academy to [illegible] the same date in 1860 he had constructed for [illegible] a machine which in the theory of Pixii, an electro-magnetic machine based on the same principle as the Gramme machine. But neither Professor Pacinotti nor Professor Meucci claimed for M. Gramme more than a merit of invention, on the contrary, enforce the correctness of the claims of the above-named patents.

I am sorry that the short time since to send you a complete report, but what I have pointed out will be sufficient for your purpose.

The Journal Encouragement de Paris decreed to M. Gramme a gold medal of the value of 3,000 francs; *La Chambre des Deputes* voted an extraordinary prize of 50,000 francs for M. Gramme, the great prize of 50,000 francs was awarded to Professor Pacinotti, Gramme and Meucci created Chevalier of the Legion of Honour, and of the Order of Leopold. All these honors and prizes, it seems, have been conferred upon him, but his merits [illegible] to an original one. I remain, dear sir, yours faithfully,

WARMINGTON.

To Professor Carholl, Paris.

On the morning of my departure from Paris, September 1, I had a brief interview with M. Gramme himself at the house of its confidential adviser, M. Hippolyte Fontaine. The points were substantially in effect such as I have stated. M. Fontaine urged, with especial emphasis the following heads: In purely theoretic regards, the Pacinotti wheel supplies, it is conceded, the idea; the scientific germ of the Gramme armature. But the Pacinotti machine was a modest little bit of apparatus (about the size of an ordinary kitchen coffee-mill), was never used for the production of electric force, on the modern commercial footing, and could not have done so even if got up on the most large and elaborate scale. It never passed from the stage of experimental to the practical stage. M. Gramme, on the other hand, with no inkling of the Pacinotti idea, struck out his own invention, on independent lines, and promptly developed it in its present point of surprising commercial electricity, as parlance, to all the various departments of human utility in which it is now employed.

I then presented the unselfishness of views which I had myself claimed in my own account in urging more positively the claims of Professor Pacinotti to have not wrested the palmies of your readers. It is barely possible that this communication may be of interest to persons scientifically interested in science, as well as to that large class in liberal and practical life who look to the fruits of science and practical invention, especially in one which bears so powerfully on human progress and importance as the art of magneto-electricity. Very respectfully yours,

CHARLES CARHOLL.

New-York University, Sept. 24, 1881.

N.Y. Tribune, Sept. 23rd, 1881.

THE GRAMME DYNAMO.

To the Editor of the Tribune.

SIR: In your paper of to-day I noticed a peculiar error in Professor Carroll's letter on Gramme machine, and though I am not by profession a scientist, I have a number of electrical machines under observation, including this particular machine, and would therefore request you to allow me to correct the mistake. It is stated that "... His (Gramme's) armature spools." This is not correct; for, on the contrary, Gramme's and Pacinotti's armatures are alike in the very particular. Gramme's armature is composed of a series of strips of metal, very thin and [illegible] being placed longitudinally along the whole of the [illegible]. These strips are separated by similar strips of [illegible] and the whole mass is connected with the beginning [illegible] which is a peculiar feature of Professor Carroll's [illegible] Pacinotti's armature is composed of a solid iron ring, [illegible] Professor Carroll will now either do me [illegible] in the electric machines, or in the Marcelle "La [illegible] Electricite" or "Les Merveilles de la Science" [illegible] he will find descriptions and accurate drawings of these particulars.

NEW-YORK, Sept. 24, 1881. G. DAVIS.

beginning as cold, dry winds, they grow more thirsty as they grow warmer, and enquire in intense desperation over. They drink up the waters of the Caspian, the Sea of Aral, and the salt lakes of Asia, and also of the coast of Mediterranean. They have blighted and blasted Mesopotamia and Persia, and turned what was once a paradise into an arid waste. In conclusion, the speaker argued that the climate enjoyed by the ancient Assyrians must have been an insular climate like that of the modern British, and ended with a well-drawn parallel between the national characters of the two races.

NEW ELECTRIC MOTOR.*

By WILLIAM WOODCUTT GIBSON.

An electric motor, as the name indicates, is an engine for converting electricity into mechanical force. This is done in an efficient manner through the medium of electro-magnetism, and the honor of inaugurating the movement which has led to the utilization of this force, as a motive power, is due to no less a person than Professor Henry. His first paper on this subject appeared in 1831. In the following year Sebrandus du Moncel constructed his motor and described it in detail. These early electric motors were rude machines, about as efficient as a locomotive steam engine, but it hardly took the world long to perfect the one from a required economy to equal that of the other. But Negro's motor consisted of a fixed electro-magnet, which, by uniform interruptions of the electric current, alternately attracted and released a lever by which the mechanism was driven.

In 1835, Prof. Jacobi, of St. Petersburg, constructed an electric engine at the expense of the Czar Nicholas, with which, after four years of further experiment, he was able to drive a rowboat-load test against the swift current of the Neva at the rate of three miles an hour. His enormous battery consisted of sixty-four cells, containing every square feet of platinum.

This was in all respects an apparent failure, and the philosopher was thoroughly disheartened while standing upon the threshold of a brilliant success. In the first place, he attempted the impossible in trying to get a great power economically from any battery, and in the second place no powerful battery had yet been invented. But his failure was an excellent one, and the subsequent inventors failed to equal it until Gramme, of Paris, discovered that one of his own dynamo-electric generators would act in the reverse direction as an admirable motor.

The interval between 1838, when Jacobi's motor was abandoned, and 1870, when Gramme's machines came into notice, was occupied by a large number of inventors, who brought to their work a world of ingenuity, and all the learning of all the centuries save one, but that one was the only key to success—*the magnetic induction*. In the meanwhile Mr. Sturgeon, a former worker after the nineteenth century philosopher's stone, dashed the hopes of his co-inventors by his demonstration of the economy of force. This magnificent work, like the grand-el perhaps in the help of science, was immediately made the basis of a series of experiments, which it would be out of place to detail here. Suffice that Mr. Joule proved that the best results of all scientific minds that the mechanical energy of the electrical current, produced by the consumption of one pound of zinc in a Daniell's cell, is sufficient to raise 1,100,100 pounds raised to the height of one foot; in a Grove cell, which has one and three-quarter times the electro-motive force of Daniell's, to 1,925,0 0 pounds raised to the height of one foot, or, in the simple chromic acid battery used before you, which has double the electro-motive force of a Daniell's, 2,222,200 pounds raised to the height of one foot. Dr. Scoresby and Mr. Joule state their conclusions in the following sentence: "Upon the whole we feel ourselves justified in fixing the maximum available duty of an electro-magnetic engine, worked by a Daniell's battery, at 400 pounds, raised one foot high for each grain of zinc consumed." This is about half the theoretical duty. In a Grove battery the same proportion would give 741 pounds, and in the chromic-acid battery 800 pounds, raised one foot high for each grain of zinc consumed. This result was immediately compared with the duty of the best type of steam engine per grain of coal, and it was found that one grain of coal lifted 142 pounds one foot high. At that time, the most favorable computation, costs ten times as much as coal, and the force it yields is, therefore, as 142 is to 80 or about nine times as costly.

The conclusion instantly drawn by the scientific world was that electricity produced by the consumption of zinc can never compete with steam, but it is the purpose of this paper to collect certain facts which will show that this conclusion is erroneous.

History is teeming with instances where noted scientific men declared that there was nothing attainable beyond their immediate vision, and greeted with sarcastic epigrams and brilliant sophistry the proposition to accomplish results which were impossible. So it was of old in the steamship. An eminent scholar and mathematician proved by the most unanswerable arguments the paradoxicalness of a steam boat. A steamship was an absurd dream. His calculations showed that one could not be built large enough to carry her coal across the Atlantic. And so these gentlemen, having proved that electricity produced by zinc is many times more costly a source of power as steam produced by coal, predict that electric motors can never usefully compete with steam engines. Now, mon power, according to the tables of a well-known English engineer, is one hundred times as costly as steam; nevertheless there are several circumstances in which we prefer men. It is evident that we would never employ men if we could get a steam engine to do the work more economically, and it is equally certain that we would not use electricity when steam is applicable. But steam is not applicable, for reasons which will appear as we proceed, to work in which we require a small amount of power for a constant confidence for action. In these cases—such as barbers' lathes, dental engines, and sometimes also in small machine shops, which employ but a small force of men—we have never been able to find a source of power united to the work which, if not as cheap in proportion as the steam engines, should yet be more economical than human energy. The fact is that whereas, according to the, the best electric motors are also times as costly as power, human energy is eleven times as costly as that of steam. Now, as human energy, which is one hundred times as costly as steam, is completely perfected to small duties *in fortiori* electricity will, when developed to the same perfection, find it employment to almost any extent. The energy thus saved from extinction in the exercise of these can be elevated to a higher use.

Any of illustration, the application of human energy

* Paper read before the Franklin Institute, Nov. 17, 1880.

to the sewing machine is not only a false economy, but has proved the cause of many new and painful diseases in female operators, which combine their force and effect the physique of their offspring. If any motor can be substituted for human energy in this field, there can be no greater or more far-reaching consideration offered to invite attention to it.

The sewing machine is in almost every home, and the evils of these diseases are spread in every class of society. The remedy, as before mentioned, is a household motor, and it was natural to suggest a small steam engine for this purpose; but steam is unsuited to this end, because

First,—It requires time and trouble to start it to work and a busy housekeeper, who may only need, perhaps, to do five minutes of sewing, has no time to waste.

Second.—It is dangerous, liable to explode, or to burn out the boiler, or get various portions of its complex mechanism out of order, so as to require an experienced engine driver to repair it.

Third.—It emits an offensive odor of burnt or boiling oil, and vitiates the atmosphere with the products of combustion.

Fourth.—It is really much more expensive than those steam engines from which our calculations were made, for gas is consumed for a household engine, the fuel amounts to from two-fire to twenty-five feet of gas per hour, according for a motor giving one-thirty-third of a horse power, as much as the fuel of a six or twelve horse-power steam engine.

This last consideration would not weigh with the actual sufferers of the acute forms of disease, but the other objections are serious, and apply to all heat motors, such as gas, steam, and caloric engines.

Other motors are before the public—the various hydraulic motors which require the special introduction of water pipes and waste pipe, and entail yearly visits from those friends of humanity, the plumber and the tax collector. Then there is the spring motor, which you wind up every quarter of an hour or so, expending, of course, much more power in the winding than you get out of it in work, and which has the unhappy habit of breaking its hands accidentally and venting its store of energy where it is least needed. Then there is the curious chair motor, whose mechanism is connected with the seat of the chair, and by various levers, cranks, cams, and wheels is to save shaking nerves. The seat of the chair gradually sinks about three inches beneath the weight of the operator, driving the sewing machine the meanwhile. The operator then rises, the spring lifts the seat, and the performance is renewed. A rapid speed can be obtained by rising and sinking forty times per minute.

The only motors which seem to be available for this purpose are electric motors, used with batteries. They may be divided into two classes, which utilize the same attractive force of an armature to an electro-magnet like the motor which drives your sewing machine, in the ordinary literary upstairs, and those which utilize the attraction and repulsion of two or more electro-magnets.

The former are by intermittent attraction only, and are wasteful of electric energy, because the useful magnetism, at the moment of the cessation of the current, retards the passage of the armature away from the pole which has attracted it.

Those of the latter type, however, convert a portion of the wasted influence of the residual magnetism into a useful force. In fact, all dynamo-electric generators, when used as motors, convert all magnetic resistance to motion into a counter electro-motive force.

Strange to consider a counter force as a help, but in point of fact it retards the consumption of power in that it very and tends to depolarize the zinc plates. It has been usual to regard this counter electro-motive force as a disadvantage. A small number of the type before you was laid motionless while a sufficiently powerful current—let us say of four webers per second—observed its cells. A running galvanometer was in circuit, whose deflection was carefully observed. Then, without changing the connections, the motor was allowed to run at full speed, when the galvanometer indicated a considerable drop in the strength of the current. The electro-motive force of the battery was practically constant, electricity obeying the law that formula

$$\text{Electro-motive force} = \text{Current} \times \text{Resistance}$$

the galvanometer should have indicated the same current as at first, unless the resistance has been changed or a counter electro-motive force produced. The speed of rotation was then diminished by a brake, and the needle immediately indicated a stronger current. This is in direct conformity with the well known fact that the electro-motive force of a dynamo-electric machine varies with the speed of rotation, whereas the resistance of a coil is not affected by mere motion.

A still more striking proof that the "back-pull" of residual magnetism may be converted usefully into a motive force is exemplified in a motor constructed some time ago by the writer on the same principle as this one, save that the coils were fixed and connected with the battery. The current of the battery is sent through the armature, which revolves with considerable rapidity. If the fresh coils of the field coils are now connected the speed is immensely increased, and if the coils are separated a spark appears, of course there is some loss. The entire amount of energy consumed by the motor is, however, less than when the coils are disconnected

A NEW DYNAMO-ELECTRIC MACHINE.

We give an engraving of a new continuous-current dynamo-electric machine, recently perfected by Mr. Clinton M. Ball, of Troy, N.Y. This inventor has been engaged during some years past in building machines similar in type to the alternating-current machine of Hefner-Alteneck (recently described in the SCIENTIFIC AMERICAN SUPPLEMENT), especially in respect to the shape therein of solid metal parts in the armature, the latter being constituted in the form of a disk composed of a series of coils without iron cores, arranged and adapted to be moved in a magnetic field consisting of a series of poles of alternately opposite polarity on the same side of the disk, and facing opposite sides of the disk.

Mr. Ball has perfected several forms of continuous-current machines of this general type, and from among them we have selected two forms, which we illustrate. These machines have been operated with entire success at Troy; and samples of the machine are either already installed at the Paris Exhibition of Electricity, or are on their way to that destination, forming a part of the joint exhibit made by the "White House Mills" and Mr. Ball.

The bipolar machine, Fig. 1, reproduces the effects of the well-known Gramme machine, over which it possesses important advantages. Its special peculiarities and advantages may be briefly summed up as follows: The armature is composed of coils, six in number, each of which occupies a sector of the disk of 60°. These coils are made self-supporting in the disk, without iron cores or metallic parts other than the wire of which they are composed, and are connected in a continuous circuit. The commutator plates are six in number and constitute the terminals of offshoots from the junctions between two contiguous coils. These commutator plates are zonally disposed apically about the axis of the arbor of the machine so as to show at opposite ends an angular displacement from axial parallelism of 90°. From this it results that during rotation a pair of diametrically opposite coils in the armature are by circuited during one twelfth of a revolution at the neutral point of the machine, and this effect recurs successively through the entire series of coils. It will be understood that an important advantage is gained by this arrangement, inasmuch as the resistance of the inactive coils of the armature is thereby eliminated from the internal circuit of the machine. This machine, used as a generator, presents striking and powerful effects with small expenditure of power. It may be used as a very perfect form of an electro-magnet motor. It runs without serious sparking at the commutator, and is simple and compact in construction. A further noticeable feature, which exists furthermore in all machines of this type, is the absence of any noticeable external magnetic field when running.

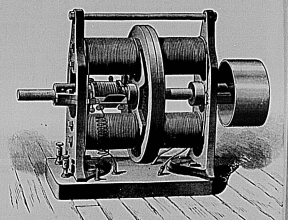


Fig. 1.—BIPOLAR DYNAMO-ELECTRIC MACHINE.

The other machine, Fig. 2, is a compound multipolar continuous-current machine embodying characteristics of fundamental arrangement which distinguish it from all others, while, as before stated, in some of its theoretical aspects it resembles the machine of Hefner-Alteneck described in the article in the SUPPLEMENT.

The machine represented in the engraving, it will be noticed, has only six opposite pairs of poles in the field system. The continuous current armature system of the machine has eight elements, and the commutator twenty-four plates. The armature is otherwise composed in two sections or layers, the major section of which is utilized through a commutator or contact rings of ordinary construction for doing work upon the external circuit, while the continuous-current section maintains the magnetism of the field.

In this machine, developed and constructed long before the publication of any descriptions of Hefner-Alteneck's machine, the currents are commutated continuously, somewhat as in his machine, the commutator connections being so made that, while the contact brushes remain in a fixed position, the currents are brought in them from the consequent electrical poles of the armature—the consequent poles, during rotation, assuming successively different positions in relation to the field, and completing the cycle of changes during half of a revolution of the armature. During this time, furthermore, the line bisecting the armature and marking the consequent electrical points, has twice traveled over the complete circuit of the field in advance of rotation. In the case of a machine having more poles in the field than armature elements, the movement of this line would be retrograde; however, if the multiple of half the number of field poles into the number of armature elements remained the same, the number of changes would be the same in either case.

It will be seen that this machine differs from that of Hefner-Alteneck in respect to the proportion of armature elements to the number of poles of the magnetic field—the Ball machine, having a larger number of armature elements than of field poles, while his has a less number. The arrangement selected by Mr. Ball is more favorable to a simplification of details of construction without detriment to the efficiency of the machine.

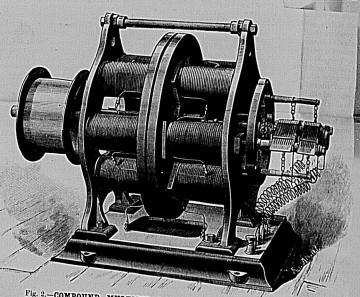
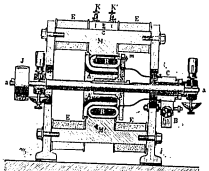


Fig. 2.—COMPOUND MULTIPOLAR CONTINUOUS-CURRENT MACHINE.

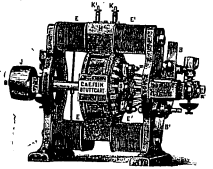
At a speed of rotation of 950 to 1,050 per minute, and with an expenditure of 5½ to 6 horse power, this machine has proved capable of maintaining a series of ten to twelve lights of good power. The machine weighs only 670 lb.

FEIN'S DYNAMO ELECTRIC MACHINE.

Last year Mr. W. E. Fein patented in Germany the machine we illustrate below. We are indebted to the inventor for the description we are now able to give. Dynamo-electric machines constructed upon the Pacinotti-Gramme principle have this disadvantage, that the inducing force of the poles of the electro-magnets acts only upon the external windings of the wire of the armature, the other parts being far less affected by the inductive action, thus increasing the resistance of the circuit, and conducing to the heating of the ring.



To avoid these drawbacks flat rings instead of cylindrical ones have been used, so that the exciting force can act on both sides of the ring, but the windings of such a ring diverging radially necessitate a much greater diameter in order to use a certain length of wire, and this enlargement of the circumference, increasing as it does the resistance to rotation, requires a great er expenditure of motive power for a flat than for a cylindrical ring.



Considering these circumstances, Mr. Fein designed the following construction, by which he claims to preserve the cylindrical ring, and to obtain the advantage it gives without the disadvantages. He says:—"By fixing it in a particular manner to the axle, and by giving the armature a suitable shape I arranged for the exposure of nearly the whole length of the coils to the effects of the magnets.

"Fig. 1. shows the cross section, Fig. 11. a side view of this new dynamo-electrical machine. The cylindrical ring R R, furnished with the coils, is screwed on to the brass star S S, which by means of a socket is keyed to the axle A A', put in motion by the pulley J. The ends of the single coils pass partly through insulated apertures in the spokes of the star, partly through the internals between the same to the commutator G, which, in order to be easily accessible, is placed on the axle lengthened for this purpose outside the framing.

"By means of the two brushes B B, sliding on the commutator, the currents are collected in the usual manner.

"To avoid the Foucauld-currents and the production of heat resulting therefrom, the ring itself is composed of a large number of insulated iron-foils. The cores of the electro-magnets are furnished with the armatures M M', which are placed in front of the external circumference of the ring; in connection with these are the half-round shaped pole pieces A A, which surround the ring on two more sides, so that nearly the whole length of the wire moves in the magnetic field, leaving only those few parts of the wire which are opposite the brass star unaffected by the inducing force. The increased useful effect of this machine may be shown in a simple and surprising manner by taking off the pole pieces AA, the induction thus affecting only the windings on the outer circumference of the ring, as is the case with the Gramme machines; only half of the force of current is obtained which the machine furnishes when under the influence of the armatures AA. The advantages of my construction may be summed up in the following points:—

"1. The windings of the coils of the ring are exposed nearly to the whole of their length to the influence of the magnets, diminishing thus the resistance of those parts which have no electromotive force.

"2. The composition of the ring is such as to restrict as much as possible the generation of Foucauld currents; therefore, the loss of motive power by the production of heat is rendered insignificant, and the excessive heating of the ring prevented.

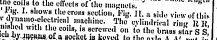
"3. The ring being of a proportionally smaller diameter the velocity of its rotation may be increased, and the machine requires less motive power in proportion to its efficiciousness."

MR. HERRING'S UNIVERSAL ALPHABET.

The following is a copy of a portion of a letter addressed by Mr. Herring to the Right Hon. Sir Stafford Northcote on the subject of the adoption of his instrument by the Post Office:—

"I will not suppose that it was intentional on the part of Sir Richard Cross, but the tactics adopted have been absolutely disastrous to the petition itself, as the fact of my having petitioned the Sovereign by the advice and with the approval of the Secretary of State deprives me of the privilege of bringing it before the House of Commons. This Sir Richard Cross distinctly wrote to Mr. Goschen, who would otherwise have moved in the matter. Thus a conspicuous case, bristling with every form of deception and injustice, fully detailed in the petition has been allowed and assisted by the Conservative party to pass unheeded, the present Postmaster-General,

RICHARD HERRING



Mr. Fawcett, being content to write to me that 'he does not feel called upon to enter into the past history of the case.' Thus, also, all my money and time expended at the suggestion of the telegraph authorities have been wasted, all their agreements with me being unfulfilled, the eminent scientific men engaged and paid by me to act as referees at the request of the Post Office not being even invited to meet, and the telegraph service, as many competent persons believe, has been deprived of a much more simple, speedy, and accurate system than the one in use. Eminent electricians affirm that had my system been adopted it would have rendered the Post Office independent of the serious risks of the present crisis.

"No doubt you are acquainted with the present system of telegraphing, and, therefore, I need only explain what I

and water. Ericsson states: "There is a rainless region extending from the northwestern coast of Africa to Mongolia, 9,000 miles in length, and nearly 1,000 miles wide. Besides the North African deserts, this region includes the southern coast of the Mediterranean, east of the Gulf of Cabes, Upper Egypt, the eastern and part of the western coast of

Studying the movements of birds and fishes, Ericsson became convinced that the principle of rapid motion was in oblique action, and the first fruit of this belief was the screw propeller. Although there has been much dispute regarding this invention, the honor of its introduction and practical utilization is undoubtedly due to him. In 1839 his propeller, the Francis B. Ogden, towed the

the authorities at Washington gave Ericsson an order to build a trial boat, and in 1844 the Princeton was completed. The lamentable disaster caused by the bursting of the great gun, the "Peacemaker," on the Princeton at the time of its public exhibit, is too well known to need a description here.

The revolution in naval engineering caused by

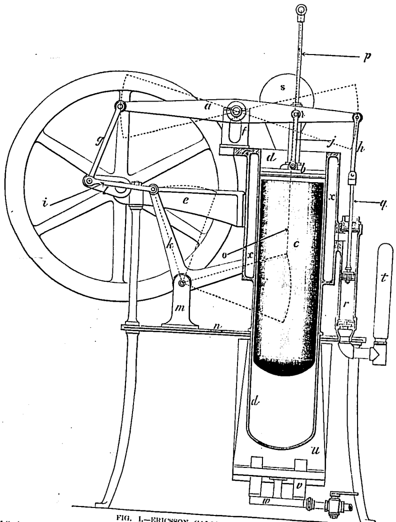


FIG. I.—ERICSSON CALORIC ENGINE.

the Red Sea, part of Syria, the eastern part of the countries watered by the Euphrates and Tigris, Eastern Arabia, the greater part of Persia, the extreme western part of China, Thibet, and lastly, Mongolia. In the western hemisphere, Lower California, the table-land of Mexico and Guatemala, and the west coast of South America, for a distance of more than 2,000 miles, suffer from continuous radiant heat." To utilize this great energy Ericsson is mainly devoting his remaining years.

British Admiralty barge on the Thames. His vessel was eighty feet in length and forty feet beam, three feet draught and was furnished with two screws, each five feet three inches in diameter. This practical demonstration of its power failed to convince the Admiralty, and resulted in Ericsson's leaving England for America in 1837. Through the efforts of Captain Robert F. Stockton, of the United States Navy, who had ordered two vessels similar to the Ogden, and after a delay of two years

the little Monitor in Hampton Roads is well known; the incident forms one of the most important events during the last war. Sweden, Norway and Russia immediately adopted the plan of the Monitor for its war vessels, but England failed to grasp the idea until the appearance of the double turreted vessel—Miantonomah—in English waters in 1866.

Captain Ericsson, having introduced a new system of naval architecture, is now devoting a por-

[b]y means of a crane, and the sponges [...] full of silt. There are three sets in [...] ple time for each set to dry and be [...] rangement has been found to work [...]

[...] duplex, high pressure, fly-wheel, [a]nd pump, with a capacity of 2,000,- [...] 24 hours, and an auxiliary Worth- [...] and pump of 1,500,000 gallons capac- [...]s, force the water into two wooden [...] ft. above ground and 260 ft. above [...]ne 40 × 24 ft. and one 30 × 16 ft., [...]ty of 300,000 gallons. They are [...] each afternoon, giving a pressure [...]ness portion of the city from 80 to [...]ver the remainder of the city from

[...] is by cast-iron pipe, of which 13 [...] in use, none of less than 6 in. in [...]h 105 hydrants, 160 taps and 50 [...] population in 1880 was 9,500, and the [...] consumption 200,000 gallons. The [...] $105,000, and the yearly cost of main- [...] $8,000.

[...]re managed by a private company. [...] was chief engineer of construction, [...] death, in 1878, was engineer and [...] of the works.

[...]on is the president of the company.

[...]CY.—FORT WAYNE.

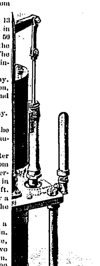
[...], Indiana, is at the confluence of the [...] St. Joseph rivers, forming the Mau- [...] miles from Lake Erie.

[...]s were built by the city in 1880, after [...] D. Cook, C. E., taking water from [...] 120 by 380 ft., excavated in water- [...] 12 ft. below ordinary low water in [...]he filtering area is 38,059 sq. ft. [...] also connected with Spy Run by a [...] water to be drawn directly from the [...]ary.

[...]mped directly into the mains by a [...]nder compound engine, with 19-in. [...]n. water cylinders of 27-in. stroke, [...] non-condensing engine with two [...]d 10-in. water cylinders of 24-in. [...]

[c]ompete on a large scale with [...]ercial world is indebted to [...]e—to New York enterprise— [...] question of such vital impor- [...] engineer has thus been en- [...]is efforts to perfect the steam [...] of rivalry from a motor de- [...]lation of atmospheric air by

[...]n withheld from further at- [...]arge scale, he produced caloric [...]ility for the production of a [...] 1862, the American Academy



acts on air-piston *b*, causing it to move through its upward stroke, actuating pump and fly-wheel by means of beam and links as shown, the momentum of fly-wheel and contraction of the air making the return stroke; the office of transfer piston *c*, by its movement derived from crank through link and bell crank, being to displace the air from the lower or heated part of the cylinder to the upper or cold part, and *vice versa*. The following are the various parts of the engine: *a*, beam; *b*, air piston; *c*, transfer piston; *d*, cylinder; *e*, fly-wheel bracket; *f*, beam center bearing; *g*, connecting rod; *h*, pump link; *i*, bell crank link; *j*, air piston link; *k*, bell crank; *l*, crank; *m*, bell crank bracket; *n*, table; *o*, side rods; *p*, transfer piston rod; *q*, pump rod; *r*, pump; *s*, air chamber; *t*, vacuum chamber; *u*, gas furnace; *v*, gas burners; *w*, gas chamber; [*x*], water jacket.

The engine is specially intended for pumping water into tanks in dwellings, factories, railroad stations and similar works. It is noiseless in action, valveless, requires no attention and is absolutely safe, being used by many underwriters of this city. The size. 6-in. cylinder, will raise 200 gallons 50 ft.; 8-in. cylinder, 350 gallons 50 ft.; 12-in., 800 gallons 50 ft.; 16-in., 1,600 gallons 50 ft. The engines are constructed so as to burn either coal or gas, the consumption being as follows:

6-in. machine, $2\frac{1}{2}$ lbs. anthracite nut coal per hour.

8-in. machine, $3\frac{1}{2}$ lbs. anthracite nut coal per hour.

12-in. machine, 6 lbs. anthracite nut coal per hour.

16-in. machine, 12 lbs. anthracite nut coal per hour.

12-in. (duplex) machine, 12 lbs. anthracite nut coal per hour.

6-in. machine, 18 cubic feet of gas per hour.

8-in. machine, 25 cubic feet of gas per hour.

These engines may be applied to deep-well pumping, where the water is more than 25 ft. below the surface, by lowering the pump-cylinder down to the water, or down to within 8 or 12 in. of the bottom of the well is better, and connecting the pump with engine by iron pipes in short lengths, [...] be screwed together as they are low-

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DYNAMIC GENERATORS.

According to reports attributed to the officers of the Western Union Telegraph Company, where dynamic generators have been substituted for decomposition batteries for the generation of the current, the cost of charging the wires with the dynamic current is about one-half what it was under the old system. Readers of the *Times* will recall that some months ago, in a description of a system of telegraphy devised by one of our prominent electricians, in which the dynamic current was employed in place of that generated by decomposition, the reduction in the cost of charging was stated in figures closely corresponding to those developed by the experience of the Western Union Company. The statement was sharply taken up at the time by the partisans of the dynamic current in a series of communications, and some even went so far as to claim that the actual cost, volt for volt, of dynamic electricity was about one-sixtieth of that developed by decomposition. This extraordinary assertion was based upon the fact that a pound of coal contains a certain amount of power whose quantity in foot-pounds can be accurately measured and determined. The amount of power in a pound of copper or zinc is also accurately determinable; and when these two factors of the problem alone are compared, and this comparison is made the basis of an estimate of cost, the relative ratio shows an advantage in favor of coal of between 45 and 60 to 1. The reasoning looked very plausible on paper, but, unfortunately, there were certain factors which the partisans of dynamo-electricity did not take into account. In the use of the dynamic generator the number of foot-pounds of energy contained in a pound of coal is one thing, and the actual percentage of that energy which appears in the circuit as electricity is quite another. In the first place, the imperfect combustion of the coal in the furnace must be regarded, and, although it may seem strange to the popular reader, in view of the great advances that science has made of late years, it is none the less a fact that not far from four-fifths of all the heat-forming energy contained in a pound of coal is wasted in the furnace through imperfect combustion; so that in operating a steam engine only about one-fifth of the actual energy of the fuel is converted into steam. This fact is so well verified that able engineers have already turned their attention to the construction of furnaces to produce perfect combustion, and the next step in the economical generation of power will no doubt take the direction of better constructed furnaces. In the second place, only about 40 per centum of the energy transferred from the engine to the generator is actually converted into available current, and so three-fifths of the steam power is lost before the transformation into current is completed. If, for example, the amount of energy contained in a pound of coal be placed at 100, 80 of this 100 will be lost by imperfect combustion, and 12 out of the remaining 20 will be sacrificed in the development of heat in the generator. The result is that only 8 per centum of the actual energy contained in a pound of coal is transformed into current in the use of the dynamic generator, while the larger proportion of the energy contained in the copper or zinc is converted, and this is the reason why the theoretical and the practical relations of the two methods are so at variance with each other, and why those who based their computations upon a mere comparison of foot-pounds of energy were so wide of the mark in their statements.—*N. Y. Times.*

ELECTRIC MOTORS POSSIBLE.

Siemens, the German inventor, who has constructed a railway in Berlin upon which the propelling power is an electric motor, has been staying for some time past in this City, making his head-quarters in the Windsor Hotel. He became intimate with Jay Gould, Russell Sage, and Cyrus W. Field soon after his arrival in this country, and is reported to have interested them in the idea of adopting the electrical motor upon the elevated railroads here. A few days ago, in company with the three gentlemen named, he made a trip of inspection over the different lines. Gen. Eckert, of the Western Union Telegraph Company, and President Galloway and General Manager Hain, of the Manhattan Elevated Railway, were also of the party. Mr. Russell Sage said last night that it was possible—he declined to say that it was probable—that the result of that conference would bring about a complete revolution in elevated railroad management so far as relates to a propelling force. "Mr. Siemens," according to Mr. Sage, "seemed to talk in a thoroughly practical manner; his plans appeared to be feasible, and we were disposed to consider favorably most of his propositions. He declared himself confident that the electrical motor could readily be placed upon our roads, and save us every year hundreds of thousands of dollars in expenses. His roads are not of the same style as are ours in the way of construction; in fact, they are materially different; but this he was not disposed to rate as an insurmountable difficulty. Mr. Siemens has now gone to Montreal, but he will soon return to this City, and there will probably be a further conference, and some decision may be reached; or, at least, a series of experiments may be undertaken."

Detroit Post & Tribune
December 19, '88.

Running Sewing Machines by Electricity.

Metcalf Brothers have contracted with W. Baer on Grand River avenue to supply power from his Edison electric plant to run five sewing machines. The distance covered by the connecting wires is about two blocks and the wires themselves afford enough surface, if exposed, to convey atmospheric electric force sufficient to shatter the city hall. The insulators used, it is said, are perfect safe-guards against fire and no doubt are, as far as the force from the plant itself is concerned; but it is said that the great danger is not from the artificially generated electricity transmitted over these elevated wires, but from atmospheric electricity which might shatter the insulators. To illustrate: Some time since and during the same storm nine successive poles between Ovid and Shepardsville on the Detroit, Grand Haven and Milwaukee railway were struck by lightning, thus falsifying the axiom that "lightning never strikes twice in the same vicinity." The question is, were these poles directly struck by lightning, or was it that the wires became surcharged with atmospheric elec-

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FEBRUARY, 1881.

DOMESTIC MOTORS.

BY CHARLES M. LUNGREN.

III.—GAS AND ELECTRIC ENGINES.

THE gas-engine differs from both the steam and hot-air engine in the character of the expansion of the elastic fluid employed and in the mode of applying the heat. In the one the fire is used to convert water placed in a vessel exterior to the engine into steam, which, let into the cylinder, moves the piston by its expansive force; and in the other it is used to expand a volume of air contained in the cylinder or adjacent chamber.

In both, the heat is applied outside of the working cylinder, but the peculiarity of the gas-engine is that the heat is developed within the cylinder itself. A mixture of gas and air is by the operation of the engine drawn into the cylinder, and then exploded, the heat generated expanding the products of combustion, which, exerting a pressure against the piston, give it motion. Simple as is this mode of converting heat into work, the practical realization of it has been found to be exceedingly difficult, and it is only within a very few years that thoroughly serviceable machines have been constructed. The most economical result is obtained from expanding gases when the pressure they exert is a continuous and gradually diminishing one, such as that of steam in the steam-engine. With an explosive mixture, like that in the gas-engine, the expansion takes place with great rapidity, producing a sudden and unsustained pressure, from which it is difficult to get either an economical result or a steady operation of the mechanism. This rapidity of expansion can be decreased, and the pressure obtained approximated to that of the steam-engine, by altering the proportions of air and gas so as to produce a quick combustion instead of an explosion, and by introducing the gaseous mixture into the cylinder gradually, instead of all at once; and it is in this direction that the improvements have taken place which make the latest forms of gas-engine so superior to their predecessors.

Among the first engines to obtain a moderate degree of success were those of Hugon (1858) and Lenoir (1860). Neither of these was, however, very economical in the use of gas, and, previous to the engine of Otto and Langen in 1867, none were produced that were at all satisfactory in this respect. This was, however, objectionable, owing to the intolerable din it made when in operation.

While this engine was at best but a very qualified success, it has led the way to a machine which is very far from being so. In the Otto silent gas-engine, introduced a few years since, and now made

ENGLISH MECHANIC AND WORLD OF SCIENCE: No. 882.
Feb. 17, 1882.

Attention is drawn by a writer in *Cosmos Repertorium* to a small dynamo-electric machine, driven by hand, and meant for laboratory or lecture use. It is supplied by Krattlinger, in Vienna. The *Spyanne* is fixed between the divergent legs of a solid table, under the top of which is a steel axle for the driving-wheel, which gives rapid motion to the Gramme armature through an endless band. The terminals are brought up to binding screws near a handy switch-board at the top. Of various experiments that may be made with the machine, the following are some:—A Bernier incandescent lamp (also supplied by Krattlinger) gives an intense light, sufficient for capital projections with Böhler's Stéréoscope. A thin platinum wire, about 20in. long, can be coiled while hot. The inductor of a bipolar Gramme machine with steel magnets, from which the iron wound wheel has been removed, can be set in rapid rotation by means of the Krattlinger machine, illustrating the transmission of force by electricity.

Scientific American.

[MARCH 25, 1882.

Electrical Progress in Vienna.

An exhibition of electricity and its various uses, after the plan of the late Paris Exhibition, will be held in Vienna during the coming summer, under the management of Count Wilczeck and Baron Victor Ebenspurr. It will be held in the central building of the International Exhibition of 1873.

The Telephone Exchange, opened in Vienna in December last, is said to be doing well. By the middle of February there were three hundred subscribers, and connections were being made with two hundred more. The charge is 100 florins, or about £10, a year.

A very successful trial has just been made of the Brush system of electric lighting in Vienna. The Place of St. Stephen and the neighboring streets were lighted with four-teen lamps, with such excellent results that preparations are making for the electric illumination of the famous Ringstrasse, the finest avenue in the city if not in Europe. One hundred and thirty Brush lights will be required. The light will also be introduced into public and private buildings.

THE ENGINEERING AND MINING JOURNAL.
Nov. 12, 1881.]

The Force of the Future.—Dr. C. W. Siemens, in a recent lecture, says: One of the great practical illustrations furnished by the Paris Exposition has reference to the transmission of power from one place to another by means of the electric conductor. The electric railway leading from the Palace de la Concorde into the exhibition and only half a kilometer in length, does its work regularly and well, running a trip every five minutes, and conveying generally as many passengers as can be packed into the cable and outside of a train-car of ordinary dimensions. This apparent propulsion will soon be in operation on a new line of railroad, six miles long, with which I am connected, in the north of Ireland, to be extended, if successful, to a further coal distance. This will give us twelve miles of electric railway without expenditure of fuel; for the motive power will be obtained from a neighboring water-fall which at present runs to waste. Mr. W. A. Traill, the resident engineer of the line, has already commenced operations, and I hope that by next spring visitors to the sister island may reach one of the most interesting agency. The experience gained by my brother in the working of the first electric railroad, two miles in length, established by him at Lichtenfelde, near Berlin, leaves no reasonable doubt regarding the economy and efficiency of this mode of propulsion, although it is not anticipated that it will supersede locomotive power upon our main trunk railroads. It will have plenty of scope in relieving the tailing horses on our tramways, Metropolitan Railroads, where the collection of the products of combustion causes not only the propulsion but the suffocation of passengers.

ENGLISH MECHANIC AND WORLD OF SCIENCE: No. 873.
Dec. 9, 1881.

AN ELECTRIC POWER METER.

At a recent meeting of the Physical Society, Mr. C. Vernon Boys exhibited and described a very ingenious new integrating-machine of his invention, and its application as a measurer of the electric energy in the circuit of an electric lamp or a dynamo-machine. Mr. Boys's mechanical integrator belongs to the class termed tangential, in which motion essentially of a small disc or wheel results through the surface of a drum or cylinder. When the wheel is driven parallel to the drum parallel to the axis, there is no motion of the latter; but when the wheel is inclined to the axis the drum rotates, and in this way it can be used to find the work done by a fluid pressure reciprocating engine, or the work done by a current. The effect, as both form one part of a factory in another. Mr. Boys has constructed, on this principle, a motor-meter energy meter which integrates the product of the strength of current and the difference of potential between two points with respect to time. In the current is passed through a pair of concentric solenoids or coils of wire, and in the annular space between these is hung a third solenoid, the upper half of which is wound in the opposite direction to the lower half. By the use of what Mr. Boys calls "a solenoid of the second order" the magnetic force is confined to a small portion of the suspended solenoid, and by this means the attraction between the fixed solenoids upon it is disproportional of position. The middle solenoid is hung from the end of a long torsion-rod (torsion is retarded by a counterweighted wheel), which attains of regulating the meter to give the required indications for any particular lamp. The motion of the clock gives standard time. The motion of the rod is caused to indicate the integrating wheel, and this wheel rests on a cylinder given the energy required. The cylinder is driven by means of an indicator or diagram, as the case may be. The wheel is driven in equal number of turns in opposite directions to the axis of the cylinder, and it is under this instrument insensible to external magnetic force.

Phila. Press, Aug 9.83.

Electricity Flying the Thames.

From the St. James Gazette.

A trial was made on the Thames on Tuesday of boat propulsion by electricity, a run being made from the Crystal Palace to Chelsea and back, a party of twenty-two to see a "Torrens" launched. The boat, forty feet long, is fourteen and three-feet straight of water when loaded. The motive power is one Gramme with eighty Sellon-Volkmar batteries of the large variety of sixty pounds each, or, in all, two tons, stowed beneath the floor. The screw is eighteen inches in diameter, with three feet of pitch, making 350 revolutions per minute. The speed obtained on the voyage was over seven miles per hour against the tide down the river, immediately after the turn of high water, being at the rate of thirty-seven minutes. For river pleasure purposes such a boat has many advantages over steamboats, for the machinery and engine occupy the least part of the vessel. The steering, reversing and manipulation of the boat were very quick and effective. The vessel is intended for the Vienna Exhibition, which will open next month, and where she deserves to create considerable interest.

Scientific American.
APRIL 15, 1882.

Resistance of Dynamo Machines.

To the Editor of the Scientific American:

Some time ago Mr. Weston and I had a discussion in your columns regarding the proper resistance of dynamo machines. Mr. Weston then claimed that low resistance machines were wrong in principle and impractical. Mr. Edison, on the contrary, claimed in the practice that a low resistance machine was the best form. His experiments have now resulted in a practical machine, which is running in London, having a resistance of one two-thousandth of an ohm. On this resistance he is able to convert 125 horse power of energy into electricity with a minimum loss, and to avail himself of 97 per cent of the electricity outside of the machine.

FRANCIS B. UPTON.

Menlo Park, N. J., March 28, 1882.

[The results here given are certainly very remarkable.—Ed. S. A.]

Brevinate Ottawa
April 1, 82.

Electricity as a Motive Power.

THE development of electricity as a motive power is an which, though difficult of realization is yet strongly to be desired. Its convenience is not, however, so very far off, if we may take the appearance of the streets of Dublin as indicating the subject as conclusive evidence of their probabilities of the future. For instance, Mr. Hemmins, presiding last week at a meeting of the Dublin Society of Electrical Engineers, observed that the ardent who needs a little motive power for his work, is forced to seek it in the employer's factory, while the thousands of workmen and workwomen there were and their bodies and destroy their strength in impelling the sewing machine, the lathe, and the other motive powers of small industry. The division of electric energy is destined to effect an entire revolution in this sphere. The day will come, and sooner than the coming, when the artisan family will see over their dwelling by means of a magic wire the force which is now so costly to them, and this will be the demonstration that he is the benefit of the working class. The solution of the question of motive force for small industrial industries is by this apparently not far distant, and it is curious to contemplate the change in our social and public arrangements which such a development of the electric motor would accomplish. At an inference, meaning apart for small machines of every kind could be readily obtained and cheaply purchased, what a revolution would come over the existing labor system! How many workmen now and workwomen for women would be closed, the sweating-system employes being supplied in their homes with the means of carrying on their work in their own apartments. Without attempting to foreshadow all that might happen, certain it is that the cost of driving lathes and machines of every kind would be largely diminished, and the means and motive for extending their application supplied. From all points of view it is much to be wished that this novel mode of actuating machinery may be developed so that its efficiency and economy may establish a reputation, and be largely patronized by both large and small employers of labor.—*Building and Engineering Times.*

Inventor Jan. 19, 1883. 58

NEW METHOD OF GENERATING ELECTRICITY.—A discovery how to generate electricity by the act of combustion has been made by Dr. Bunsel, of La Rochelle. This discovery, which is yet only in its infancy, will probably lead to many developments. Dr. Bunsel has an electro-generative herb or candle, which yields a current of electricity by the act of burning. It is prepared by making a paste of coal-dust and molasses, and moulding it into a stick, which serves as the positive pole of a candle. This rod is then covered with asbestos in a thin sheet, and dipped into fused nitrate of potash until a good thick coating of the nitrate adheres. The wick being ignited, it burns away, and a current of electricity is drawn from the candle by wires inserted into the nitrate and the coal. The light which this current is comparatively feeble and lost to part of such practical value, the discovery is important as showing the possibility of such a generation. It is pointed out that the candle has lost a fraction so constructed that on burning any solitary fact in it so as to give heat, it would, at the same time, keep up an electric current sufficient to ring electric bells or charge an accumulator, and thus give light also. Dr. Bunsel is understood to have this also in view, and his researches are based on the discovery of Becquerel, the great French physicist, who found that red-hot carbon plunged into nitrate of potash forms an electric battery.

Inventor Sept. 21, 1883.

THE TRANSMISSION OF POWER.—M. Bertrand, perpetual secretary, has announced to the French Academy of Sciences the complete victory of M. Marcel Deprez, inventor for transmitting electrical force to great distances. Theoretical objections were raised on the occasion of the recent experiments at the Northern Railway station. Certain improvements in the mechanism have since been made, and now Colonel Laussedat, of the engineers, at the head of a scientific government committee, certifies that a vertical of 14 kilometres from Grenelle was by M. Deprez's apparatus emulated to work to the extent of 7 horse-power a small mill, a printing press, and other machinery at Grenelle.

ELECTRIC LAUNCHES.—An electrical launch was tried on September 10, by Messrs. Gilbert, Bagle & Co., Glasgow, on the Clyde, at Kilmarnock. It was driven by Clark's patent battery and engine, Mr. Clark, the patentee, himself managing the machinery and also steering the boat. The only other persons on board were Mr. Bagle and Major Mcclliver, of Bristol and London, for whose benefit the trip was made. Clark's patent dispenses with dynamo machines and accumulators, and need no charging, and enables the motive to be instantly re-filling the batteries with a simple chemical compound. In the launch boats a speed of four to five miles is obtainable, and Major Mcclliver, who had with him a 16-foot launch, built for him by Powell & Douglas, of Waukegan, Illinois, has ordered it to be fitted with Clark's machinery. If the experiment be successful, Messrs. Bagle are to construct a much larger vessel for him, which it is intended to take through the canal between the Rhine and the Danube next year, to make the trip from the German Ocean to the Black Sea through these rivers and their artificial junctions. The large boat will be designed for a speed of ten miles an hour, and it will take several months to construct her, but the smaller one will probably be on the Thames before the end of October. Major Mcclliver believes that he can make the trip from ocean to ocean in about three weeks, and intends to do so without any assistance whatever.

53 59 Boston Herald, Aug. 14, '83.

THE COLWELL MOTOR.

An Invention for Which Great Things Are Claimed.

Steam Supplemented, but Not Quite Supplanted.

A Combination of Most Ingenious Devices.

From time to time for some months past there have been references, especially in the Lowell papers, to a new and wonderful motor, which would be revolutionary in its effects, and Lowell business men have become largely interested in it, financially as well as otherwise. Rev. Dr. T. M. Colwell, pastor of the First Baptist Church in that city, is a brother of the inventor, and associated with him in the development of his ideas. The inventor, William S. Colwell of Pittsburg, Pa., was for 19 years a manufacturer of steam engines, but has devoted the past six years entirely to his "triple thermic motor." It has been patented throughout the civilized world. One motor has been set in operation at Pittsburg, where it operates a saw mill. Another is now in operation in New York, where it was examined last week by some one who occupies nearly a page in the Lowell Courier in describing it.

Bi-Sulphide of Carbon

changed into vapor, is used to propel an engine, instead of the vapor of water. The bi-sulphide of carbon consists of one part of carbon and two of sulphur, and is produced wherever carbon is burned in a sulphuric atmosphere, with the natural atmosphere excluded. It has been used heretofore for extracting oil from seeds and dissolving gum and material for rubber goods. Its chemical symbol is CS_2, and, of 100 parts 84 [illegible] carbon. Bi-sulphide of carbon was discovered 67 years ago by Lampidas. In practice it requires 530 pounds of sulphur and 243 pounds of wood charcoal to produce 570 pounds of bi-sulphide of carbon. Sixty years ago it sold for $2 an ounce, but now sells for $6 per hundredweight, and can be manufactured for 3 cents per pound. It is a clear, colorless liquid, and boils at 118° Fahr. Its specific gravity is 1.272; the specific gravity of its vapor compared with air is 2.64 at 118° Fahr. The specific heat of the liquid bi-sulphide is .238, and the specific heat of its steam is .156. The latent or elastic heat is 156°. It is claimed to be shown that in changing bi-sulphide of carbon and water into vapor there is an advantage of 94° in favor of the former; i. e., the amount of heat necessary to change bi-sulphide of carbon into vapor is 94° less than the amount of heat required to vaporize water. The large saving here is apparent, but the expansive force of the bi-sulphide is shown, it is claimed, to be 21 times that of water, which is another important consideration.

The Objections

to the employment of this substance are referred to. Mr. Colwell says: "The trouble with the Keely motor was that, though it had a tremendous pressure, it had no volume." Experts have said that this was also the trouble with the employment of bi-sulphide of carbon, but Colwell, Prof. Campbell, his chemist, and others who have investigated with them, say that the volume of bi-sulphide of carbon steam is greater than that of water steam, being over 2000, as against 1696; and besides, and more important than this, the volume of bisulphide of carbon steam increases with the temperature, instead of decreasing.

It has also been stated that bi-sulphide of carbon is explosive, and that it has so strong and so injurious an odor that no one could work with it any length of time without injury to health. The explosive theory is pronounced absurd, and there is a standing offer of a liberal reward to any one who will explode a particle of it. In regard to odor, there is none, or very little, to the bi-sulphide which is used in the motor, as what is used is not the commercial bi-sulphide of carbon, but that which is chemically pure; and what little smell there may be to this is entirely removed by a simple device connected with the motor. It has also been stated that the vapor of bi-sulphide of carbon cannot be controlled—that when applied to the engine it will leak out with the motion of the piston rods, and cause serious, if not fatal, loss of power. This, it is claimed, has been overcome by a device which creates at each piston rod a vacuum and atmospheric pressure, so that the vapor is entirely prevented from escaping. It has also been said that bi-sulphide of carbon will oxidize or rust iron or steel, but this is true only when exposed to the action of the air or when the metal reaches a red heat, and the Colwell motor is so arranged that the iron is never heated so high as to turn color in the slightest. Mr. Colwell has never found the slightest trace of oxidization upon iron or steel after having lain in bi-sulphide of carbon as long as 23 months.

The Points Accomplished.

The points which Mr. Colwell claims to have accomplished are these:

First—Security against the escape of the vapor, hitherto regarded a fatal obstacle.

Second—He has discovered a successful lubricant, no kind of oil being available for the purpose.

Third, condensation and repeated use of the bi-sulphide, which can, it is claimed, after being used to propel the engine, be carried to a condenser, where it is changed back to a liquid, and thence be returned to the boiler, where it is once more heated to a vapor, goes to the engine and repeats its work, after which it is again sent to the condenser, and so on in this rotation indefinitely.

Fourth, control of the vapor by keeping it at a desired temperature without fluctuation.

Fifth, the utilization of the latent heat. In every steam engine the latent heat is lost, being thrown away in the exhaust steam. In the new motor, it is claimed, this is all utilized. The boiler holding the bi-sulphide is surrounded with a shell containing steam, and the bi-sulphide, being so surrounded, becomes a vapor of considerable expansive force, as the steam is above a temperature of 212°, while the bi-sulphide becomes vapor at a temperature of 118°. A table shows that at 212°, when water has barely become steam, there is a working pressure of 51 pounds in the bi-sulphide of carbon vapor.

The Motor on Exhibition

in New York consists of four principal parts, a generator, boiler, engine and condenser. The generator is an ordinary steam boiler, capable of supplying power for an ordinary 15-horse power engine. The boiler, as the inventor calls it, is built like any tubular boiler, but has 212 1½-inch tubes, while an ordinary one would have but 53. It would run, with steam, a 30-horse power engine. It is filled to the water line with bi-sulphide of carbon, about 2500 pounds of the liquid being used. This is surrounded by a shell or jacket, perhaps 8 inches more in diameter than the boiler, which is filled with steam from the 15-horse power boiler or generator. The engine is a common one of some 30-horse power, but is peculiar in one respect, having two smaller cylinders connected with the main one, as a patented device, which really gives five piston rods instead of one, and it was selected because it would best show the fact that the bi-sulphide would not escape from the cylinder around the piston, and that a lubricator could be made which would work to perfection. The condenser which restores the vapor to the liquid form is of the smallest size made. Connected with it is a simple arrangement of pipes, which at the same time assists in condensing the bi-sulphide vapor into liquid, and in heating it after it becomes a liquid so as to raise it nearly to the temperature required to again convert it into vapor. It will be seen that there are several points here where Mr. Colwell claims considerable saving in heat, and the Courier reporter thinks, whether the motor is an entire success or not, there seems to have been wonderful mechanical ingenuity in its construction.

How It Works.

A fire is made under the first boiler, or generator, and, when the boiling point is reached, the steam passes through a pipe to the shell of the bi-sulphide of carbon boiler. The steam is "wire drawn," as the engineers put it, and its flow into the shell is regulated by a very sensitive automatic valve, the diaphragm of which is made of a beef's bladder, which, curiously enough, is not at all affected by the bi-sulphide. On disseminating itself throughout the shell, the steam, being at a temperature of at least 212°, heats the bi-sulphide of carbon, which is quickly converted into vapor and is ready for work. After thus heating the bi-sulphide, the steam, having given up all its heat, becomes water, and is pumped back into the generator to be again converted into steam. The steam of the bi-sulphide of carbon, being ready for use, as we have explained, is conducted through a pipe, which is also inclosed by another pipe, or shell, containing steam, to the cylinder of the engine. Were it not for the fact that it is continuously surrounded by steam the bi-sulphide of carbon would lose 50 per cent. of its expansive force before it reached the engine. Even the cylinder itself is surrounded by steam in the same manner as the boiler and conducting pipe. The steam of water is allowed nowhere to come in contact with the bi-sulphide or its vapor, as the impurities in water and its action on metallic surfaces would create compounds which would destroy them. The bi-sulphide vapor operates the steam engine exactly in the same manner as common steam. Just one more point of advantage is claimed by the inventor right here. In steam engines there is a loss by cooling in the working power of steam from the point where the steam enters the cylinder to the point of cut-off reckoned equal to double the loss by friction of the engine. When the bi-sulphide vapor enters the cylinder, instead of losing working pressure it gains heat and expansive force from the steam with which the cylinder is surrounded, and the stroke is completed by the extra expansive force of this superheated vapor.

What It Is Doing.

This motor is located at the works of the Russell Pavement Company of New York city, where it has been seen by many people. It is running a stone crusher and two pulverizing rollers, as well as two sand-drying machines, the work requiring about 30-horse power. The pressure of steam, when the reporter saw it, was insufficient to operate the engine at all, but out of the bi-sulphide a working pressure of 51 pounds was obtained. The inventor expects, by increasing the supply of steam used from the generator, to get, by means of the bi-sulphide, 100-horse power out of the present engine, which, with steam, would yield only 45 to 55-horse power. The amount of coal used per day was stated to be 500 pounds, while it would require 2100 pounds per day to run a 30-horse steam boiler and engine. The advantages claimed by the inventor are briefly these, comparing the triple thermic motor with steam engines.

First—A saving of over three-quarters of the fuel, or, to be exact, 81 per cent. The extent of this tremendous claim will be understood when it is remembered that the manufacturing companies in Lowell use about 80,000 tons of coal in a year. With the Colwell motor generally adopted, there would be consumed about 20,000 tons, or a saving of 60,000 tons, the cost of which would go a long way toward paying, in a single year, for all the steam engines used in our local mill.

Second—The triple thermic motor requires no greater skill to operate than a steam engine.

Third—It insures a more uniform power.

Fourth—It is adapted for all purposes for which the steam engine is now used, and for some purposes for which it is entirely inapplicable, especially in mines.

Fifth—There is less liability of explosion.

Sixth—There is no corrosion in the boiler.

Seventh—The boiler cannot be burned.

Eighth—No grease, no sparks, no noise, no dust.

Springfield Daily Republican, September 1883.

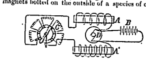
The Electrical Propulsion of Vessels.—A good deal has been said of late about electricity as a motive power, and there is doubtless a popular faith that the storage batteries have practically solved this interesting problem. But this is not Thomas A. Edison's view. He declares the idea of propelling vessels by electricity to be absurd, and the claims put forth for the storage batteries on both sides of the Atlantic to be the work of unscrupulous persons. The chief difficulty with stored electricity is that it is nothing more than a secondary battery; it must receive its energy from something else, and it cannot possibly exceed that in amount. The cheapest mode of producing electricity is by a steam engine fed by coal. The electricity is but the energy developed by the coal, and practically there is a great loss of power. Then the expense must be much greater than steam, so great as to destroy the practical value of this motor. Arguing in this way it is readily seen that Mr Edison thinks but lightly of the recent successful driving of a 40-feet steam-launch upon the Thames, eight miles an hour for eight hours, by means of the Sellon-Volckmar storage batteries. It is certain that this feat was accomplished, but Mr Edison evidently considers it nothing more than an interesting scientific experiment and a possible future amusement for some rich man who would not hesitate "for a lark," to fill a boiler with champagne and use London Dock brandy for fuel. The marine steam-engine, on the other hand, is a model of economy as well as mechanical perfection, and can now produce one-horse-power an hour at an expense of from one and a half to two pounds of coal. Electricity must either be cheaper than this or present some decided advantage if it is ever to displace coal. The general impression is that electricity does offer an advantage in that it throws open to freight the great space occupied by a steamer's coal bunkers. But Mr Edison disputes this too. The engine of the Alaska, for instance, the best ever made, develops 11,000-horse-power. The maximum possible efficiency of the electric storage battery, supposing its construction to be theoretically perfect, is 86 pounds per horse-power an hour. But supposing it possible to propel the Alaska across the Atlantic as she is navigated now by stored electricity, it would not only necessitate an engine at Liverpool and another at New York to charge the batteries, but the dynamo and batteries carried on board would have to weigh something like 63,000 tons. If Mr Edison is right therefore, marine navigation by electricity must be considered, as far as present attainment goes, only the wildest dream of the visionary.

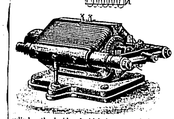
Engineering, Dec. 22, 1882 60

A SMALL DYNAMO-ELECTRIC GENERATOR.

Under this title Mr. Preece at the last meeting of the British Association, gave a short account of a new dynamo, of which we are now able to give a fuller description.

M. de Meritens has lately brought out this machine which he designed more particularly for working a limited number of incandescence lamps, or a small arc light for experimental purposes. This machine, as shown in the following drawing, consists of four field magnets bolted on the outside of a species of cast-iron





cylinder, the inside of which is accurately bored out to receive the armature, which latter is built on the well-known principle employed by M. de Meritens in the construction of his larger machines for lighthouse work. This armature consists of a brass ring divided into segments; in each of these segments is a small coil composed of a number of thin iron plates, round which the insulated wire is wound, the free ends of the coils being fixed to a commutator of the ordinary kind; the insulation of this ring is very high, cork being used to insulate the coils.

The shaft carrying the armature runs in bushed bearings, which are fixed on two studs screwed in the cast-iron cylinder between two of the field magnets. The bearings are self-lubricating, and only require to have a small quantity of oil poured in every four or five days; the bearings are moreover very long. This machine is made with three different kinds of wire coiled on it, viz., for working arc lights or incandescent lamps, working a plating bath, and for charging secondary batteries; when used for the latter purpose it has the field magnets coupled in a branch circuit, as shown in the following diagram, Fig. 2, in which A A[1] show the field magnets, B the accumulators, C commutator, and D brushes. M. de Meritens also constructs this machine to work by hand, and for this purpose bolts it down to a cast-iron bedplate, on which is also cast a vertical standard; on the top of this is a large spur wheel gearing with a pinion, the motion from which is transmitted through a pulley and belt to the machine. The following is a Table showing the capabilities of this machine and one of a larger size:

Type.	Candle Power.	Number of Swan Lamps.	Power Required.	Will Transmit	Speed per Minute.	Weight.	Size of Pulley.	Size of Carbon for Arc Light.
			HP.	HP.	rev.	lb.	in.	mm.
C	600 / 1 arc light	6 to 7 20-candle	¾ to 1	½	3000	54	2	4
H	6000	about 25	4	1½	1600	118	4	

Type.	Resistance in Field Magnets.	Current.	E.M.F.	Resistance in Circuit.	Speed per Minute.	Resistance in Armature.	Remarks.
	ohms	ampères	volts	ohms	rev.	ohms	
C	1.33	10.69	55.05	6.15	3000	1.33	Will charge 28 accumulators.
H	0.38	61.84	83.84	1.35	1600	0.33	

A great point in favour of these machines referred to by Mr. Preece is their low price.

Mr. J. Thame, of Battersea, is agent in London for these machines.

5. 61

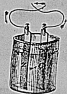
of the boat is borne by the rollers. The castings holding the rollers are constructed with a stop resting on the deck, and the centres arranged in such manner that when the bars or handles are pulled over to the full extent, they cannot be thrown back by a weight on the rollers.

THE DYNAMO: HOW MADE AND HOW USED.—III.*

By SELIMO R. BOTTONE.

§ 4. THE student will do well to compare the effects produced on the galvanometer by the battery current, and by the current obtained from the magnet. Any single cell will do for this purpose; and in order to have an intelligent perception of what takes place, the student must bear in mind, that *in* the battery itself, the electricity (undulatory movement of the molecules) passes from the zinc to the negative plate (be it copper, silver, platinum, or graphite), while *outside* the battery, the electricity passes from this latter round through the wires, galvanometer, or other circuit open to its passage, back again to the zinc plate (See Fig. 4, where the direction of the undulation, or "current" is shown by the

FIG. 4.



arrows; the plate marked Z being zinc, the one marked C being carbon, copper, or other conductor; W W being the wires forming the *poles* or *electrodes*). If the positive pole (the one from which the "current" is flowing: the wire attached to the C plate) of such a battery be connected to the galvanometer by means of the binding screw marked "over," the other pole being attached to the other binding screw, the north pole of the needle having previously been adjusted so as to lie between the two binding screws, it will be found that the N. pole of the needle will deflect to the *left* of the line of the coil; the operator being supposed to be standing at the binding-screw end of the galvanometer. Since the wire of our coil returns *below* the needle, it is evident that a positive current (an outflow of undulation) passing *over* the north pole of a horizontally suspended needle, or a negative current (an influx of undulation) passing *under* such a north pole, causes it to deflect to the *left*.

If we disconnect the battery, and reverse the connections, *id est*, join the negative pole (the wire coming from the zinc) to the binding screw marked "over," the other pole being connected to the other screw, the opposite effect results—viz., the north pole now deflects to the *right* of the coil. This will be understood by reference to Fig. 5, in which *a* represents the effect of the positive current flowing *from* the operator *over* the needle, the N. pole in both illustrations being nearest to him; in *b* the positive current is supposed to be flowing *from* the operator, *below* the needle, in either case returning to the battery the opposite way.

§ 5. This effect will enable us at once to recognise, by means of our galvanometer, the *direction* in which a current is travelling; for, on connecting the two terminals of any source of electricity to the binding screws of the galvanometer, whilst the N. pole is in a line with the coils, between the two binding screws, the operator facing the north pole of the needle, it is evident that if the N. pole of the needle is deflected to the *left*, the terminal attached to the binding screw marked "over" is *positive*; but that, if the N. pole deflects to the *right*, then the said terminal is *negative*. It must be borne in mind that by the term *positive* in this connection is meant the point *from* which electricity is flowing, negative being the point *towards* which it is flowing, or *at* which it enters.* This power of recognising the direction of a current will be found of great service to us in the construction of the dynamo.

§ 6. Returning now to our experiments with the magnet (see latter portion of § 3), and using in preference a straight soft iron rod, about 6in. in length, and ½in. in diameter, coiled with about 100ft. of No. 24 covered wire as our armature, and a good bar magnet to produce the electrical

FIG. 5.

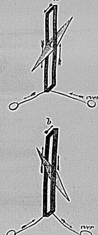
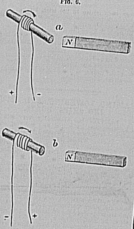


FIG. 6.



effects, we shall find, on coupling up the armature wires to the galvanometer, and approaching one end of the armature to or receding it from the N. pole of the magnet, that the electrical flow set up is always in one direction in approaching or making contact, and in the opposite direction on receding or breaking contact. Fig. 6 will make this clear. The arrow at *a* shows the direction of the current produced on approaching or making contact with the N. pole of a magnet; *b* illustrates the direction of current produced on receding from or breaking contact with the N. pole of a magnet. If now we reverse the experiment by presenting the S. pole of the magnet to the coiled armature, we shall find that the direction of flow is also reversed; that is to say, the *withdrawal* of a south pole produces the same effect as the *approach* of a north pole, and *vice versâ*, the *approach* of a south pole is equivalent in its effects to the *recession* of a north pole. It must be noted that the direction in which the wire is coiled round the soft iron rod (or armature), while it has no influence on the direction of the electrical current set up round the iron rod (which is always the *reverse* to the hands of a clock in the face *approaching* the north pole) determines the extremity of the said wire at which the current leaves or enters the coil. In the figure we have supposed the wire to be wound from *left* OVER towards *right*; had we wound our rod from *left* UNDER towards *right*, the opposite ends of the wire would have been respectively + and —. This must be borne in mind when we proceed to actual work.

§ 7. *Currents can produce Magnetism.*—If we take the coiled soft-iron U, of which we made use § 3, and apply it to pieces of soft iron, nails, filings, &c., we shall find that it possesses little or no magnetic power of attraction; but if we couple the projecting ends of the coiled wires one to each terminal of a single-cell battery, we shall find that the U will become powerfully magnetic, retaining its magnetism as long as electricity flows around the coils, but losing nearly all the instant that the flow is caused to cease, either by breaking connection with the battery, or by any other interruption. The rapidity and completeness with which the iron loses its magnetism depends almost entirely on its *softness* and *purity*. Anything which tends to put a strain on the molecules of the iron, such as hammering, filing, twisting, sudden cooling, vibration, &c., render it liable to retain magnetism, or increase its *coercitive* force; whereas raising to a high temperature and very gradual cooling, which allows the molecules to range themselves with little or no strain, furnishes a soft iron, eminently incapable of retaining magnetism, or possessing little *coercitive* force.

* All rights reserved.

* We have no desire to enter into any theoretical matters in these papers; but comparing electricity to sound, we may say that in blowing a blast in a trumpet, the trumpet may be considered as *positive*, while the ear of the listener may be considered as being negative. The chief difference seems to be that electrical undulations seem to require a complete circuit wherein to display their effects, sound undulations being bound by no such conditions.

ELECTRICAL REVIEW

A WEEKLY JOURNAL OF ELECTRIC LIGHT, TELEPHONE, TELEGRAPH AND SCIENTIFIC PROGRESS.

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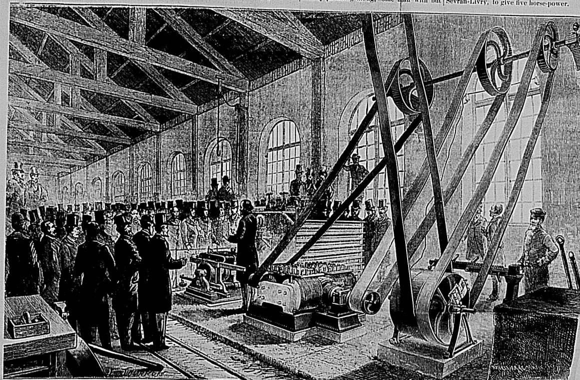
M. Deprez's Discovery.

POWER TRANSMITTED BY ELECTRICITY OVER AN ORDINARY IRON WIRE—ONLY FIFTY PER CENT. OF LOSS—THE SUCCESS OF THE RECENT EXPERIMENTS—WHAT IS LIKELY TO COME OF THEM—PROF. SIEMENS' PROGNOSTICATION ABOUT NIAGARA LOOKING LESS AND LESS CHIMERICAL.



TRANSMISSION OF MOTIVE POWER TO GREAT DISTANCES BY ORDINARY TELEGRAPH WIRE.

The electrical transmission of power from points where it is cheap, as at the coal mines or on the banks of a running stream, to distant parts where its generation is costly, is a problem whose solution has long been sought. Only a few years ago Prof. C. W. Siemens, of the Royal Society of Great Britain, read a paper upon the subject before the Glasgow University wherein he made predictions of the ultimate success of the project which, had they come from a less reliable source, would have been regarded as preposterous. As it was, the scientific censors on both sides of the ocean were inclined to look incredulous when the scheme was referred to, and not having the temerity to laugh outright, contented themselves with characterizing it as the dream of a scientific enthusiast.

But have not all the great scientific schemes been so regarded at their inception? Was it not so with the earlier applications of steam, of the use of the paddle-wheel for propulsion, of its successor, the propeller, of the application of electricity to telegraphy, of the forcing of gas through pipes by pressure, and a host of others? There would seem to be a factor in the make-up of the average scientist which leads him to doubt the feasibility of all schemes not devised in his own laboratory. Learned scientists have from time to time applied themselves to transmitting power to a distance, and we have at hand their estimates of the diameter of the copper wire which would be required at various distances from the source of power, and the losses, or, more practically speaking, the leakages of the electricity *en route*.

According to these estimates, when but a few miles had been traversed the diameter of the copper wire had multiplied itself many times, and, at the ruling price of copper, the interest on its cost price would prove greatly in excess of the sum that could reasonably be demanded for the power transmitted over it, and the amount of power recovered at the second machine so small a percentage of that with which the wire had been originally charged at the source, as to be practically of but slight, if any, advantage for ordinary usage.

As was demonstrated some time since, the learned scientific gentlemen already referred to are apt to work in grooves. That is to say, they make up their minds that a certain thing for which they are in search is to be found only by keeping strictly within the limits of certain well-known physical laws. While they are still methodically and laboriously plodding along, some man with but a tithe of their learning, but far more ingenuity and enterprise, reaches the goal by means of devices of such simplicity as to have never been dreamt of in their philosophy.

Such is the discovery by M. Deprez, of a means of transmitting power to a distance by means of electricity. [See illustration.] He does not use copper at all in his wires, but sends the gathered power by means of electricity from point to point over ordinary iron wires.

Before a large number of scientific men, M. Deprez recently tested his discovery in the machine shops of the *Chemin de fer du Nord*. The experiments which it was proposed to make were the transmission of six horse-power over a line of 20 kilometers *via* Bourget, and of ten horse-power over a line of 35 kilometers *via* Sevran-Livry. In each case, it is alleged, the results proved to be as claimed by the inventor, viz., 50 per cent. of the force generated was rendered to the receiver—that is to say, the six horse-power sent by way of Bourget was found at the terminus of the line to give three horse-power; the ten horse-power, by way of Sevran-Livry, to give five horse-power.

Estimating a kilometer to be 1093.633 English yards, we thus have three horse-power transmitted about 12½ miles, and five horse-power transmitted 21¾ miles, and the most astonishing part of the experiments, if they have been faithfully described is, that the loss while *in transitu* was the same in each case.

The amount of electricity taken off at any one point might be readily regulated in the same manner as the current taken from a battery for telegraphic purposes is now regulated—that is, by introducing suitable resistance in the local line.

We do not wish to be understood as say-

Natural Scientific Journal
May 15, 1879

TELEGRAPHING BY THE DYNAMO-ELECTRIC CURRENT.—A plan for utilizing the dynamo-electric current in the Indian telegraphs instead of batteries has been devised by Mr. Louis Schwendler, and tried successfully. *The Journal of the Asiatic Society*, of Bengal, relates that one of the dynamo-electric machines used in lighting the sheds at Howrah Railway Station was selected to generate the main current which was conveyed to the Calcutta telegraph office by an ordinary telegraph wire two miles long. The strength of it at the beginning of the trial was carefully measured and found to be 36,801 millionths; one ampere being equal to one weber per second, and one millionth being therefore equal to one milliweber per second. At the Calcutta office eleven long telegraph circuits, running to Bombay, Madras, Kurrachee and Rangoon, were worked with currents tapped from this main stream for a period of three hours. The traffic was dispatched without accustomed regularity, and the signal currents were found by measurement to be stronger than the ordinary battery currents in use. The practical success of the trial has disposed the administration to introduce the system at the Calcutta office; and as there will be a large surplus of main current, Mr. Schwendler intends utilizing it for lighting and motive purposes. "The electric light," he says, "would produce at least fifty times less heat than if the same quantity of light were obtained by combustion; and this is no doubt a great advantage in a hot climate like that of India. During the daytime the main current might be used for working the pneumatic system of dispatching messages between the head telegraph office and local centres in Calcutta."

In regard to the heating powers of such a current, Mr. Schwendler says that if sent through an iron wire laid along the walls of a room like a hot water pipe, it would produce about as much heat as is given out by the ordinary German stove consuming six pounds of coal per hour, supposing that the loss of heat when coals burn under a steam boiler is about four times greater than when they burn in a German stove.

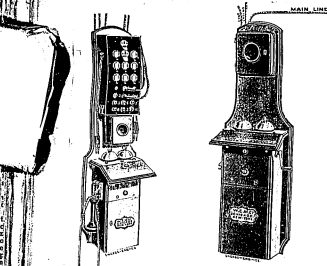
National Scientific Exposition June 14 1883

THE WESTERN ELECTRIC-MAGNETO CALL BOX. AND PONY SWITCH BOARD.

There is nothing in which the general public take such genuine interest as matters touching the wonderful results of the application of electricity to the common necessities of life. There is so much that is unknown and entirely mysterious in this wonderful force our electricians are experimenting with, and reducing to harness in some new discovery of the application of its power every day. All of us are glad to see some new device, or be informed of the application of one which has come into general use. The average woman is not heartily reconciled to the telephone yet; there still remains for her a mysterious air, a faint suggestion of witchcraft about it, or if of a sensitive temperament, too uncomfortable a realization of the tremendous force harnessed up for the occasion to prevent her feeling stress and nervousness the sound of that mysterious "Hello!" The truth of this is inditerously exhibited a hundred times a day in our large drug stores, where the clerks are annoyed from morning until night by timid suggestions from lady customers (who buy a ten-cent sponge, and consume half an hour's additional time) that "they can't hear," "are not yet used to it," "and must send a message," etc., until said clerks wish the telephone in Hades.

The Western Electric Manufacturing Company's establishment, on Kinzie Street, exhibits a great variety of telephonic apparatus manufactured by them. The illustrations below represent the Western Electric Magneto Call Box and the Pony Switch Board.

The Call Box, as seen in the illustration, is mounted on a base board with a battery box. The generator is compact



PONY SWITCH BOARD.

WESTERN ELECTRIC MAGNETO CALL BOX.

and powerful, and the bell, it is claimed, rings louder than any other in use. There is an automatic crank switch which is simple and effective, and the crank works the switch when turned in either direction. The telephone switch is so arranged that the circuit can never be left open. One of the special merits of the box is its compactness in form and arrangement.

The Pony Switch Board is made for factories and small exchanges, and is considered very complete. The number of wires for which it is made is for from ten to twenty-four lines. It is mounted on a base board with a magneto call box. The operation of the board consists simply in inserting plugs, with cords attached, in the spring jacks of the subscribers wishing to be connected. The annunciator drops and switches are the same as those used with the standard and duplicate boards; consequently they can be utilized should a larger board be required at any time.

Storing Electrical Energy.

Continued from page 21, March 1st.

The gases in the tube were formed by passing a galvanic current through the pair. The gases forming at each plate in well-known proportions. The battery being discommected and the plates connected by a wire, a continuous current is produced resembling that of a Daniell's element in electro-motive force. The current continuing to flow until the gases previously accumulated have recombined.

The current produced by the Grove gas battery is equal to the current which produced the gases by the decomposition of the acidulated water. A modification of this battery, affording greater surface of triple contact between metal, gases and acidulated water, pomlines the best of any form of storage battery for many uses.

In subsequent experiments Mr. Grove employed plates covered with peroxides of metals, and C. W. Siemens employed carbon tubes, very porous. The cooling gave a greater quantitive effect, with less intensity. The intensity was increased by coating the tubes by galvanic deposition of platinum before introducing them for charging.

In 1845, Wheatstone constructed what he was pleased to term a *galvanic* battery which employed platinum plates coated with peroxide of lead in contact with cloth soaked in solution of potassium; in describing the same, he says, "when a plate is easily exposed by making it the positive electrode in a decomposing cell charged with a solution of acetate of lead."

In 1852, C. W. Siemens con-structed a secondary battery by employing carbon plates impregnated and coated with peroxide of lead, in acidulated water; describing it he says: "The plates were dipped into a solution of acetate of lead. Then treated to dull redness, cooled, and again dipped in the lead solution. After repeating this operation several times the plates were acted on by galvanic currents by which the lead was converted into peroxide of lead. The current from the secondary battery thus formed gave two volts from a single pair. A larger battery of carbon plates thus coated and held separate by a porous partition gave good results."

The power of this form of cell depends upon the time of application as well as the power of the charging current. It affords a large amount of active surface in a small space, and is less expensive, and of less weight than batteries employing lead plates.

In 1859, M. Gaston Plante showed that lead was the most favorable metal for use in secondary batteries and he has since then multiplied proof of this superiority.

In its first form the battery of Plante consisted of sheets of lead held separate by a sheet or strip of felt, and rolled together to form a cylindrical shape or fit the jar, etc. This battery thus constructed was filled with acidulated water and the peroxide of lead formed on the plates by the first charge of a galvanic current.

In the first formation when the battery is new there is an advantage in polarizing the electrodes first in one direction and then in the other, and by reversing the current in each direction of the charge, but in subsequent uses care should be observed to always charge it in the same direction.

After the battery is "formed" the plates are found to be coated with a layer or crust of absorptive sub-stance that will receive and discharge electricity.

The number of times a secondary battery is charged and discharged the better it is. Intervals of rest improve this form of battery.

He connected four or five elements or cells side by side, and charged them from three Bunsen elements, and connected them in series for discharging. The secondary currents are able to magnetize electro magnets more powerfully than the primary currents from which they are derived.

It is found that when the resistance is considerable the current remains constant during several hours. It is found that a well "formed" element would give a good current several weeks after it was charged.

In order to obtain currents of great energy, a number of secondary elements are arranged side by side, and charged and connected in series to be discharged.

As commonly understood, Plante's secondary batteries are constructed only in view of scientific researches; he, nevertheless, used forms possessing industrial qualities. He employed the peroxide of lead as a cement or paste, pressed into spaces in a metal plate or electrode, in shape not unlike a gridiron.

In 1861, Charles Kleebhiel described several modifications of secondary batteries. One of these batteries consisted of metal plates coated with mercury and immersed in acidulated water or in solutions of sulphate of copper. He describes another, consisting of plates of metal coated with peroxide of lead and non spongy lead, by electro deposition in a solution of nitrate and acetate of lead. He describes using lead plates coated with mercury, and says: "Electricity from any source may be stored up, so, for instance, connecting these forms of batteries between a lightning rod and the earth to obtain atmospheric electricity, or with a reader of a fictional machine, or with a magneto-electrical machine."

In 1880, Gen. G. Percival employed electrodes for secondary batteries, consisting of plates coated with crystalline coke and powdered lead, in dilluted sulphuric acid.

In 1880, Mr. Percival published a description of an improved form of secondary battery, con-sisting of a positive electrode of coke, with a neutral solution of the positive metal, as Zn. Sn. &. By this means not only is peroxide of lead deposited on the negative electrode, but there is also a finely-divided deposit of zinc on the positive electrode, and sulphuric acid is liberated.

In this arrangement a much more-negative chemical, and consequently electrical action, is developed, when the charging current increases, than if both electrodes were of lead. He amalgamates the zincs.

In 1872, Deschwel, of Paris, employed a secondary battery, consisting of electrodes coated with metallic salts, mechanically applied.

He describes two electrodes coated by electro deposition, but says: "It is not necessary that the deposition of the sub-stances on the plates should have been brought about by electrolysis. A similar result will be obtained if the plates be coated with the substances in any other way."

In 1879, Count d'Arsonval employed carbon plates covered by oxides of lead and manganese, coupled with zinc plates in solution of sulphate of zinc.

It will appear from the foregoing that a secondary battery can be formed by the use of gases in the presence of unoxidized electrodes, preferably of platinum or carbon:

By electrodes of different character, whether of different metals or of the same metal, when surrounded or coated with chemicals of different character; or

By electrodes of different electrical potential, made so by galvanic action.

It has been shown in the foregoing that secondary batteries can be formed by the use of electrodes coated with an active layer of absorptive substance, such as metal or metal compound that becomes spongy, and thus capable of receiving and discharging electricity, that the electrodes have frequently consisted of plates impregnated and coated with oxides, insoluble salts, and amalgams of metals applied as a paste, by electro deposition or otherwise.

The electricity received into secondary batteries is not retained as electricity, but is held in a chemical embrace, and gives out the electrical energy by the action or chemical affinities as disclosed by Faraday in 1799.

In all the foregoing described forms of secondary batteries, the electricity that is used to charge them, passes through them and does not accumulate in the battery as some might suppose, but in passing through the battery it acts to create a difference in chemical potential between the positive and the negative plates which constitute the battery, and when these plates are fully charged in their chemical relations to each other, and the charging current increased to flow, these batteries are then simply galvanic batteries, and in the act of being discharged they lose their power like other galvanic batteries, but they can be charged whenever exhausted by the action of electricity passed through them, and do not consume zinc and chemicals which require to be replenished.

Galvanic batteries which consume zinc and chemicals give electricity at less expense, and if they had continued to be the principal mode of supplying electricity we should not have so much need of secondary batteries, as it would be as well to employ these batteries direct as to store their energy.

But chemical consuming galvanic batteries are too expensive for producing light and power.

The development of Faraday's discovery that the motion of a coil of wire in front of the poles of a magnet or in a magnetic field gives rise to an electric current in the wire, has shown us that the bunding of zinc or other materials in batteries, such as Grove's or Bunsell's, is a very expensive way of producing an electric current, and that it is far more economical to obtain electric currents by employing the best mechanical means we have to produce rotation of the coil of wire in the magnetic field. The different magneto and dynamo-electric machines that they abound are but the results of attempts to find the best form of coil, the best kind and best form of magnets, the best proportion of the-masses, and the most suitable arrangements for the special work in each case which is required to be done. The dynamo-electric machine is very satisfactory as a mode of producing electricity, and both the electromotive force and the current increase with the rate of rotation of the coil. This mode of producing electricity is like raising water to any level that may be required for any particular use; but the electricity must be used at once. This may be very inconvenient, and hence the necessity for something like a reservoir to store up the electricity. The labors of Faraday have shown us the relation between the quantity of electricity and the weights of the chemical elements decomposed by it, in electrolyte, and that these chemical elements may unite again to reproduce the compounds from other which will remain apart, even when joined by a liquid conductor, until a complete electric circuit is made. Then these two substances should be at considerable difference of potential, so as to give a strong electric current in uniting again to form the substance from which they were decomposed.

Besides these secondary batteries previously described, convenient forms are had by employing a scroll of copper and a scroll of zinc, arranged as in a gravity battery, in a solution of sulphate of zinc, or—

By employing plates of lead, disk shaped, filled with red oxide of lead, or peroxide of manganese, covered with cloth or like porous layer, and set one on to the other; a dilute solution of vinegar or sulphuric acid can be used. A secondary battery employing a negative plate of palladium, which absorbs the action of electrolysis absorbs more than 900 times its volume of hydrogen with a positive pole of lead, is well spoken of; good results are said to have been obtained by the use of iron turnings in place of the palladium plate, as it will absorb 200 times its volume of hydrogen in a solution of sulphate of ammonia of 50 per cent. of salt.

The negative electrode should have the property of absorbing hydrogen, and the positive pole should have the property of absorbing oxygen or of becoming peroxidized.

[*To be continued.*]

A Boston landlady, whose impecunious boarder owed her a bill of $50, was finally prevailed upon to take 18 shares of telephone stock, which then had no market value. She can now sell them for $3,000.

Electric Light vs. Gas.

A striking illustration of the economy of electric illumination over gas has been practically afforded for some time past at No. 182 Hegent street, London, England, in the studio and photographic establishment of Mr. Henry van der Weyde, the son of the editor of this paper. He takes photographs by electric light and same, and uses for that purpose a Gramme dynamo electric machine, driven by a gas engine consuming thirty cubic feet of gas per hour, and producing an arc light, which by help of a parabolic reflector illuminates the sitter with a soft, but no active light that a portrait is taken in six seconds. Now, the question arises, if this same amount of gas, thirty cubic feet, were consumed by a number of ordinary burners, say, six feet-burners, a picture could be taken by it in six seconds? Every photographer knows that this would be utterly impossible, and that the most sensitive preparations would require as many hours.

Or, to look at the matter from another point of view, thirty cubic feet of gas per hour is, per minute, half a cubic foot, and in six seconds one-twentieth of a cubic foot. *Question:* Is it possible to make a photograph by means of one-twentieth of a cubic foot of gas? *Answer:* It may be possible by the addition of combustion promoting chemicals to increase the quantity of light, but as it is possible to increase the heat produced, or the power by making an explosive mixture; but surely it is utterly impossible in the ordinary way of burning gas, which is very wasteful in all respects, not only in the production of light, as of heat and power.

It is, indeed, strange that in place of burning coal directly, it is more economical to employ the roundabout way of placing the coal in a retort, and heating it so as to transform its principal constituents into gas, and then, instead of using the gas directly, to burn it in a gas engine and generate power; then to transmit this power to a dynamo-electric machine, and transform it into magnetism and induced positive and negative electric currents; then to pass these currents over a conducting wire, and then place in the circuit so formed a few carbon points, and by separating them create a local resistance, by which the two opposite electricities, while neutralizing one another and appear ently disappearing are transformed into a more intense light and heat than it is possible to obtain from the fuel used in the ordinary way of combination.—*Industrial News.*

The Microscope and the Electric Light.

Mr. C. H. Stearns, F.R.M.S., recently brought an interesting application of the incandescence lamp to microscopy before the Newcastle-upon-Tyne Chemical Society. A small 8-candle lamp of two or three candle power is permanently attached to the microscope, and screws in place of the ordinary oil lamp, over which it has the advantage of requiring no cleaning, giving off no smell or much heat, and yielding a purer light. The great ease and facility with which the lamp can be adjusted is beyond comparison with the ordinary gas or oil flame, especially when the light has to be shifted to above or below the stage for illuminating opaque or transparent objects. Condensers may also be got rid of by its use. The light of the lamps controlled by a small resistance coil, and two or three Grove or Bunsen cells are sufficient to work it. Where the battery must go with the instrument, and the latter is placed in a drawing-room or study, the inodamatic or lithonomatic batteries are preferable, as they give off no offensive fumes. In Mr. Stearns' micro-scope, as shown to the society, there are three lamps—one above the stage revolving round its own axis, one below the stage fitted to the sub-stage, and one below the sub-stage for use with the polariscope. Each lamp is connected with a three-way switch, which sends the current to either lamp at will. Mr. Stearns also arranges the fittings so as to shift a single lamp to any of the three sockets mentioned, and thus save expense in lamps.—*Engineering (London).*

Cost of Electric Lighting.

The Fuller Electrical Company make the following estimate as the cost of electric lighting by their system:

"Owing to the various conditions under which intending users are placed—some already having ample power, either water or steam, while others have boilers, but no engine—it is impossible to give figures applicable to every case. It is therefore well, we think, to let each individual establishment figure power for themselves.

"In forming a fair estimate of cost of lighting, the matter seems, naturally, to divide itself into two parts; firstly, *cost of installation;* secondly, *cost of maintenance.* The first includes apparatus, dynamos, lamps, wire, services of competent men to properly prepare the plant for operation; *to which* must be added engine and boiler, shafting and pulleys, if these are not already available. Where the last are already in place, it is obvious that the *first cost* of electric lighting is very much reduced. The second division includes a fair charge on the investment on interest account; depreciation, which may be said to include wear and tear; carbons, attendance and power.

"By reference to our testimonials, it will be seen that electric light apparatus requires no more attention than any other well constructed machinery. It is erroneous to suppose that the services of an electrician or expert are required after the first twenty days, during which the Fuller Company leave their men in charge.

"A twenty light apparatus is an ordinary sized one, and we select it for purposes of estimate. Supposing we have a machine shop, mill or large store, hotel or factory to light, under ordinary conditions and circumstances, we make the following estimate:

TWENTY LIGHTS, FULLER SYSTEM, Dynamo No. 2. No. 20 Spool Gramme	$2,000 00
Lamps—20 Weeks' Patent, @ $50 each	1,000 00
Wire—Say 1,000 feet, 38 p. per foot—10 feet to the lb., @ 35c. per lb.....	35 00
Cost of running circuits, about.....	100 00
	$3,135 00

"The cost of maintenance, including carbons, attendance, interest on investment and depreciation, is so moderate as to render this mode of lighting unlimited to owners of isolated plants requiring large spaces to be lighted, and also to afford a handsome profit to persons making inquiries for the renting of lights, at rates which they readily command wherever introduced.

"The above machine requires not more than fourteen effective horse-power. For those unaccustomed to figure cost of power on a basis of steam, we append the following figures, which we believe are those ordinarily recognized by competent engineers:

When fires are built afresh each day for express purpose of running electric light apparatus, the coal necessary each hour to develop one effective horse-power is..... 4 lbs.

When fires are constantly on and power is applied for other purposes, driving shafting, running elevator or heating, the additional coal necessary to develop one effective horse power *additional* is..... 2½ lbs."

Electrical Motors.

It is intimated that experiments will soon be made with a view of introducing electricity as a motive power on the elevated roads in this city. These experiments, which are to be made on the Thirty fourth street branch, will be conducted by Mr. Stephen B. Field, the electrician for the Mutual Union Telegraph Company. Mr Field has been at work experimenting with electric motors for a long time, and claims priority in his ideas to both Siemens the originator of the electric railroad in Berlin, and Edison, whose road at Menlo Park has been running for experimental purposes for over two years. Mr. Field first began his experiments several years ago, and afterward, at Stockbridge, Mass., constructed a road forty feet in length, upon which, with a dynamo-motor car run by a 2½ horse-power engine obtained results which fully satisfied him that the elevated railroad cars in this city can be run much more cheaply than at present, and without the smoke and noise which render the roads a nuisance at present. Mr. Field has obtained permission from the managers of the elevated railroad to thoroughly test his experiments on the Thirty-fourth street branch, and says that several capitalists have promised to aid him financially in carrying them out.

According to Mr. Field's system in case of the adoption of electricity on the roads, of which he has no doubt when his experiments have been submitted to the management, there will be two stations or plants where the power will be generated from large dynamo machines. One of these stations would be placed at the Battery and the other at the Harlem river, on account of facilities for getting water necessary for the engines that run the dynamos. After the electricity is generated, it will be conveyed over to the present rails or else to a supplemental rail which could be laid in the centre between the tracks. The current running through the rails is then taken up by the wheels. By the simple turn of the lever in the engine the circuit can be broken and a train stopped. Any number of trains can be moved from one station to another, and all would be under the control of men at the stations, or even at the central station. The motor would be noiseless, Mr. Field declared, and of course there would be no smoke, cinders, or clouds of steam. By the system, various sections of the road could be divided into blocks in which only one or two trains would be allowed, thus increasing the safety of travel to a great extent. "In fact," said Mr. Field, "the trains would be under perfect control. If a train was at one station, the trainmen there could positively prevent another from coming up to it. Precaution has been made for the stopping and starting of trains, also for the running of any number on the same circuit without the motion of one exerting upon others to any damaging extent." In regard to brakes, Mr. Field's idea was that they should be operated by electricity or compressed air, whichever should prove the most convenient for the purpose. If electricity was used, it would probably be taken from storage batteries. In the plan probably to be adopted, storage batteries would be used any way to furnish the electricity for lighting the cars. This power could be derived from the rails while the trains were at a stand-still at stations. Alarm mechanisms or whistles, if their use was necessary, could be actuated by compressed air. According to one of Mr Field's plans, the locomotive is dis-united altogether, the power being applied to the trucks of each car. In this manner an increased number of cars could be carried with each train, and it was a pet idea of Mr. Field that a short car should be placed at the front of the train, to be fitted up as a smoker, which would be used in the same manner as the dummies now drawing the trains. "However," said Mr. Field, "if an engine or motor is used, the entire weight for a forty horse-power locomotive would not be much over 10,000 pounds, or five tons, which I think much lighter than those now used."

In regard to the cost of running trains, Mr. Field thought it would be at least fifty per cent. less than under the present steam system. An engine now required from eight to ten pounds of coal per hour for one horse power. With the electric power on tracks, the expenditure would not exceed five pounds per hour to produce one horse-power. The wear and tear on the structure would also be much decreased, as the trains would run smoothly, and the motion would be uniform.

Mr. Field said that his claims of patents antedated those of Edison or Siemens. There was much litigation over the patents, but Mr. Field was confident that he would come out ahead. He was fully assured of the success of his motor, and thought it simply a question of time before it would be introduced on all the elevated roads in the city.

Mr. Thomas A. Edison said that Mr. Field was one of the men who were fighting over patents. Already the testimony had been taken, but he did not think the matter would be settled for a long time, perhaps not for over a year. If the elevated roads should run electric motors, both Mr. Siemens and himself should consider it an infringement of their patents. Mr. Edison claimed priority in time over Siemens, and also Mr. Field, and thought that it would be so decided by the Examiner of Interference in Patents, before whom the matter was pending. Mr. Edison did not believe that the elevated people would introduce any new system as long as it was controlled by the present management. Mr. Edison said he had commenced his experiments with electric motors in 1869, and had run trains at times over since at Menlo Park. He had now a freight and two passenger cars on the two-mile road at that place, and had also run three engines at a time on the road. His experiments had been suffering in all but an economic view, and of late he had made great advances in that point. A light train he could now run 45 per cent. cheaper than by steam. If it was heavily loaded with freight, the reduction would amount to only 30 per cent. He was now at work constructing a large engine of over 300 horse power, which he intended, when it was completed—and it would be finished in the spring—to try on a regular railroad, the Pennsylvania probably. This engine would be experimented with in carrying freight. Mr. Edison also stated that at Boston, next August, he intended to build a short road, upon which his electric motor would be run. As soon as the difficulties concerning the patents were settled he would be prepared to take contracts for furnishing the locomotives. On his road at Menlo Park, already a speed of forty two miles had been acquired, and the success of the system was assured. He thought a supplemental track should be used, so that both electric and steam trains could be run.

In reference to the elevated roads, Mr. Edison thought that the best use they could make of electricity, at present, would be to fit up the stations with continuous elevators, such as were used in several buildings in London. These elevators could be fed with electricity by means of wires from a central station, and the expense would be very light. —*Ex.*

Limits of Telephone Action.

The power of the telephone to transmit the voice to long distances is intimately associated with its delicacy. Mr. Willoughby Smith has found by experiment that a telephone will work through a "resistance" of wire corresponding to 150,000 miles of telegraph line; and hence it would seem possible a child's play to fulfill the words of the poet, and "waft a sigh from Indus to the Pole." But this was only a laboratory experiment; for on actual telegraph lines the leakage of electricity from the wire to the ground, damp, and other drawbacks, render the transmission of speech by wire for long easy in practice than was at first supposed. Nevertheless, it is on record that Mr. Edison transmitted speech over a line 250 miles long in America; and conversation has been carried on over 500 miles in India; 390 miles, from Tabriz, in Persia, to Tiflis; and 700 miles in Spain, Australia, and other places where the atmosphere is dry and pure. In England, we have not been able to work through such long circuits, owing to the wetness of the atmosphere; but Mr. Van Rysselberghe, the inventor-Chief of the Meteorological Observatory at Brussels, has telephoned from that city to Paris, a distance of 215 miles; and this while the same wire was carrying simultaneously an ordinary Morse telegraphic message. By a peculiar disposition of his apparatus, Mr Van Rysselberghe spoke to Paris by telephone without any interference from the Morse signals that were traversing the identical wire at the same time.

The day after the bombardment of Alexandria, it was announced in the London papers that the ends of the cable had been heard at Malta by telephone through 1,000 miles of submarine cable. Experienced electricians took the statement with a grain of salt, because they knew that a submarine cable differs from a land telegraph wire in the greater retarding effect which it has on electric currents traveling along it. A cable has the effect of condensing together—jamming up—the delicate and rapidly succeeding vocal currents of the telephone, and thereby muddling the articulation or creating absolute silence. Five hundred miles of land-line would make little or no difference in the distinctness of a telephonic message, supposing the wire to be well insulated from the earth; but two miles of ordinary submarine cable will probably be quite enough to spoil some experiments made by the wire, with Dr. Muirhead's artificial cable. Since the cable the voice could be faintly heard through a length equivalent to fifty, or even sixty, miles, when it came to a cable when sound at all was audible. The inductive retardation had frittered away and blotted out the delicate undulations of the vocal currents. Telephonic messages have, however, been successfully sent by cable across the Channel, and from Holyhead to Dublin; but in no case has the length of cable reached 100 miles. The dream of whispering across the Atlantic under the "roaring forties" is likely to remain a dream for along time to come.—*Chambers's Journal.*

Electricity and Ears.

It is gravely affirmed in a floating paragraph that a person in Texas having had to use a telephone a great deal during eighteen months, found to his dismay that his left ear, which he constantly applied to the instrument, had grown to three times the size of his right ear, and that it still continued growing.

Mr W. H. Eckert, General Superintendent of the Metropolitan Telephone and Telegraph Company, said, when asked what he knew about the effect of electricity on the ear:

"Well, I never heard of any such property as this thing as the statement in that paragraph. I have heard it said that the use of the telephone was injurious to the hearing, but from the facts within my knowledge I do not believe to pronounce that absurd. I have been in the business, in Cincinnati and here, since 1878, and have never yet to add any complaint whatever of such an effect from operators who were steadily at the receiver of a telephone circuit hours out of every day for months and years. I would certainly have known of it if there had been anything of the sort. The source of the trouble is probably be made is by the effect during a thunder-storm, and I know that that produces no uncomfortable feeling, and is attended with no danger. We never stop work on account of thunder-storms, nor did we do so in Cincinnati. In Cincinnati our receivers in the main office were all stationary, and fixed to the left ear. In addition to these, however, I had put in at first receivers with flexible connections, that the operators might use on the right ear in case of necessity. After a time it appeared that these were useless, and I gave an order for them to be removed. One distinctly a young woman—a very nice girl and one of our best operators—sent in her resignation. I saw her, and asked her why she was the reason for her going away. She was crying, and said that no one had ordered it impossible for her to do her work and so she had to leave. It then appeared that she had always been using the right ear, though we had never suspected the fact of the kind in the 20 or 30 that we had with us. Of course I left it to the discretion of the people, and this was one of the best receivers. She was dead before I came to us."

Six years ago on February 12, 1877, the first public exhibition of the telephone in Lyceum Hall, Salem, Mass., was reported being sent to telephone in the *Salem Gazette* and printed the next morning.

The "Ferranti" Dynamo Machine

IN September of last year, a considerable stir was caused in electric lighting circles by a statement of Mr. Hammond, made at a meeting of the numerous "Brush" companies, as to the capabilities of a new dynamo machine, with which the name of Mr. Ferranti was associated; and which, it was said, had been practically perfected. The statement of Mr. Hammond was to the effect that the machine in question was five times as efficient as any then in use, or, in other words, that it would give results equal to five times those obtained by the employment of any other dynamo. In many quarters this description of the possibilities of the invention was received with some amount of incredulity, and almost with ridicule; but among those interested in the financial success of the "Brush" subsidiary companies, in some of their "concessions" becoming in a great measure valueless was not unnaturally viewed with no little alarm. The "Brush" dynamo was notoriously ill adapted for incandescent lighting, and the announcement that the new machine was specially fitted for this class of work therefore materially helped the scare. Much speculation of course, followed as to the nature of an invention which was said to be capable of yielding such results, and it was afterwards learned that the great feature in the new machine was the absence of iron in the revolving armature. Very greatly decreased in weight, and, by enabling the field magnets to be brought very close together, greatly increased in efficiency. It was not until the end of November that there was a public demonstration of the light-producing powers of the dynamo, but it was generally felt that what was witnessed by the electricians and others assembled on that occasion indicated—if not the accomplishment of all that was predicted by Mr. Hammond—certainly real and very considerable progress. A full account of the exhibition appeared in these columns at the time. A small alternating current machine was shown running no less than 300 lamps of 20-candle power each, and in steadiness the illumination left absolutely nothing to be desired. On examining the machine every one was struck with the very small weight of metal contained in the revolving armature. As most systems the armature is of very bulky dimensions, the result being that any endeavour to multiply the size of the machine would lead to the making of an armature quite unwieldy in its proportions. It was of such a construction that it could be enlarged to almost any extent with a corresponding increase in electrical results. Indeed, we were assured on that occasion that the 300 lights, and that a machine to give 2,000 lights, which was then in course of construction, would be only very slightly larger.

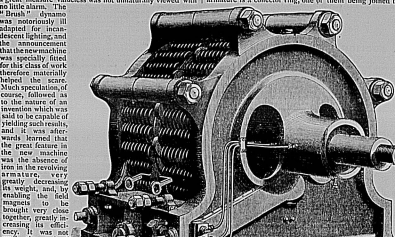


FIG. 1.

The holders of the Ferranti patents have since been devoting themselves to the practical and commercial development of the system. In view of the great extension of electric lighting which is anticipated upon the passing of the numerous provisional orders approved by Parliament, and more particularly in readiness for the needs of their own district of Hampstead, Messrs. Ferranti, Thompson, and Ince have been making more powerful types of their machines, and have also recently introduced many changes which have resulted partly from additional extended experience, and partly from the aforesaid greater demand for machines as compared with small ones. We are indebted to *Engineering* for the accompanying engravings illustrative of one of the larger machines of the latest type. Much of the description which follows is necessarily technical, but its general purport will, doubtless, be fully understood. Fig. 1 is a view of the complete dynamo, which is designed to supply no fewer than 5,000 lamps. It comprises three principal parts, each of which is self-contained. These are the armature (Fig. 2) and the two sets of field magnets (Fig. 3). The former consists of 10 discs or bobbins insulated from each other and from the shaft, and carrying between them an insulated ring. To the periphery of each disc is fastened an equal intervals eight copper strips 11 in. wide and 1·75mm. thick, and these strips are then bent into the undulating form shown in Fig. 2, each strip making the circuit of the whole periphery of the armature twice and being secured at its outer end to a rivet in electrical contact with one of the discs. Thus, as the strips are divided from each other by insulating material, there are eight parallel circuits around the armature, the ends starting from the internal brass ring and ending after two revolutions, in the case of the smallest, at the same point. At either side of the armature is a collector ring, one of them being joined by a heavy copper connection (Fig. 2) to the internal brass ring, and the other to the opposite disc, so that the two rings form the terminals of the armature circuit. The current is not taken off by brushes in the usual way, but by solid rubbing pieces (Fig. 2) which embrace both sides of the collector rings, and are held up to their places by springs. The current is led from these collectors down heavy copper bars enclosed in a casing on the outside of the framing (Fig. 1) to two terminal studs, by which it is transmitted to the main leads. The suitable diameter of the armature is 9 ins., and its speed rather less than 1,000 revolutions per minute, at which rate it will furnish some 2,000 amperes of current with an electromotive force of 200 volts. As the machine is separately excited from an independent generator, and as its internal resistance is exceedingly small in comparison with that of the outside circuit in which it will be applied, it follows that the difference of potential at the terminals of the station varies exactly with the number of lamps in action, the power absorbed by the machine increasing and falls with the number of light produced, and there is no waste of energy.

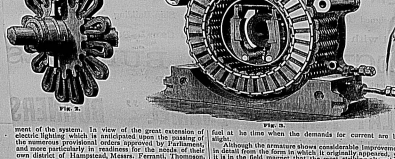


FIG. 2.

FIG. 3.

In the field magnets (Fig. 3) the cup of the armature fits between the two sets of field magnets (Fig. 3). The former consists of 10 discs or bobbins insulated from each other and from the shaft, and carrying between them an insulated ring. To the periphery of each disc is fastened an equal intervals eight copper strips 11 in. wide and 1·75mm. thick, and these strips are then bent into the undulating form shown in Fig. 2, each strip making the circuit of the whole periphery of the armature twice and being secured at its outer end to a rivet in electrical contact with one of the discs. Thus, as the strips are divided from each other by insulating material, there are eight parallel circuits around the armature, the ends starting from the internal brass ring and ending after two revolutions, in the case of the smallest, at the same point. At either side of the armature is a collector ring, one of them being joined by a heavy copper connection (Fig. 2) to the internal brass ring, and the other to the opposite disc, so that the two rings form the terminals of the armature circuit. The current is not taken off by brushes in the usual way, but by solid rubbing pieces (Fig. 2) which embrace both sides of the collector rings, and are held up to their places by springs. The current is led from these collectors down heavy copper bars enclosed in a casing on the outside of the framing (Fig. 1) to two terminal studs, by which it is transmitted to the main leads. The suitable diameter of the armature is 9 ins., and its speed rather less than 1,000 revolutions per minute, at which rate it will furnish some 2,000 amperes of current with an electromotive force of 200 volts. As the machine is separately excited from an independent generator, and as its internal resistance is exceedingly small in comparison with that of the outside circuit in which it will be applied, it follows that the difference of potential at the terminals of the station varies exactly with the number of lamps in action, the power absorbed by the machine increasing and falls with the number of light produced, and there is no waste of energy.

The electrical details of the generator have been designed with great care. Each bearing, both cup of the armature and in addition to this three oil pipes in connection with a pump driven by the crosshead, and through these latter lubricants can be forced if the ordinary means fail to keep the bearings cool; all the parts are made interchangeable, and the whole machine can be entirely taken to pieces in a short time. At present we are not in a position to give any account of its performances; but as we believe that no other firm, except the Telegraph Construction Company, has as yet attempted the manufacture of a machine of such dimensions with the ambitious objects in public lighting which have been put forth, we are sure that the public will await with interest the results of the process has attended this attempt to provide apparatus for electric light undertakers suited to the responsibilities they have undertaken.

ELECTRICAL REVIEW

A WEEKLY JOURNAL OF

TRIC LIGHT, TELEPHONE, TELEGRAPH AND SCIENTIFIC PROGRESS.

(Formerly Review of Telegraph and Telephone.)

NEW YORK, THURSDAY, APRIL 26, 1883.

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DELANO & COMPANY, 25 Park Row, New York.

Entered at Post Office, New York, as Mail Matter of the Second Class.

...CITY AFLOAT.

...lighted by Electricity.

...MPELLY APPLIED ELEC... ...DATION—NO ENGINE, SO ...ORK, NO DANGER—THE ...AL LAUNCH—ITS SUCCESS... ...ES—A NEW AND POWERFUL ...APPLIED—FUTURE POSS...

The current is led through the filler ropes, made for the purpose, and twisted wires, covered with silk and cotton, and encased in an India-rubber tube, to what is called the *governmental motive propellers*, or combined rudder and propeller.

The electrical motion, designed by M. Trouvé, while in many ways similar to the Siemens coil, has been made by modification so as to secure more efficiency than that before in use, when this was applied to marine architecture. It is placed in the rudder-head while the propeller itself revolves on a slot in the rudder itself, motion being communicated by an endless chain. So great is the action of the rudder intensified by this arrangement that, unlike its prototype propelled by steam, this boat can be made to turn almost on her own centre. Thus a complication of machinery required in order to permit of a boat's forward movement being reversed, is rendered unnecessary. The filler ropes are provided with contacts to enable the steersman to instantly stop the movement of the boat or start or back her. By taking off the rudder, which can be performed in a few minutes, the boat is ready for towing, and always make sure, while anchored in unfrequented waters, that no one will run off with her.

So far, all that electrical boat travel through the water that, at a normal rate, a four-oared gig or racing boat going at full speed can usually overhauled and passed by her.

Now, there are said to be over two hundred electric boats, built upon the model of the Tarolea, navigating French and English waters, and constructed are being made for the construction of many more.

We look forward with appreciable enthusiasm to the construction of one of these craft *for our own waters*, in the full conviction that, when its many advantages are thoroughly comprehended, the building of a fleet of them will follow.

The electrical boat glides smoothly and quickly over the water. There is no smoke and no disagreeable odors. Instead of the cumbrous engine and huge coal bunkers, to fill which the craft must be covered with coal dust, there are accommodations for passengers, the batteries taking up but little room in comparison.

Again, as is well known, the engine of a steam-launch is, unless watched with great care, liable to breaks and even more serious accidents. The pumps and gauges are so small that they are easily clogged up, and when the water in the boilers, as it is not an unusual thing for the water-gauge facing the cabin, to register "full" when it is the boiler when in reality there is hardly any at all, and many an excursion party has been surprised to see the engineer suddenly open his doors and draw his fires as if life itself depended upon his getting them out without a second's delay, which in many instances has been known to be the case.

No such dangers attach to the use of the electrical boat. Of course, when a continuous journey is contemplated, the electrical boat could not at the present time be used for the reasons that there are, as yet, no electrical stations established to supply the supply of electricity could be had when the storage battery aboard had been charged. Until the establishment of these however, the boat may be run until half the stored power of its batteries is drawn off, and return trip made with the batteries only.

The lines of force diffused between when electrical storage stations will be found on the banks of all populous watercourses and the power of the charged boat can obtain a new supply of electrical power without difficulty, and at a cost so trifling as to be quite an item in the expense account, comparatively speaking.

The American District Telegraph Co. has filed papers in two suits against the Postal District Messenger Co. (Limited) and Postal District Telegraph Company, for infringement of patents of Prof. A. E. Dolbear, of Providence, R. I., and Rogers and Cowen, of Boston.

On the Composite Character of the Induction Spark.

By CUNT DE MOSCEL.

(*Translated for the* ELECTRICAL REVIEW *from* *Le Lumière Electrique.*)

We have already spoken several times in this journal (*La Lumière Electrique*) on these two lines of theory, chiefly in connection with the subject of magnetic reactions on the induction spark, but the matter is treated more fully in our number of June 16th, 1883, a bearing of the various forms of the electric arc. We, however, must here, deem it to be well to return to the subject at this time, for the reason that the preceding article was discussed very briefly, and in all works treating specially of static electricity, M. Mascart's theory of sparks, the matter has been dismissed in a few lines.

I had already treated of this subject in the latter volume of my notice on the Ruhmkorff apparatus, but in my pamphlet on the non-homogeneity of the induction spark, I have treated it with all the fullness due to the subject although I will now give a summing up of that work.

It is noteworthy that all the effects in question were much better developed and more easy to observe in the earlier Ruhmkorff machines than in those used at present. The modern makers seem to have aimed at the single end of producing the spark, and to reach this result they have sacrificed quantity to quality, and by their *new mixture in the secondary coils: At first thin wire and dense; then thick wire, thickened, and the* ...ubbins longer, and, if the experimentalist ...obtained ...very 2 centimeters long, they were well suited, composed by a dense smooth, and productive of calorific effects much more intense, for the same battery, than those of the former, but they were not, as we shall, therefore, speak of the effects produced by these earlier machines in this article.

If we attentively examine the Ruhmkorff coil induction spark, we first notice that it is not simple, and that it is composed of several luminous disks of extreme whiteness, surrounded by a species of sheath or luminous envelope of a dull greenish red, which seems to be formed by the luminous atmosphere, and which is sensitive to the movements of the surrounding air. It is this envelope which Mascart has called the *aureole*. It is produced by a layer of air heated by the spark, and this layer, in proportion to the electricity thus acquired, serves as a vehicle for the transmission of the greatest portion of the charge. The spark, then, is composed of two distinct portions—one represented by the flashes of light of the direct discharge, which constitute the spark, properly so called; and the other represented by the aureole, which is only a discharge transported by an ...form conductor, and which restores under

* 2 centimeters = .78 inches, or about ¾ inches.—TRANS.

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March 17, 1880 W. O'Hara

FINANCIAL AND MINING NEWS.

Storing Electricity.
Insert Advertise.

A company has been formed in this city which is expected to occupy a prominent position in the process of storing electricity for lighting and other purposes. Its patents are now before the Commissioner of Patents at Washington, and if all the claims of the Newark organization are granted the celebrated Frenchmen, Faure, and the hardly less famous Brush will lose some of their titles to consideration as discoverers.

The Newark company claims priority in the invention of the true system of storing electricity, of which M. Faure has been said to be the prophet and inventor. The electrician of the company, whose inventions the corporation holds and proposes to operate, is Nathaniel S. Keith, of New York. The company is named "The American Electric Storage Company," and its directors are George W. Hibbard, Henry Young, George O. Frelinghuysen, Barker Gummere, Jr., and F. T. Fenny. Mr. Keith claims that two years before Faure secured his French patents he (Keith) and discovered the principles of the storage of electricity, and that to him belongs the right of the invention. The patent asked for is not on the principle of electric storage, however, but on the process of constructing the reservoirs. As is known, the great thing desired in electric lighting as to its practicability has been demonstrated, has been accomplished by which the lights were not dependent on every stroke of an engine for continuity. The storage of power as every master mechanic knows, has been one of the great problems in mechanics, and its necessity was seen at once in electric lighting. If the lamps were only to burn when the engines were working, it was seen that the time would come when the engine might give out and leave every customer without a light, and it was also evident that the engines could not be kept working night and day to supply the demand which ceases at all hours. Storage was a necessity.

The Faure, Brush and Keith inventions step to at this point. They provide a box reservoir composed of a series of lead plates into which the electric current is forced. The electricity produces a chemical action on the plates which forms a "potentiality of electric force," which will discharge the electricity in almost the same volume as received. The Keith invention differs from the Faure and Brush principally by the use of pure lead plates in the reservoir, instead of red lead. The pure lead yields much more rapidly to the action of the electric current and the reservoir may be prepared for use in far less time. The reservoir will discharge ninety per cent. of the electricity it receives, and the inventor claims that the properties may be made even larger.

The system is now in working order at the company's office, No. 792 Broad street. The storage reservoir is a box eight inches square in one corner of the room. It is filled with a series of lead plates, and altogether weighs about forty pounds or less. Into the box is conducted a wire from the electric generator in Mechanic street, which supplies the reservoir. The Mechanic street engine runs eight hours a day, and thus supplies the reservoir with sufficient electricity to supply incandescent lights for seven hours, provided the lights use up in one hour as much electricity as the generator supplies in the same time. From the box extend wires connecting with beautifully executed incandescent lamps of both the Weston and Edison make. The light is perfectly steady, and in color is between the yellow gaslight and the perfectly white light of the sun, having a pleasant effect on the eyes. Various forms of lamps may be used, and the reservoir will supply any number, thus attaining more perfectly than at any time heretofore the great desideratum of a wide distribution.

After the reservoir is once prepared for his work (which takes forty hours with the Keith and 800 hours with the Faure) it needs nothing but the electric current, and therefore works as simply as a reservoir of water. It may be filled at any time and to the full extent of its capacity, or it may be supplied with only enough electricity to keep the lamps running for a single evening. In factories furnishing the motive power of electricity to the reservoirs, the latter would be filled at night, when the power was not used for other purposes. The reservoirs are portable and when supplied with electricity to say running distance may be detached from the supply wire and used anywhere. The stored electricity may be used not only for lighting, but for running sewing machines, turning fans, pumping water, etc. The current is governed by a key similar to that used for turning gas on or off.

The American Company does not intend to go into the lighting business itself, but will sell its licenses to other companies which will apply the process practically.

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ELECTRICAL REVIEW

A WEEKLY JOURNAL OF ELECTRIC LIGHT, TELEPHONE, TELEGRAPH AND SCIENTIFIC PROGRESS.

Formerly Review of Telegraph and Telephone.

Vol. 2, No. 5. NEW YORK, THURSDAY, APRIL 5, 1883. $3 per Annum. Single Copies, 10 Cents.
WEEKLY.

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A New Electrical Street Car.

A STORAGE BATTERY THAT WILL PROPEL A CAR FOR SEVEN HOURS — THE ELECTRIC POWER COMPANY DOING GOOD WORK — CHEAP, SAFE AND EXPEDITIOUS PROPULSION — FUTURE PROSPECTS.

The newly devised electrical street car has been illustrated for the benefit of the readers of the ELECTRICAL REVIEW, not by reason of its perfection as a motor, which as yet, it is not assured, but because it would seem to be the exponent of that system of electrical locomotion of which the charged rail and running wire constructions were the pioneers.

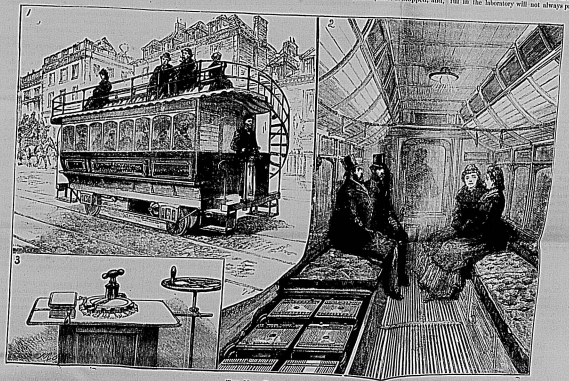
The car, a faithful representation of which is here given, was recently tried on the lines of the West Metropolitan Tramway Company, from Gunnersbury Station to Turnham Green, and thence back to Kew Bridge. Upon the morning of the day of trial the car was tested in the presence of the Government Inspector, on the Acton line, and had abundantly demonstrated its ability to do that which had been claimed for it. Smoothly and noiselessly it ran hither and thither, partly filled with passengers, of which it has accommodations for forty-six. The rate of speed attained was six miles an hour, though considerably more than that was shown to be possible.

As everyone knows, trial tests of newly devised machinery are rarely satisfactory, and at such times accidents seem more frequent than at others, where less critical observers are at hand. The electrical car was fated to meet with one, and, by an and after successfully traversing a part of the line in the afternoon's trial, a portion of the machinery, presumably the belts of the driving gear, got out of order, and, while taking from the number of cells by means of an ordinary electric switch, by breaking the circuit the motive power is stopped, and, with the axle of the wheel. Nearly set in the body of the car is an accumulator, consisting of fifty Faure Sellon-Volckmar cells, each measuring 13 in. by 11 in. by 7 in., and weighing about 80 lbs. The power of this accumulator is capable of supplying a constant motive power in the car for seven successive hours. Of course, the duration of the motor may be reversed at will, and, by an ingenious contrivance, the power may readily be increased or diminished, by adding to or the brake being then applied, the car is quickly brought to a standstill.

The car, with the accumulators and machinery, weighs 4½ tons, and when loaded with the forty-six passengers which it is designed to carry, there will be a total weight of 7 tons on each wheel. It has been computed that the daily cost of working the car, including first cost and wear and tear, &c., &c., against 30s. the daily cost of keeping horses.

For several years electricians have been busily engaged upon the various problems connected with electric lighting and have, with few exceptions, paid little attention to electric locomotion, which, there is reason to believe will, at no distant day, be considered of primary importance. The efforts of those few persons who have employed themselves in applying electricity to locomotion have not, up to the present, been rewarded with a very flattering measure of success. The road electrically operated between Berlin and the Sindenbrunnen, and the other and some what similar experiments in other countries, have but demonstrated that their projectors, if not their engineers, were on the wrong track; that what has proved successful in the laboratory will not always prove feasible commercially; and, doubly, that the cost of maintaining a unit of electrical railway is to the cost of a unit of railway operated by horse-flesh nearly as two is to one.

In the two-rail system, whose currents from powerful electric generators were sent along the rails and picked up by the car-wheels as a return, the public, which it was designed to benefit, were placed in great danger. Men, women and children were seriously injured by coming in contact with the non-insulated electric mains, and horses, while trying to cross the track, connected both mains with their body, were instantly killed. The third system, also, has not as yet proved any-



THE NEW ELECTRIC STREET CAR.

THE EDISON-HOPKINSON DYNAMO.

ELECTRIC MACHINE.

THE following abstract of the report by Mr. Frank S. Sprague on the Edison-Hopkinson dynamo-electric machine will be found of interest to electrical engineers :—

Characteristic features of the dynamo are : General arrangements.—Use of a shortened and differently proportioned Edison dynamo. The pulley, however, is outside of bearing, and with a face of 6½ inches. Diameter of 10½ inches projects 8½ inches outside the iron plate. Field coils wound over 3-inch core with ten layers of No. 16 copper wire (B.W.G.). Two legs in series. Armature : Diameter of core 9 inches, 74 c.-ds, single turn, 8 strands of No. 16 wire, average length 43 inches. Wire bound. Diameter 10-1 inches, with 3-inch clearance from pole face. Zinc plate connecting pole faces. Number of magnets not stated. Resistances : Field coils, 36·5 ohms ; armature coils, 0·06 ohms. Field measured ; armature calculated. Total resistance of circuit, armature varies, 0·235 ohms. Power supplied from a Lawrence —Armington and Sims—engine, high-speed and non-condensing, driven by a link belt through an Allerech tension belt dynamometer.

Engine diameter	8½ inches receipted.
Stroke	9½ inches measured.
Piston-rod	1¾ inch "
Fly-wheel	40 inches "
Indicator spring	50 inches "

I.H.P. = $\frac{2 \times P. \text{ m.} \times L. \text{ ft.} \times \text{revs.}}{33,000}$

$= \frac{2 \times P. \text{ m.} \times \frac{12}{12} \times 178 \text{ revs.}}{33,000}$

$= \frac{42 \times P. \text{ m.}}{33,000}$

= Mean pressure × 0·00127.

The magnets were tested by the Poggendorff method.

Total H magnetic field = Gr × E × $\frac{1}{\text{p-vel.}}$ × $\frac{1}{\text{revs.}}$ × K dif.

E = 1·437 Clarke's standard

Gr = 6·28

Mean force in laboratory—Westmire-ter —

	Earth.	No. 45.	No. 12.
May 7	7·21	9·41	11·49
May 8	7·25	9·36	11·38
May 12	7·22	9·40	11·32

Total H field for Manchester—

E and No. 45	9·83
E and No. 12	11·91

The results of three fairly full loads are given. No. 6 Time, about one hour ; load, 192 lamps and ground of about 5 amperes. Lamps not up to candle power.

Potential galvanometer, magnet ...		No. 45	
" " position ...		2	
" " strength ...		9·55	
Average deflection		20·79	
Potential at brushes		99·27	volts.
Current galvanometer, magnets ...		No. 12	
" " position ...		2	
" " strength ...		11·61	
Average deflection		19·39	
Current in loop circuit		112·56	amp.
" field		2·65	"
" armature		115·21	"
Resistance, loop circuit		·882	ohms.
" field		·964	"
Total resistance of circuit		·8935	"
E.M.F.		102·97	volts.
Electrical energy in loop circuit ...		14·97	H.P.
" " field		·20	"
" " armature		·58	"
Total		15·91	H.P.
Dynamometer spring at rest		112·23	lb.
" " running free		115·02	"
" " load		126·74	"
Total difference		6·765	"
Above friction		6·515	"
Total power to armature		16·14	"
Power above friction		16·65	"
Friction		·71	

Dynamo speed, 1681 ; engine speed, 289·3 ; efficiency of center-box, 97·7 per cent. ; commercial efficiency, 86·5 per cent.

Dynamo behaved well. Fields cold. Armature moderately warm. Wrist not uncomfortable to touch. Can't be told on commutator. Little sparking. Bearings cool. No increased heating after standing.

The same remarks about the behaviour of the dynamo are pertinent to two later experiments with 192 and 236 lamps respectively. There was no appreciable increase in the heating, and the load could easily have been carried a long while. An increased load of 50 lamps could be carried some time.

Summary of Three Experiments

No.	Time.	Speed.	Currents in amperes.			E.M.F. in volts.		Electric H.P. approximately.		H.P. delivered to pulley.		Efficiency.	
		Engine.	Dynamo.	Field.	Loop circuit.	Total.	Brushes.	Total.	Field.	Armature.	Loop circuit.	Total.	Armature.	Total.	Commercial.
6	1 h. 10 m.	...	1071	2·65	112·56	102·74	99·3	16·30	·58	15·72	14·97	15·91	95·2	94·1	86·5
7	30 m.	...	1057	2·60	110·00	102·90	99·5	16·00	·56	15·44	14·64	15·56	94·8	94·1	86·5
5	1 h. 10 m.	...	1071	...	112·56	102·74	99·3	16·30	·58	15·72	14·97	15·91	95·2	94·1	86·5

Means ... ... 94·8 94·1 86·5

ELECTRICAL REVIEW

A WEEKLY JOURNAL OF

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(Formerly Review of Telegraph and Telephone).

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Copyright, 1883, by DELANO & FOREMAN, 23 Park Row, New York.

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The Ferranti Dynamo Machine.

In an interesting descriptive article of this machine our esteemed contemporary, *Engineering*says that in view of the great extension of electric lighting which is anticipated upon the passing of the numerous provisional orders now before Parliament, and more particularly in readiness for the needs of their own district of Hampstead, Messrs. Ferranti, Thompson, and Ince have been making more powerful types of their machines, and at the same time have introduced many changes which have resulted partly from their extended experience, and partly from the altered conditions of large machines as compared with small ones.

The dynamo which we illustrate on this page is one of these, and is designed to supply 8,000 lamps, each requiring a current having an electro-motive force of 200 volts, and an intensity of .33 amperes. It comprises three principal parts, each of which is self-contained. These are the armature (Fig. 2) and the two sets of field magnets (Fig. 3). The former consists of two discs or bosses insulated from each other and from the shaft, and carrying between them an insulated brass ring. To the periphery of this ring there are fastened at equal intervals eight copper strips 1¼ in. wide and 1·75 mm. thick, and these stripes then bent into the undulating form shown in Fig. 2, each strip making the circuit of the sinuous periphery of the armature twice, and being secured at its outer and too ether in electrical contact with one of the discs. Thus, as the strips are divided from each other by insulating material, there are eight parallel circuits around the armature, each starting from the internal brass ring and ending, after two complete revolutions, at one of the bosses. At either side of the armature is a collector ring, one of these being joined by a heavy copper connection (Fig. 2) to the internal brass ring, and the other to the opposite disc, so that the two rings form the terminals of the armature circuit. The current is not taken off by brushes in the usual way, but by solid rubbing pieces (Fig. 3) which embrace both sides of the collector rings, and are held up to their places by springs. The current is led from these collectors down heavy copper bars enclosed in a casing on the outside of the framing (Fig. 1) to two terminal studs, by which it is transmitted to the main leads. The middle diameter of the armature is 30 in., and its speed rather less than 1,000 revolutions per minute, at which rate it will furnish about 2,000 amperes of current with an electro-motive force of 200 volts. As the machine is separately excited from an independent generator, and as its internal resistance is exceedingly small in comparison with that of the outside circuit, to which it will be applied, it follows that the difference of potential at the terminals will be sensibly constant for a given speed, whether there be few or many lamps in action, and that these will burn with the same brilliancy whether a part or the whole of them be lighted. Further as the amount of current in circulation varies exactly with the number of lamps in action, the power absorbed by the machine rises and falls with the amount of light produced, and there is no waste of fuel at the time when the demands for current are but slight.

Although the armature shows considerable improvement in detail from the form in which it originally appeared, yet it is in the field magnet that the most striking alterations are to be seen. There are thirty-two magnets on each side alternately north and south, each north pole being confronted by a south pole, and likewise having a south pole on either side of it. The cores of the magnets are cast with the framing, which, as shown in Fig. 3, is made in halves, and then by the removal of six bolts the machine may be divided in the center, and the whole of the internal parts held open for inspection, while at the same time there is no danger of accidents from parts jarring loose and getting into the path of the armature. The magnet cores are excited by a current circulating among them through a system of copper bars. These are of rectangular section ¾ in. by ¾ in., and are bent in a special machine to a shape somewhat like that of the conductor in the armature. Supposing the cores to be numbered 1, 2, 3, &c., the first bar will pass over 1, under 2, over 3, under 4, and so on ; the second bar will pass under 1, over 2, under 3, over 4, and so on for the whole 8 bars and 32 cores, and thus each core will be completely surrounded both at its sides and ends by copper conductors. The exciting current will flow in no waste of fuel at the time when the demands for current are but slight.

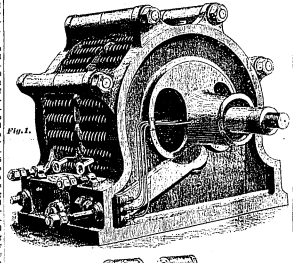

Fig. 1.

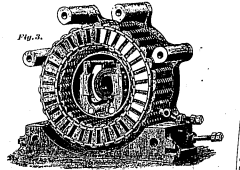

Fig. 3.

THE FERRANTI DYNAMO-ELECTRIC GENERATOR.

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The mechanical details of the generator have been designed with great care. Each bearing has an oil cup of the usual form, and in addition to this three oil pipes in connection with a pump driven by the countershaft, and through these latter lubricants can be forced if the ordinary means fail to keep the bearings cool ; all the parts are made interchangeable, and the whole machine can be entirely taken to pieces in a short time. At present we are not in a position to give any account of its performances, but as we believe that no other firm, except the Telegraph Construction Company, has as yet attempted the manufacture of a machine at all commensurate with the ambitious schemes of public lighting which have been put forth, we are sure that the public will await with interest to learn how much success has attended this attempt to provide apparatus for electric light undertakers suited to the responsibilities they have undertaken.

The Electrical Transmission and Storage of Power.

By DR. C. WILLIAM SIEMENS, P. R. S., M. INST. C. E.

Amongst the numerous other applications of the electrical transmission of power, *that in electrical railways, first exhibited by Dr. Werner Siemens at the Berlin Exhibition of 1879, has created more than ordinary public interest.* In it the current produced by a dynamo machine, fixed at a convenient station and driven by a steam-engine or other motive and driven by a steam-engine or other motor, was conveyed to a dynamo placed upon the moving car, through a central rail supported upon insulating blocks of wood, the two working-rails serving to convey the two working-rails serving to convey the return current. The line was 900 yards *return current. The line was 900 yards long, of 3-feet gauge, and the moving car served to purpose of carrying twenty visitors through the Exhibition each trip. The success of this experiment soon led to the laying of the Lichterfelde line, in which laying of the Lichterfelde line, in which both rails were placed upon insulating sleepers, so that the one served for the conveyance of the current from the power station to the moving car, and the other for completing the return circuit. This line has a gauge of 2 feet 3 inches, is 2,300 yards in length, and is worked by two dynamos machines, developing an aggregate current of 6,000 Watts, equal to 12·31 H. P. It has now been in constant operation since the 16th of May, 1881, and has never failed to accomplishing its daily traffic. A line 1½ a kilometer in length, but of 1 feet 8½ inches gauge, was established at Paris in connection with the Electric Exhibition of 1881. In this case, two suspended conductors in the*

IRON.

THE EDISON-HOPKINSON DYNAMO.

A DISPLAY of electric lighting, embodying some novel features, took place last Tuesday at the works of Mr. Peter Brotherhood, in the Belvidere Road, Lambeth, and which a large number of electrical and other engineers were present. The main object of interest was an Edison dynamo machine, which has been improved by Dr. Hopkinson so that its size has been reduced, and at the same time its efficiency improved. This machine was driven direct by a Brotherhood three-cylinder engine, also of improved construction, being practically a new pattern of this type of engine. The dynamo machine, which was manufactured by Messrs. Mather & Platt, is intended for 200 Edison A lamps, or 300 Swan 100 volt lamps. The resistance of the armature equals 0·015 ohm, and that of the magnets 70 ohms. Working as shown on Tuesday the potential is 102 volts, the current external to the machine 225 amperes. The external work done equals 22,950 Watts (or volt amperes), or 30·8 horse-power. The work lost in the magnets equals 700 Watts, and the work lost in the armature 550 Watts. The commercial efficiency of the machine is 90 per cent. The total work done in driving the dynamo is 32·2 horse-power. The machine was shown both for incandescent lighting and for a single arc lamp. The improved three-cylinder engine combines all the advantages of the well-known Brotherhood engine with an economical use of steam equal to that obtained by the best types of high-pressure high-speed engines, and it runs with perfect steadiness and smoothness at very high velocities. The speed on Tuesday evening was 650 revolutions per minute, the engine being of 45 horse-power indicated. The dynamo machine was driven through a novel flexible coupling, in which leather plays an important part. This coupling is of great advantage, not only for direct driving as exhibited, but for ordinary shafting, relieving the bearings of any strain due to the shafts not being strictly in line. It consists of a ring of leathers, the outer periphery of which is held by means of a junk ring to one half coupling, the inner periphery in a similar manner to the other half coupling, the radial distances between the two half couplings being such as to allow of a very considerable amount of flexibility. Thus all friction which would arise through want of alignment in the shafting, or through unequal wear in the bearings, is avoided.

The engine and dynamo were placed in the main fitting shop at Mr. Brotherhood's works, which is about 100 feet long by 70 feet wide, and the lower portion of which was fitted up with 223 Swan and Edison incandescence lamps in equal numbers, and which were lighting the works at the same time and from the same machine. In the galleries of the fitting shop were 12 arc lamps, and in the foundry, which is about 70 feet square, were four more. These were all supplied with the current from a Siemens alternating dynamo and exciter driven direct by another Brotherhood engine. Besides these there were eleven 40-cell chloride of silver accumulators, for storing the energy generated by the engine of the Edison-Hopkinson machine, which were also in operation. These consisted firstly of a harbour light and lantern complete of the sixth order (200 m.m. internal diameter), provided with clock and screws to give the slightly-varying velocity of a double-revolution, and secondly of a masthead light, 250 m.m. internal diameter, with lantern complete. There were also shown side lights swinging in gimbals adopted to be placed in the turret now under construction on steamers. The luminous intensity of the beam from the masthead light was stated to be about 500 candles. The Edison-Hopkinson machine was shown to be instantly adapted to give a powerful search light for naval or military purposes. The carbons used are 35 m.m. diameter, and the current 200 amperes of such electrostative force between the carbons as may be desired. The reflector used in the projector was made by Messrs. Chance Brothers & Co. in accordance with suggestions from Captain Carden. Altogether the demonstration was most successful.

e had passed. The highest number 277, and the first upon the list was 272 marks. In the second year ge section, Mr. H. P. Barnet was Jr. H. Skinner in the second term, ield third in the third term. The ding and the drawing office of the r, by the results attained, the value instruction practised by Mr. J. W. nd the mode of its administration, is fortune to be ably seconded by Mr. , and his assistants. The workshop ll by the specimens of fitting and ed, is highly creditable. The colonial ch is to impart a practical knowledge work, &c. (branches of industrial art g men seeking employment in the nt of considerable importance; the other sections, has given very great ision for electro-mechanics has just of three of the school, which marks of the directors to keep this estab- ition in the front rank. We hope that th the success the present has exerted his was the first time that he had been highly gratified by the g was carried on in it. The war now ness gratified by the report of the good fortune to commence his career had four years of it, and he had backbone of his career. There was evening. They must make up their ughly earnest hard work, and if they linary ability, they would probably n engineer was one of noble enter- nment with all the great forces of duty and his privilege to tame those ters for the benefit of mankind and ation. Therefore, no nobler career e a young man, and to begin that n it in a well-regulated workshop. ctical education to avail themselves of y advantages to them there of acquiring training. . . . Sir Frederick's visit for his address, was to Bengin said Institution of Civil Engineers, and the members would be a good number, all the work that was required, but than 2,000 members, and there was many.

FOR THE WEEK.

SDAY, August 21.
. ASSOCIATION.—Annual Meeting Dp.
SDAY, August 22.
—) p.m.
SDAY, August 23.
leeting at Southampton, address by the Simmons, 8 p.m.
ASSOCIATION.—Show of Farm Implements,
SDAY, August 24.
Ames 8 p.m.
TDAY, August 25.
15 p.m. Mr. C. W. Merrifield. Dis-
URDAY, August 26.
.m.

GY AND MINING.

CK SLAG.—Experiments have lately of crushing blast-furnace slag into road and railway making, &c., and a constructed by the Kingsbyian Com- to be very effective.

g Mill.—New continuous train of a great success at Dilworth, Porter ton Street, South Side, Pittsburgh, as placed in at one end, and, after it ateen rolls, emerged at the other end required but three men to attend to for a bar of iron from two inches to ple rail, requires about thirty men

ng.—At the bi-monthly meeting of Mining Institute, on Monday even- Hedley read a paper on Sonth and ing coal by caustic lime. He had seen ons at Shipley, and he minutely agent consisted of lime in cartridges d, and the experiments were made in ere was a good roof, and the seam work being done on the long wall inces under which lime was used at th from those of North Staffordshire it could not be successfully applied of the latter district, where the roofs at Shipley. Neither had they the ing Crossgill, which was a very ble bed of coal. There were other th Staffordshire, as compared with nd which would enable them to dis- vould be heartily welcomed, and he lime process fairly tried in the dis- n which followed, a general wish was w explosive should be fairly tested. place relative to the properties of d, and several recent instances of coal ained. Mr. Lawton said there was detecting such a small quantity of Abel said was dangerous when mixed rged that further experiments should be made to obtain the requisite knowledge with which to guard against the mischievous effects of fire-damp. Mr. Young said he could add as a reason of laying the dust in the most dusty seam in the district, and it answered well. Mr. Macdonald said, if salt was used for laying the dust none where the shots were fired, if any explosion occurred. his efforts were to be successful. Several other members joined in the debate.

THE NEW METHOD OF WORKING COAL.—Considerable attention is just now being taken in the mine system of getting coal by means of new catapults, which are in regular use at the Shipley Collieries, Derbyshire. In addition to the fact that trials have been made in various parts of the country with a view of testing the new method, a visit has recently been paid to the colliery by the officials of the Miners' National Union for the purpose of inspecting the system at work. Amongst those who descended the workings were Mr. Burt, M.P. (president), Mr. B. Pickard (vice-president), Mr. Crawford (secretary), &c., &c. Some of them were much impressed with what they saw, and have given notice to lay the matter before the Miners' National Conference to be held at Manchester. The notice for discussion is as follows:—"That we urge upon the House Office the necessity of finding means to test the working of coal by machinery into use the new system of getting coal with lime." When the party visited the mine, they were conducted into the workings, two yards in length, where they found a large quantity of coal had been brought down by the new process, and by reading of the above blocks. Workmen then prepared a number of holes, each 1 yard and 3 inches in depth, the time of drilling each hole did not exceed six minutes and a quarter. Four cartridges were put in each hole, and were then saturated with water, and in less than twenty seconds the coal began to crackle and was forced down in large blocks. The party were much impressed with what they had seen, and it is understood that in addition to the easy mode of getting coal, the system will be recommended, owing to it enabling miners to remove coal without having to resort to blasting or drilling, thus making it valuable in thousans which are wrought in Yorkshire and other coal-fields. It is also said to be even more economical in blasting, while the coal is brought down in much larger and more saleable blocks. A trial of the system has been made at one of the largest collieries in South Yorkshire, where the measures are inclined at a very steep angle, sudden outbursts of gas from the roof are likely, necessitating the strict use of the very best safety lamps, accompanied with strict discipline.

ELECTRICITY AND TELEGRAPHY.

THE ELECTRIC LIGHT AT SOUTH KENSINGTON.—Lieut-Colonel Festing reports that the substitution of electric lighting by the aid of two machines driven by one engine in the place of gas at the South Kensington Museum has resulted in a saving in the working expenses at the rate of nearly £70 a year, or more than £23 per annum for each lamp. Up to the end of last year the thirty-two lamps illuminating the Lord President's Court and the Sheepshanks and Raphael Galleries had been at work for nearly six months, or 1,365 hours of lighting. The second 16-light Brush machine was brought into operation in May.

SUBMARINE TELEPHONES.—From the report which has been addressed to the National Telephone Company on the recent experiments at Dover with a view to establish telephonic communication between vessels and the shore, it appears that the operations have been attended with complete success. In spite of rough weather, the cables were finally laid, and various persons and offices in the town of Dover were placed in communication with a vessel anchored at the Admiralty Pier, and subsequently with the Marine Christine Club. The conversation, it is stated, was very distinctly maintained, whether by the aid of an Allen or a Cooper apparatus. Some time later the wind gained strength and the vessel rolled considerably; but the voices of the parties in communication were nevertheless distinctly heard. This new application of telephony is expected to render important services to maritime commerce, since it will allow vessels arriving off a port to place themselves immediately in direct communication with their owners or agents ashore.

ELECTRIC RAILWAYS.—The development of electric railways and tramways is now considerable. Putting aside numerous lines that are merely in course of construction, there are now in actual work, or in course of construction, about a total length according to the *Revue Industrielle*, July 19, of more than 160 kilometres (about 100 miles), and grants are becoming even more numerous. The lines actually at work are those of Lichterfelde (about 2½ kilometres in length), and that from the Spandauer Bock to Charlottenburg, near Berlin; another line, from Port Rush to Bush Mills, in the north of Ireland, has been inaugurated (length about 10 kilometres), and also in Holland, one from Zandvoort to Kostverloren (length a little over 2 kilometres). Among lines authorised or in construction, the following are noted.—In Austria, the Mondling line, near Vienna (2½ kilometres), to be constructed by the Southern Railway Company there. In Germany, the line from Wiesbaden to Nerobergs (4 kilometres), and that from the top to the bottom of a quarry at Cudenbach, in Silesia. Where there is a fall of water, as at Leading Crossgill, the Lichterfelde Stations (1·2 kilometres), also a line in South Wales (60 kilometres), for which the force will be derived from fall of water. In Italy, Turin and Milan will soon begin the construction of electric tramways. In America, the Edison Company have arranged for the working of 80 kilometres on one of the great lines from New York. Another small line (1·8 kilometres) is to be made at St. Louis, in Missouri, by Mr. Heslet.

ELECTRICITY AND EVAPORATION.—Experiments very recently made by Mr. Lemstrom have thrown an important source of atmospheric electricity. Experiments, however, hitherto yielded little evidence of this. Thinking further inquiry desirable, Mr. Freeman, of the Johns Hopkins University, Baltimore, lately experimented thus. A copper or tin

IRON.

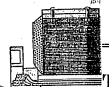
No. 550.

LONDON, FRIDAY, MARCH 9, 1883.

THE ELPHINSTONE-VINCENT DYNAMO-ELECTRIC MACHINE.

In the year 1879, Lord Elphinstone and Mr. C. W. Vincent, F.R.S., commenced a series of researches and investigations with respect to dynamo-electric machines, the results of their labours having been from time to time communicated to the Royal Society. The practical outcome of their joint labours is the continuous current dynamo-electric machine which we illustrate on page 186 of our present issue. In our engraving, fig. 1 represents a longitudinal and fig. 2 a transverse section of the apparatus, fig. 3 being a general perspective view. In these machines a very cylindrical drum upon which the armature coils are laid longitudinally rotates between the poles of an exterior and interior magnet; each coil is made some what in the shape of the frame of a saddle. They are removable, and a faulty one can be replaced in a short time. The armature consists of eighteen of these coils. The separate magnetic circuits enable the inventors to have a low resistance, although comparatively thin wire is used. There is no iron in the armature, consequently there is no magnetisation and demagnetisation, and Lord Elphinstone and Mr. Vincent maintain that this is the most efficient system upon which to construct dynamo machines. It is stated that an electrical efficiency of 82% to 84% or 91 per cent. can be obtained, according to whether it is desired to attain the best return per horse-power used or maximum current without considering horse-power; and this change of efficiency can be effected in a few seconds. With from 240 to 320 ampères of current—*i.e.*, enough to light more than 400 Swan lamps—the armature is barely warmed. It is stated that a machine on this system can be built of a size to light a whole town, supce the parts are capable of almost indefinite multiplication. The great object of the inventors has been to provide the current for a large number of lights without multiplying the number of the machines, shafting, and belting. As the coils and magnets are wound apart from the machine, they can be always attained by many of his successors in the ranks of inventors, yet it amply illustrates the value of diligent and patient application and perseverance, qualities which, as they are at the foundation of this country's greatness as an industrial nation, we would fain hope are as ever present with our workers now as in the past. How these qualities were employed and led to early and deserved success in the case of Nasmyth, could not be told in a more graphic and straightforward manner than by the pages before us from his own pen.

James Nasmyth was born at Edinburgh in 1808, and came of a gifted family. He early manifested a very decided taste for mechanical pursuits, and was fond of frequenting the workshop of his father, for though the latter was by profession an artist and architect, his chief relaxation was found amongst his tools and tools. The son's natural bent took a ractical turn at an early age, and he drove a small rade among his schoolmates in the spinning-tops and ninature cannon which he was able to turn out in a father's workshop. Amongst his school companions were two of a similar disposition to his own, and in the foundry belonging to the father of one, the latter



JAMES NASMYTH.

THE inventor of the steam hammer has been conspicuously the right man in the right place. James Nasmyth was the child of the era inaugurated by the opening of the Liverpool and Manchester Railway in September 1830, and he was the parent of many of the inventions which have contributed to the wonderful progress made in the mechanical arts during the past fifty years. With the adoption of railway locomotion, and the rapid development of steam navigation, it was found that the method and appliances which had done duty up till then were not adequate to the demand upon them. There was a call for machine-making tools of increased power and precision, and on more than one occasion Nasmyth proved his possession of an admirable resource by the ready response with which he met the want. We should not be doing justice, however, to his foresight if we omitted to mention at the same time how often he had paved the way, by the invention of some simple but ingenious contrivance, for the realisation of the perfection to which machinery has been brought nowadays. If his life does not present a record of fierce battling with difficulty and failure, such as has so often been the only road by which success has been attained by many of his successors in the ranks of

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steel being fused. The current was then made to run through a coil of iron wire immersed in a glass vessel holding three quarts of water; instantly there was a flame as when a red-hot poker is plunged into water. This was followed almost immediately by steam; in half-a-minute the water boiled, and before a minute had elapsed half the contents of the vessel was on the floor. An ordinary steel flat file 1 inch by 1 inch was then placed instead of one of the carbons in an arc light, and the current being passed through, the end of the file was melted and consumed like a tallow candle in a fire, throwing off a shower of sparks. The experiments concluded by the lighting up of a very powerful search light, as used by the navy, the carbons of which are 12 inch in diameter, capable of giving a light said to be equal to 100,000 candles, and which made a very brilliant display. The mechanical arrangements were carried out by Mr. Arthur Rigg, C.E. The motive power used for driving the dynamo machine is supplied by one of Rigg's high-speed engines, capable of developing 60 indicated horse-power. In conclusion, we have only to congratulate Lord Elphinstone and Mr. Vincent on the marked success of their efforts to produce a cheap, simple, and highly efficient machine, and to state that the temporary offices for these dynamos is at No. 78, Gracechurch Street, London.

Engineering, Dec. 29th 1882.

THE SPEED AND RESISTANCE OF DYNAMOS.

It is well known that the internal resistance of magneto and dynamo-electric machines increases with the speed at which they are worked; if the recent experiments of M. E. Lecoine are correct, this effect is mainly, if not entirely, due to the increased resistance between the rubbers or brushes and the commutator. These brushes rubbing on the slips of the commutator are, in fact, so many microphones, and their resistance varies with the speed of rotation and the pressure of the rubbers on the slips. According to M. Lecoine's experiments made at Montmirail, the resistance of a circuit comprising a battery, a telephone, a galvanometer, and a commutator made after the model of the Gramme machine one, was when at rest only 08 ohms; at a speed of 2000 turns per minute it rose to 180 ohms; at 3000 turns, to 900 ohms; at 5000 turns, to 1507 ohms; and at a very great but unmeasured speed it reached the enormous value of 2993 ohms. In these experiments each spring or rubber touched three slips at once; of course in making a touch more than three the effect was less appreciable but still great. For a given speed the resistance decreased when the pressure of the springs was increased; and it is possible to arrive at a pressure which will suppress the microphonic effect and produce silence in the telephone joined up in circuit. Measurements taken by M. Lecoine led him to infer that the increase of resistance is proportional to the cube of the speed.

Occasional Notes.

THE MANUFACTURE OF CAST-IRON PIPES IN FRANCE.

In France the founders of Torteron in 1822 and of Maruejols in 1841 first put down plant for casting pipes horizontally. In 1847 the engineers of the Paris municipality required that all pipes over 400 millimetres (4 inches) in diameter should be cast vertically, which led to the Torteron foundry being the first to produce them. In 1848 the Maruejols works followed suit, and until the year 1862 these two establishments had the monopoly of making cast-iron pipes in France. In 1860 the firm now incorporated with the Société anonyme des Chementery-Four chenbusch obtained a patent for an improvement in the manufacture, whereby a greater quantity of pipes per day was obtained; but it was only put into practical operation in 1861-2.

By their patent of March 1, 1861, they claimed the manufacture of pipes in vertical foundry boxes, invariably fixed, the moulds being dried in place by natural or gaseous fuel. A little later MM. Pinart Frères, of Marquise, renewed their plant according to the process of Messrs. Walker & Stewart, patented in England a few years previously. This process was not followed at any other works; but, on the contrary, all founders tried to imitate the Torteron method. The next patents secured in France were those of MM. de la Rochette & Cie. in 1862, the Terre-Noire Company in 1868, and of M. Dard in 1868-9. In these systems the pipes are cast vertically, and the box is fixed, though movable laterally, ideally and round a vertical axis. Another method, patented by MM. Hubly-Rochling & Cie. differs from that of Torteron in that the upper instead of the lower box being lowered. To these methods must be added in France the casting pipes inside themselves into two—(1) the English system of compressing the sand mechanically and moving the boxes on a track, as practised at the Marquise works; and (2) the Scotch system with boxes attached to a fixed or movable frame, as practised at Torteron, La Voulte, Fourchambault, Mans, Aubrives, Pont-à-Mousson, and Montluçon.

THE DISTRICT RAILWAY VENTILATION.

Extensive steps are being taken with a view of conveying the Metropolitan District Railway Company that they cannot with impunity defy the public opinion in being organised, on a scale which cannot but be despised even by a powerful railway company, in the form of somewhat modified plans before the House of Commons. Mr. Fowler, the late mayor of a northern town, and Mr. Lockwood, has given "After second reading of the Metropolitan and District Railway (City Lines and Extensions) Bill, to move, That it is referred that they have power to insert in the said bill a clause making it compulsory upon the said companies to pull down the ventilators now erected, or in course of erection, in Tothill Street, Broad Sanctuary, Victoria Street, the Thames Embankment and Garden, and in Queen Victoria Street, under the Mansion House and Cannon Street Railway Stations, and to reinstate the said ground in such terms as may seem reasonable to the committee." This opposition is seconded both by the Corporation of London and the Metropolitan Board of Works, the Court of Common Council, and the Metropolitan Improvement Committee to draw up a clause for insertion in the Lunac Circular Company's Bill, which have declared a petition in the Private Bill Office of the House of Commons, praying that the Standard Office of the House may be dispensed with in the case that a bill may be introduced for the repeal of the clauses under which the Metropolitan District Railway Company are empowered to erect ventilators on the Thames Embankment and other parts of the neighbourhood. It would be very strange indeed if the railway company were able to resist such combined pressure.

THE NEW BANKRUPTCY BILL.

Mr. CHAMBERLAIN was able, on Monday evening, to move the second reading of his bill in the House of Commons. In introducing the measure, he described the cardinal principle of the bill to be that it would secure for every case an independent and impartial examination. The person best able to do this duty of cross-examiner. The powers entrusted to the official receiver under the new bill would be very extensive. He would be the person to whom the debtor would have to make his statement of affairs, and he would have the power to investigate the conduct of the bankrupt and the causes which have led to the bankruptcy, to conduct the public examination of a debtor before the court, and, if necessary, to report to it any misconduct on the part of the debtor's affairs, and any misconduct on the part of the bankrupt which has been disclosed in the course of the proceedings. This officer will be subject to the control of the Board of Trade. The other main object of the bill is to provide for the honest and economical administration of bankrupts' estates. The criticisms presumed upon the measure on its second reading cannot be said to be very hostile to its general principles. On the whole, the House was in its favour, as there is much good in the bill, and it is a decided reform in our bankruptcy law.

PRIVATE BILL LEGISLATION.

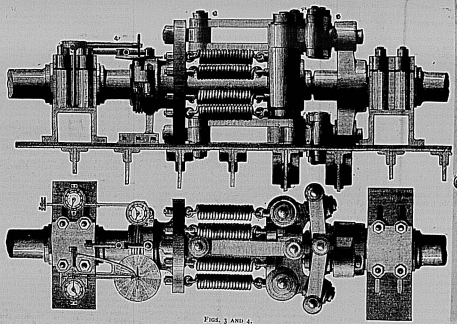
In the speech with which Mr. Sclater introduced his motion for the above subject to the House of Commons there appears to be evidence of a somewhat important character. We allude to the effect which the existing system exerts upon the trade and manufactures, and, we may also add, upon the agriculture of this country. It has been computed by competent persons that, if the lines owned by the various great English railway companies could have been constructed on the Prussian system, *i.e.* without the usual preliminary and parliamentary expenses, each of those companies would be able to carry traffic at a reduction of 25 per cent. upon the prices at present charged, without adversely affecting the market value of their stock, or diminishing in any way the dividends which their shareholders are now receiving. What the effect of such a reduction in traffic rates would have upon the manufacturing interests of the country, at the present moment, it is needless for us to point out. It is a matter of common knowledge that the migration of Messrs. Cammell's steelworks from Dronfield to the coast has been occasioned solely by the high railway carriage of fuel and raw material and the manufactured products; and there are scores of other industries in addition to the rest of the kingdom which, from the same cause, added to the fierce foreign competition to which they are now subjected, will be compelled altogether to close their works. If, on the same principle, the carriage of the ordinary mails were delivered, in a greater or less degree, the charges of all gas and water companies, and in every case is in the public who suffer.

THE AFRICAN INLAND SEA.

A party of explorers, under the guidance of M. Fernand de Lesseps, has left Tunis for Gafsa. Of course it is supposed to proceed on horseback across the desert lying between that town and the great marsh lakes of Southern Tunis. M. de Lesseps is very sanguine as to the results and details of the inland sea scheme. The proposed basin will be fifteen times as large as the lake of Geneva. The excavations engendered in its course will be of time-to-time extracted by the fact of four batteries, consumed with 1,000 foot-pounds) of work per second, producing 1 kilogrammetres of water per minute, pre-heating 1 kilogrammetres per minute, pre-heating 1 kilogrammetres per minute, pre-heating 1 kilogrammetres

BOURRY'S DYNAMOMETRIC GOVERNOR.

(For description, see page 468.)



FIGS. 3 AND 4.

BOURRY'S DYNAMOMETRIC GOVERNOR.

(For description, see page 468.)

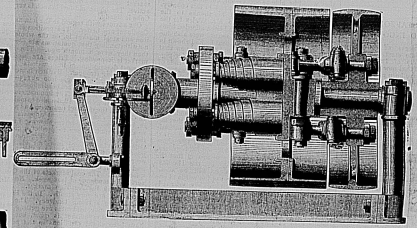


FIG. 1. [CUT 7]

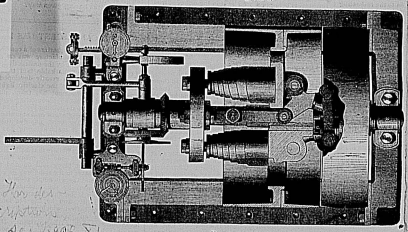


FIG. 2.

IRON. June 16, 1882.

BOURRY'S DYNAMOMETRIC GOVERNOR.

THE great increase in the adoption of electrical illumination opens up a new field for this governor, which variations of the resistance. The first two instruments are is claimed to be the only one, really practical, that can be easily distinguished in the illustrations. As regards the of employing the electric light in many works where power is not constant. Hitherto, the plece of the pencil only is shown at the end of is not always in excess of power available. By its aid the the rack of the dynamometric index, the arrangement of the power is automatically distributed among two or more lamps, and the number of these can be increased or diminished according to requirements, while still thus serve as accumulators of figures. An ordinary counter is shown in the last two lines of this governor also renders it especially useful in exactly with that of the steam-valves of the engine; these valves almost momentary, as well as in connection with positions of the slider, which may be obtained empirically, the engine engines. Instead of depending upon variations or better still by calculation. It is not necessary that all from the normal speed, the increase or M. A. Bourry, of Saint- these instruments should work constantly. They, in alternate by the tendency of centrifugal force on the shaft, and also the fact that in the same way as an indicator. On the this shaft is subjected to a rotatory force at one end and to a screw engine, there is every reason to cause the work of substance at the other. At a rule, this shaft is under strain, the engine and the resistance of the propeller to be broken utilisable; but, in order to make it serve for the desired record of the state of the sea. It is always useful to be purpose, it must be increased artificially, by concentrating the dynamometric counter to work continuously, whatever be the load. This point by means of springs judiciously applied. The nature of the motive to which it is applied, it will indicate in the mode in which is reflected, as it were, the resistance the power given out from any given instant, and will opposed to the engine. The arrangement adopted by M. permit of comparing the effective force developed with the Bourry consists in converting all circular strain into quantity, at the moment of observation, and, therefore, in case of rectilineal pressure, which permits of applying the greatest checking of the amount of motive power let on blow, this number of the best springs known. These are placed round instrument is always indispensable. The dynamometric and near to the shaft, and, as this offers great advantages indeed, when given a constant indication of the resistance, as regards distribution of the strain, facility of installation, and consequently the strain is not constant, but, on the contrary, there are quite a host of claimants for the engine-man and stoker, enabling them to with a perfect governor, which may be set, to small limits, record the measure of the work done in any powers as well as the largest engines, such as those of screw- establishment, while an exact reproduction of the indications steamers, because it consumes no part, without sensible can be obtained at any moment. This governor, in the office, which, moreover, is applicable to all cases where regulation is required.

The engravings on pages 564 and 565, for which we are indebted to M. Dingler's Polytechnisches Journal, show two types of this governor, the first, for Belgium, may possibly exist, and the second, applicable to all cases where elevation at fig. 1 and in plan at fig. 2, the appliance is mounted on a special bed-plate, which may be attached to the floor, to a wall, or to the engine. An intermediate shaft is interposed between the motive-shaft and the driven shaft, and carries two pulleys, one of which is fixed, and the other, on the left from the engine, while the screw and loose, receives for allowing of the manipulation of the latter. The fixed pulley is driven by the motive-shaft, by means of a belt, and receives its motion from the first by means of a belt, and coupling; under certain cases, the two pulleys may be replaced by grooved wheels.

The second arrangement, shown in elevation at fig. 3, and in plan at fig. 4, places the appliance connecting the lay shaft with that of the engine in the case of screw steamers. In both arrangements, according to circumstances, by compression, by the engine is put in motion, the and it afterwards transmitted to the slider and the spring, slider, by the position of which, according to the load on the engine, is always corresponds exactly with ment to the steam-valves, the slider is provided with a collar which participates in its reciprocating but not in its rotary motion. This governor, resembling the whole power given out by the engine, acts as a constant dynamometer, which may be fitted the various arrangements, to which reference of which are derived from that of the collar on the slider.

The first of these instruments, the dynamometer proper, serves to measure the resistance opposed to the engine; it consists of a graduated dial, on which works a pointer; it carries its motion from a rack attaining a small pinion, to become a counter, recording with greater or less speed according to the resistance to be overcome by the engine, which resistance it records in kilogrammetres or foot-pounds.

thus constituting a dynamometric indicator analogous to gas and water meters. A third instrument, the "dynamograph," represents graphically, on an endless band of paper, the

For Illustrations see previous & page of

In order that this appliance may work with precision as governor, its action must be regulated so as to correspond

THE TELEPHONE PATENTS IN AMERICA.

THE labours of Prof. S. P. Thompson to put on a proper footing the work done by Philip Reis towards the perfecting of the telephone, as we know it, have little room to doubt that the Friedrichsdorf schoolmaster need be recalled in future with the honour of being the inventor of the telephone; but Reis was only a teacher of natural sciences at a school in a small Germam town, and probably had not the means to push his invention into the notice of capitalists, even if he was in a position to demonstrate its capabilities to them in such a way as to induce them to furnish him with the means of patenting his device. So far as we know, the very word "telephone" was Reis's invention, and there can be no doubt that the publication of his paper in

the *Sitzenberichte des Physikalischen Vereins zu Frankfort-am-Main* for the session 1860-61, gave just the information that inventors and investigators would be likely to take hold of, and turn to account in the commercial world, and also in the domains of science. It must be confessed that, with the exception of Varley, Barlow, and perhaps one or two others, very little had been done in this country by inventors or men of science on the line which led Bell to success, although in all probability Reis himself derived the initial idea from some observations in the works of Dr. Robert Hooke, and of Dr. Robert Willis. On the contrary, there are quite a host of claimants for some parts of the telephone, and as their claims are supported [and limited] by documentary evidence, there is no doubt of their bond-fide character so far as the evidence carries them. So far back as March, 1878, the first of the "interferences," as they are called, was declared, and the United States Patent Office has ever since been engaged in deciding between and amongst the rival claimants. The interferences originally involved in the first "interference" were Bell, Berliner, Blake, Channing, Dolbear, Edison, Gray, Holcombe, Irwin, McDonough, Phelps, Rhoades, Truesdell, and subsequently Pollard. There are other claimants, but their cases have not yet been decided. Six of the above-mentioned persons were disposed of, as far as the first interference is concerned, some time ago, and the examiner-in-chief appointed by the United States has now given his decision as regards the claims of Bell and Dolbear, which decision practically leaves the whole dispute between these two. In order to settle the rival claimants—that is, those who are left with anything—an arrangement between Edison, Gray, Holcombe, Irwin, Pollard, and Dolbear did not avail those devices prior to Bell's patent, and consequently awarded priority to the last named.

The subject matter of the interference between Bell and Dolbear is so important of all, for the invention is described and fitted as a telephone receiver, consisting of the combination in an electric circuit of a magnet, and a diaphragm, and so arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality. The invention is awarded to James W. McDonough, of Chicago, and May, 1873, is fixed as the date of the invention. Three other cases were awarded in favour of Bell, and another—Channing—lost on the spring forming or carrying one electrode and constantly pressing against the other and the diaphragm—to Edison. It seems that no day of the month is assigned to McDonough's invention, nor is it gathered from the following:—It appears that in December, 1867, McDonough invented and constructed a telephone and on the 20th of August, 1871, he made a drawing of a diaphragm telephone-call receiver, with its circuit and the battery; and early in May, 1873, he constructed and practically operated, a telephone, by means of the human voice and an electric current through wires connecting a diaphragm transmitter with a diaphragm receiver. On the 10th day of April, 1876, he filed application for a patent claiming the reproduction of articulate speech, and, subsequently, he was awarded a "telephone." It was not until Jan. 15, 1877, that Bell described such an instrument; but thanks to the arrangements connected with the examination department of the United States Patent Office, a patent was issued to Bell fifteen days after McDonough's invention had been available by issue of the patent for nine months. It will be seen by carefully reading the descriptions of the inventions above given, that the question of the telephone patent is a very peculiar position. Indeed: for the examiner has granted McDonough's claim to be the inventor of what is commonly known and used as the Bell receiver, or, in fact, of any receiver combining a magnet with a diaphragm. But inasmuch as the examiner has granted Bell's claim to be the inventor of the art of transmitting and reproducing at a distance sonorous waves or vibrations by increasing or decreasing the strength of an electric current, he has practically awarded to Bell a monopoly of all conceivable systems of telephonic transmission by electric means, although it is clear that as McDonough made a receiver and used it before Bell, he must himself have been the inventor or the discoverer of the "art." As if this complication were not sufficient to puzzle the historian of invention and the defenders of the American system of examination of patents, there is a possibility, some say a probability, that all the decisions given will be so much waste paper if Jenkins' Lenin tissue, for which Mr. Dewhurst has entered claims which, if they are upheld by evidence, will destroy those of McDonough, who certainly did invent a speaking telephone before Bell. In one sense it may be hoped that Dewhurst will establish his right to the title of inventor of the modern speaking telephone, for such a result will probably facilitate arrangements with the holders of the present patents and prevent innumerable appeals to the law courts. The result of the recent inquiry was to show that the United States patent system is in a most confused state, and it would appear as if arrangements for the examination into the novelty of inventions are likely to become drawn very badly when tested by a really complicated case, and should certainly not be copied by this country or any other which really desires to promote invention. One other point may be noted in connection with the above cases, and that is the fact that several contemporary inventors equally deserving of honour.

THE DYNAMO: HOW MADE AND USED.—II.*

By Silvanus P. Thompson.

NUMEROUS inquiries have appeared in "notes" respecting the construction of dynamo-electric machines, and replies equally numerous have been forthcoming. But except to those who have turned their hands to the construction of small dynamos, appear to have little comprehension of the principles on which it is intended to put the dynamo when constructed.

In the following papers, I shall confine myself strictly to the latter purpose, as being more within the reach of our amateurs, whether students of science or of the practical arts, who are engaged in repairing steam or other engines to act as motive power.

I. *What a Dynamo is and how it is used.*—At present, the dynamo-electric machine may be described as a machine whereby energy received is converted into electricity by the aid of the rotation of magnetic power in certain two portions: which electricity is caused to react on the iron and so heighten its magnetism; and this increased magnetism in its turn gives rise in the conductors to greater effects, and so, until a limit is reached, dependent partly on the capacity of the machine, partly on the speed and experimentum of the size and quantity of the wire and iron employed in its construction, and partly on the resistance throughout the circuit. Although this principle was fully understood, and

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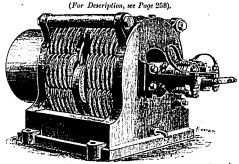
THE FERRANTI CONTINUOUS CURRENT GENERATOR.

(For Description, see Page 258).



THE FERRANTI CONTINUOUS CURRENT GENERATOR.

THE Ferranti generator is of the alternate current type, and avoids a separate alternate-current machine to excite its field magnets. In the past the Ferranti Company, while concentrating their attention upon improving the details and lessening the cost of construction of their machines, have been content to buy their armatures from other makers. Lately, however, for reasons which will appear, they have turned their attention to the problem of obtaining continuous currents from their machines, and have attained very satisfactory results. On page 12 last we gave illustrations of a Ferranti generator designed to feed 5000 incandescent lamps. The most striking novelty in its construction was in the use of simmers bars of copper wound in and out below the field magnet cores as the conductor for the exciting current. These had an almost insignificant resistance, and therefore it followed that the exciting machine which furnished the current reversing the lamps would also have a small internal resistance, and be capable of generating a current of great intensity and small electromotive force. Except for the purpose of electroplating, such machines do not exist, and hence it was necessary for the Ferranti Company to bring out a new pattern suited to their requirements, and they determined to adopt a design which had been successful in their hands for the generation of alternate currents, adding to it a commutator for the purpose of turning the vibrations into the same direction. By the kindness of the owners of the machine we may before our readers not only a perspective view of the machine, but also a complete set of working drawings, from which it will be seen that very good care and thought have been expended over the details of construction, and that no pains have been spared to make it possible in the way of providing ample bearing area and efficient means of lubrication to insure that the original conception shall not suffer from being carried out under unsatisfactory mechanical conditions. It has been our lot at different times in the past to see many electrical experiments fail, and much wrong and unnecessary expense in their promoters by faults of construction which might have been avoided if the electrician had been sufficiently trained to accept the assistance of a mechanical engineer, and we fail with satisfaction file evidence that the electrical companies are awaking to the fact that a dynamo machine must not only be capable of generating a current, but also of running continuously without hitch or trouble.

The general design is that of a Ferranti machine having five inwardly-projecting armatures in the armature, and ten field magnets, or a multiple arc of 5. The magnet cores are cast with flat faces and are wrapped with copper strips 11 in. wide by 3/16 in. thick bent edgeways so that they pass in a zig-zag fashion backwards and forwards between the ends of each strip passing not round and round one particular core as is usual in the conductors of electro-magnets, but under one, over the next, under the succeeding one, and so on. The silver plate strips are applied to break joint, as it were, and thus each core is completely surrounded with conductors not only at the sides but also at the top and bottom. The magnet poles are alternately of opposite polarity, the current flowing in one direction between any two cores producing a north pole in the right-hand core, and a south pole in the left-hand core, the connexions between the strips being so arranged that the currents in them all tend to produce the same effect on a given core. The strips are insulated from one another and from the iron cores by pieces of vulcanised fibre, and after they have been laid in their places, are secured by two brass bands (Fig. 1, page 258), one encircling the outer periphery of all the cores and one being within them. The resulting current enters the one terminal (Fig. 3), traverses the strips on one set of magnets, is then led by a copper connecting piece (Fig. 4) to the other strips, and thence to the second terminal.

The armature consists of a boss having five double arms (Figs. 1 and 2), carrying four copper strips 12 in. wide by two millimetres thick, bent into a sinuous form somewhat resembling the outline of a wheel with five blunt pointed teeth. Each strip makes two complete coures round the armature, and is connected at either end to an insulated conductor passing through the main spindle (Fig. 5). The whole of the strips is fixed to the boss by thimble-rivets (Fig. 1).

Coming now to the commutator it will be seen that it differs in construction entirely from any previous device for the same purpose. The rubbing surfaces are not set around the circumference of the commutator as is usual, but at its end, and they move in contact with solid conducting pieces in place of brushes. There are ten fixed collecting pieces arranged in a circle, and insulated alternately to the three and negative leads, and there are six moving contact pieces sliding over them, the latter joined to one terminal of the armature, and three to the others. At a given moment when a current is being generated in the armature in one direction, three moving contact pieces connected to one end of it, stand opposite three of the fixed collecting pieces which are in communication with (say) the positive lead, and the contact pieces in connexion with the other end are similarly in communication with the negative lead. When the armature has rotated through the current in its conductor becomes opposite to that just imagined, and at the same time the three contact pieces which were touching their collecting pieces become transferred to the negative collecting pieces and *vice versâ*. Between the two instants when the current is flowing one way or the other in the armature, there is a moment of rest or neutrality, and at that time the contact pieces are passing over insulated strips interposed between the positive and negative collecting pieces.

A general appearance of the commutator is to be seen in our perspective view on page 250, while Fig. 9 is a plan of it. The main spindle is hollow for a portion of its length, and within it there are placed two insulated conductors P, P (Figs. 5 and 10), one connected to each end of the armature. Two insulated terminals are screwed into the conductors (Figs. 10 and 16), and convey the current to two insulated half discs B B (Fig. 17) fixed to the end of the spindle. Upon these half discs there are six raised contact pieces, 1 to 6, the odd numbers being connected to one pole and the even numbers to the other. Opposite the half discs there is mounted a stationary plate A (Figs. 5, 8, and 11) in whose face there are 15 sector strips, a, a_1, a_2, of which five are connected to the positive terminal and five to the negative terminal, and five are insulated. These marked a form part of the front plate A, which is a ring with five degree pockets inwardly towards the centre; those marked a_1 form part of the thrust plate A1, while those marked a_2 (Figs. 10, 11, and 12) are separate blocks fixed by their flanges to the face of material between the plates A and A1 (A to be insulated (Figs. 5 and 9), while a second bundle joins the plate A1 to the second terminal (Fig. 9). There is worm G and a worm segment D (Fig. 6), by which the collectors can be set to the place for sparking.

A moment's reflection will show that if the disc B, be applied to A in such a position that the contact pieces 1 (Fig. 17) coincides with a sector in (Fig. 11), then the pieces 3 and 5 will also coincide with two other sectors a, and the pieces 2, 4, and 6 will coincide with three of the sectors a_1. At such a time the two radial portions of the armature will be generating, and the poles of the magnetic field and the current will be at its maximum. From this point a rotation of 10 deg. will carry the armature bars into the neutral spaces between the poles, and during this position the current will have fallen from its maximum to zero, and at the same time all the pieces 1 to 6 will have been transferred from the sectors a and b to the insulated sector c, and thus all communication between the armature and the external circuit will be cut off. Another 5 deg. of rotation exactly reverses the first conditions, but as the current is now flowing in the opposite direction in the armature, it follows that it maintains its old course in the external circuit, while the positive collecting pieces come with each rapidity that they form practically a continuous current. The machine is intended to run from 300 to 400 revolutions per minute, and at that speed gives a current of 500 amperes with an electromotive force of 10 volts.

Engineering, Feb. 1883.

THE DYNAMO MACHINE AND ROLLING STOCK.

The electric locomotive of Dr. Siemens will doubtless be useful in many ways, and prove a good auxiliary to the steam locomotive, but it will be very long, if ever, before it supersedes the latter for general traffic. There is, however, some value in the suggestion of Lieutenant Cardew to use the dynamo-electric machine in conjunction with the steam locomotive in order to communicate the power of the latter to the wheels of the carriages in a train, without having to resort to the wasteful "grip" or friction of the driving wheels upon the rails. Moreover it could be made to apply the brakes to the carriage wheels in stopping the trains. Lieutenant Cardew's plan is to have a dynamo machine on the locomotive and each carriage, the revolving armatures being mounted on the axles of the wheels, and all connected up together in such a manner that the current generated in the armature of the locomotive machine by the revolution of its driving wheel would circulate through the magnets of all the other machines, turning round their armatures, and consequently also the carriage wheels. When it was desired to stop the train, the engine driver and guard, by means of two switches, under their respective control, would change the direction of the current and reverse the motion of the armatures on the axles of the wheels, thus tending to bring the latter to a stop. The check would be strongest at first, and gradually less, but this is in accordance with Captain Galton's finding that a brake should apply a powerful force to begin with for a short time, followed by a gradually diminishing one in order to prevent the skidding of the wheels which takes place if a strong pressure is kept upon them while they slacken. At first sight it might seem against Lieutenant Cardew's plan that the wire connexions to be made would prove very inconvenient in practice where trains are made up of different carriages; but this drawback could be overcome by properly designed contact pieces. With regard to the efficiency of the dynamo-electric machine for transmitting power, Mr. Mansell has shown it to be a half when it is giving out work most *readily*, and Professor Ayrton has proved it to be as much as three-fourths when giving out work most *economically*.

ELECTRO-MOTIVE FORCE OF THE BRUSH DYNAMO-ELECTRIC MACHINE.*

PROFESSOR HENRY MORTON.

Some recent experiments, which I made in determining the electro-motive force of the Brush dynamo-electric machine, and various instruments for the accurate measurement of electric currents of great strength, show that each pair of coils on the armature of the machine develops a fluctuating electro-motive force, the projection of which gives a kind of oval curve around the centre of a diagram.

When the ends of the main pair of coils are considered, it is found, that they show a kind of eight-lobed

* Read before the National Academy of Sciences, N. Y., 1880.

figure with intersecting lines in certain places. These intersections, if compared with the positions of the commutator, are found to coincide exactly with the points at which rupture of circuit occurs, and thus show that each pair of coils is thrown out, not at the point where its force is least, but at that at which its electro-motive force is equal to that from which it breaks; thus suppressing a spark, but only at a certain sacrifice of theoretical efficiency.

EDISON DYNAMO-ELECTRIC GENERATORS FOR ISOLATED PLANTS.

(For Description, see opposite Page).

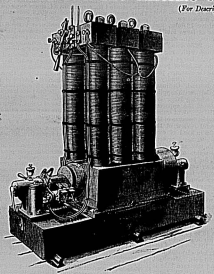


FIG. 1. 250-LIGHT (S) DYNAMO.

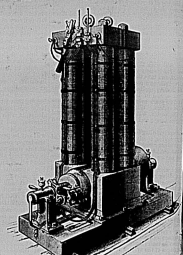


FIG. 2. 100-LIGHT (L) DYNAMO.

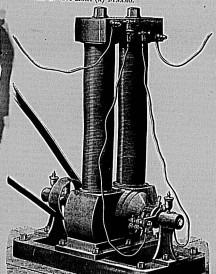


FIG. 3. 50-LIGHT (J) DYNAMO.

EDISON DYNAMO MACHINES.

LAST week we published an engraving of the 1200 light dynamo machine employed by the Edison Company in central stations, and now we give on the opposite page three other illustrations showing smaller machines designed for private lighting. These are designated by the makers as L, J, and Z machines, and are intended to feed 100, 50, and 40 lamps respectively. The general characteristics of the three machines are very similar; in each suitable drawing, spun from their axis, lying in the number of field magnets employed, which varies from six examples before us from two to six. In every case the field magnets is mounted upon the crossbar of the electro-magnets are stationary and the armature alone revolves; and to follow the principle of the earliest machines designed thirty years since by Professor Holmes for lighthouse use, in which the magnets were ranged round the periphery of a large revolving wheel. In the so-called new machine of Mr. Gordon the wheel is 8ft. 9 in. diameter, weighs 7 tons, and revolves at a speed of 140 revolutions per minute. This gives a point in the rim of the wheel a velocity of rather more than 60 feet per second, or 1200 yards per minute—a very fair rate for an express locomotive. The machine is driven by an engine indicating 150-horse power; but there is another smaller engine employed to drive the subsidiary Jürgen machines, which, running at 800 revolutions per minute are required to excite the magnets of the large dynamos. It should be stated that the total weight of the large machine is 18 tons, and it stands on a bed-plate measuring 19 ft. 4 in. by 7 ft. Great advantages are claimed by this return to the Holmes type of machine; but it may be remembered that equal benefits were supposed to be obtained when the armature was for the first time placed within and instead of the magnets. It is understood that Mr. Gordon's machine has been "designed to take the place of large gas-vans as a central lighting station;" but, from what has been allowed to transpire respecting it, its bulk cannot be regarded as conferring on it any extra immunities from the risks of breakdown attending all dynamo machines. The sole apparent advantage of working large lamps from one machine, instead of feeding the same number of lights from 13 dynamos each supplying 100 lamps, is that all the lamps shall go out together instead of by groups.

ELECTRIC LIGHTING NOTES.

THE Edison Company have undertaken the lighting of H.M. troopships Serapis and Crocodile. Two sets of high-speed engines and two 250-light dynamos will be employed on each vessel; together with 400 lamps, a variety of fit candle and parts of accessories.

Messrs. A. and S. Gatti's restaurant, the Adelaide Gallery, is about to be lighted by Edison-Hopkinson (Z) machines. The light will be in duplicate throughout, consisting of two Field boilers, two Ingram and Royle high-speed engines, and four 140 Edison dynamos. The installation at the Hotel Métropole, which includes about 800 lamps, is now about to be increased by an additional 1000 lights, and when completed will be the largest of the kind in existence.

Messrs. Siemens Brothers have received an order from Messrs. Denny and Co., of Dumbarton, to apply the electric light to two vessels, Nos. 272 and 273, now building for the Compañia Transatlántica (Antonio Lopez and Co.) There are to be 90 lamps in each ship, fed by two generators (D S D?) each driven by a separate three horse-power Tangye engine. The power will be transmitted by Dynamos through friction pulleys, in the manner which has already proved very successful on the Aurania. Altogether there are five ships on the Clyde, receiving electric machinery from Messrs. Siemens Brothers, the aggregate number of these lamps being 1084. Besides these ships, Messrs. Siemens have in hand, including the Dumbarton vessel lead, the Manilla, and the Westerland, in course of construction at Laird's. Those of our readers who attend the forthcoming meeting of the British Association at Southport will have an opportunity of inspecting the kind of plant used by Messrs. Siemens Brothers on board ship, as that firm is taking advantage of the contract with the Association Committee to make a special display of this kind of machinery, which hitherto has not been seen at exhibitions. In the case of the frictional driving the dynamo is carried in trunnions with its pulley immediately over the flywheel of the engine, and the two shafts are connected by an adjustable torsion bar provided with brass steps at each end. Thus the wear resulting from the transmission is confined entirely to two extra bearings, and both engine and machine are relieved from strain.

THE LAST AND LARGEST DYNAMO MACHINE.

MR. EDISON is not to have the credit of designing and working the largest dynamo-electric machine in the world: this honour, such as it is at present, being claimed by Mr. J. E. H. Gordon, of London. The machine in question has been constructed and set to work at the East Greenwich works of the Telegraph Construction and Maintenance Company, where it is used to supply electromotive force to about 1000 Swan incandescent lamps distributed about the shops and offices. The machine appears to depart from the type of similar arrangements introduced of late years, wherein

Journal of Gas Lighting &c
July, 1882

THE EDISON ELECTRIC MACHINERY IN NEW YORK.

A detailed description of the machinery at the central station of the first district in New York City where the Edison system of electric lighting is to be applied, has been given in a paper by Mr. T. A. Edison and Mr. Charles Porter, read before the American Society of Mechanical Engineers. The district is not particularly described with respect to its location and area; but it will, when fully equipped, contain 12 dynamos, each capable of supplying 1400 improved 16-candle lamps, and driven by a horizontal steam-engine coupled direct to the armature. The engines have cylinders 21½ inches in diameter and 16-inch strokes, designed to run at 300 revolutions per minute. The steam is to be supplied from eight water-tube boilers of 3000 aggregate horse power. The boilers are fitted in the basement of the building, and the engines and dynamos are fixed on an iron superstructure over them, and entirely separate from the walls. The weight of each dynamo is 27,000 lbs., of which 9440 lbs. is the pure copper. The engine weighs 9446 lbs. The total weight of the united apparatus, including bed-plate, is 61,500 lbs. When working for a recent trial, while running among 1000 lamps, the engine indicated 159·4 horse power, and the corrected duty of the machinery showed 9·96 lamps per horse power. For 16-candle lamps this is consequently 149·70 candles per horse power, which is a very good result, taken, it must be remembered, under test conditions. The degree of perfection of the machinery may be inferred from the statement that the losses of efficiency due to undiscovered resistances averaged only 0·4 per cent. It is perhaps needless to say that the expenses of the establishment are not treated of in this paper.

Engineering, Dec. 1, 1882.

THE FERRANTI-THOMSON ELECTRIC MACHINE.

A RECENT correspondence in the *Times* has doubtless rendered the name of the Ferranti machine familiar to many of our readers, but it was not until the beginning of the present week that its form and construction were made public, a delay having occurred in perfecting improvements made in the machine, as well as the securing of the patent rights for the invention.

The Ferranti-Thomson machine—which is the joint invention, or, to speak more correctly, a combination of the inventions of Mr. S. Zimi de Ferranti and of Sir William Thomson—is an alternating current machine of an exceedingly interesting and original type, the special characteristic feature being the armature, which contains neither wire nor iron, and is of such small dimensions and weight that it can be rotated at a very high velocity between the magnetic poles, which are only separated by a distance of three-quarters of an inch, and therefore within a magnetic field the intensity of which can hardly be approached by any machine with which we are acquainted.

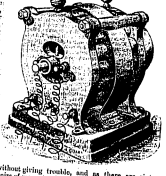
It is impossible to see, for the first time, this remarkable little machine running, without being struck with its exceptionally small size as compared to the work it is capable of doing, for on the occasion of its first exhibition to the public it was illuminating on one circuit no less than three hundred and twenty "20-candle" Swan lamps, equal to a luminous intensity which we should estimate at from fifteen to seventeen candles, although its total weight is but 60 cwt., and the whole machine measures only 24 in. × 20 in. × 18 in.

In general external appearance the Ferranti machine, as will be seen from the illustration on the present page, has some resemblance to the well-known Siemens alternating, and Wilde machines, but the resemblance is only superficial, for not only are both the armatures and construction and arrangement of the field magnets perfectly distinct from either and which is under one of the arches of the Cannonof those machines, but the principle of action instead Railway Station, the apparatus is driven by altogether different. The form and construction of Messrs. Fowler's semi-portable 16-horse of the Ferranti armature may be understood by imagining an eight-toothed pinion, 18 in. in dia-power, and this drives, through the intervention of meter, and 4 in. thick, around which are loosely wound two thick turns of copper ribbon 4 in. wide, having an insulating band of the same width wound to the armature of about 7000 ft. per minute, a with it, so as to insulate contiguous convolutions velocity which, by reason of the extreme lightness from one another; if now by any mechanical con- of the moving parts, is in no way inconvenient, and trivance such, for example, as causing the pinion so coiled to gear into another similar wheel the copper ribbon be forced into the spaces between the teeth, an undulating outline, which will be parallel to that of the circumferential surface of the pinion on which it is wound, will be given to it, and if the pinion be then removed, the copper strip will be left as a hollow pinion-shaped gear, through the axis would to all intents and purposes be a Ferranti armature.

The armature is composed of a continuous strip of copper ribbon 120 ft. long, half an inch wide, and one twelfth of an inch thick, coiled upon itself in twelve layers with an insulating tape between the convolutions, and having the undulating or pinion-shaped outline which we have already described. There is no iron core to this armature, the interior space being quite open, thus permitting of free circulation of air in and around the copper coil while the machine is running. The whole of this portion of the apparatus weighs but 18 lb., and this is perhaps the most interesting feature of the machine, for there is certainly no other electric generator at present in the field, that with an armature weighing but 18 lb. can render incandescent 320 Swan lamps, that is to say, nine-tenths of an ounce weight of moving armature per lamp of sixteen candles.

The small size of the armature, and especially its extraordinary thinness (only half an inch), enables it to be run within a correspondingly narrow magnetic field, and therefore one of exceptionally high intensity. The field magnets are arranged in two crowns around a pair of discs of cast iron, which form the outer framework of the machine, their free ends, which constitute the poles of one set of magnets, being directed towards the free ends of the opposite set, and towards the armature which rotates between them. Each crown is built up of sixteen electro-magnets, which are, like the armature coils of the Wallace-Farmer machine,* sector-shaped in cross section, and the exciting coils with which they are wound are also of similar shape; in fact, if the sketch given in our article on the Wallace-Farmer armature were altered so as to show a crown of sixteen coils instead of twenty-three, it would convey a very fair idea of the arrangement of field magnets in the Ferranti machine. As, however, the current generated by this machine is alternating in character, the field magnets have to be excited by a separate machine, and for this purpose a small Siemens D, machine is employed, the current from which represents about two horse power of electrical energy. The magnets, of which there are thirty-two, are wound 6 in. long, and are each wound with one hundred and forty turns of insulated copper wire of about No. 10 B.W.G., and are all connected together in series in such a manner as to alternate a polarity around the crown, so that any fixed point in the armature passes alternately a north pole, and a south pole

* See ENGINEERING, vol. xxvii., page 309.



at its rotation around the axis. The weight of copper on the field magnets is about 81 lb., and the total resistance of the exciting coils, of which 24 ohms belong to the armature coils, is 8 ohms.

The installation to which we have referred, engaging at the flywheel about 26 horse-horse-power, and the latter, through the intervention of Swan lamps per horse power when 320 are in circuit is about 12.

We need hardly point out to our readers that the above figures if substantiated, show for the Ferranti-Thomson machine a remarkably high efficiency, and this is, in our opinion, due to the fulfilment, to an exceptional degree, of three elements which should, among certain other things, be contained in a theoretically perfect machine.

1. Small weight of moving conductor.
2. High velocity of ditto.
3. Intense magnetic field.

The first is obtained by the peculiar shell-like character of the armature with no iron cores to add to the weight, or to absorb energy either in the production of local currents, and therefore of heat, and these conditions control the second element, enabling the machine to be run with advantage at a high velocity. The third element of efficiency is rendered possible to an exceptional degree by the form and dimensions of the armature, for, as that part of the armature is but ½ in. thick, the poles of the magnets can be approached to within a small fraction of an inch of that distance, and the convolutions of the armature are thus under the best possible condition to be influenced by electro-magnetic induction, and this fact is alone sufficient to account for a large proportion of the efficiency of the Ferranti machine.

We may state that the owners of the machine and system are a private company; Messrs. Ferranti, Thomson, and Ince, whose object is to manufacture and sell the machines and apparatus covered by the patents, and not to form subsidiary companies or grant licenses for exhibiting the objects for which they themselves are established. We understand, however, that the Hammond Electric Light and Power Supply Company possesses the exclusive right to use the Ferranti machine so far as this country is concerned, and we have little doubt that it will before long become largely employed for incandescence electric lighting.

Certain commercial reasons connected with the patents under it undesirable to publish at this date more detailed drawings or descriptions of this very interesting machine, but we shall in a short time be free to do so, together with accurate data of its performance, so that our readers will be able to form their own opinion of the merits of an electric generator which is at the present time the greatest novelty in the world of electric science.

There is no commutator to the machine, the armature being connected to the outside circuit in a manner precisely similar to that adopted in some of the early Siemens machines—that is to say, one end of the armature conductor is permanently connected to one metallic collar fixed to and forming part of the spindle upon which it rotates, and the other end is attached to another similar collar fixed to the spindle, but insulated from it. Upon the circumference of each of these collars is pressed a piece of short lever, so as to maintain a good rubbing contact, and these two levers are connected, the one to one terminal screwed into the framework of the apparatus.

On the occasion of the first exhibition of the machine the 320 lamps were arranged in 102 groups, that is to say, 100 groups of three lamps, each in series, and one group having two lamps in series, and the constancy of illumination at a constant speed of the engine was all that could be desired. With 300 lights in circuit the electrical energy being thrown into the circuit was about 224 horse power, and if, as we are told was the case, the engine was at that time giving off 26 horse power, the machine would show an efficiency of about 86½ per cent., after allowing for about two horse power of electrical energy representing the magnetising current from the small machine; we shall, however, before long be able to give accurately determined data.

The following are some of the figures connected with this very interesting machine and installation:

Resistance of armature	...	.0265 ohms.
Total resistance of circuit	...	.7200 "
E. M. F. in main circuit	...	122 volts.
Current	...	156 amperes.
Resistance of lamps, each	...	31.5 ohms.
Current absorbed by each lamp		1.5 amperes.
E. M. F. taken	"	47 volts.

The weight of armature and collars is about 1260 lb., or 13 volt-amperes per pound weight of apparatus; the number of Swan lamps per horse power when 300 are in circuit, is about 11½; and the number of

The efficiency of the machine as an experimental machine, without any attempt at special construction, is about 90 per cent., and the machine will work without giving trouble, and as there are sixteen pairs of magnets of alternating polarity, it follows that there are no less than 500 reversals of the current for every second, or 30,000 per minute.

capital. In our next article we shall deal with bills deposited by companies on the south side of the Thames.

THE CHERTEMPS-DANDEU DYNAMO MACHINE.

In my system which includes private or domestic electric lighting the necessity of providing some means of regulating the generative power of the machines in accordance with the requirements of the mews has to be considered. In a circuit of arc lamps the extinction of one or two is usually followed by an increased brilliancy in the remainder, while if a large proportion is cut out there is great danger of burning the insulation of the generator. With incandescence lamps arranged in parallel are

Fig. 1.

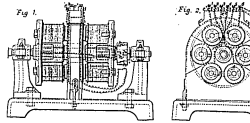


Fig. 2.

the same effect is produced, except that it is usually the lamps that suffer from the increased current. The leading manufacturers of electric light apparatus have each their own method of dealing with this difficulty. Mr. Brush long ago devised a plan of regulating the current by means of a variable carbon resistance arranged as a shunt across the magnet coils. This was subject to a pressure obtained by passing the current that was to be regulated round an electro-magnet, and allowing a portion of the exciting current, dependant on the current in the main circuit, to run to waste. We have heard that this system gave good results in America, but we are not aware that it has been employed to any extent in this country, indeed few of the installations carried out by the Brush Company have been of a nature to require it. Mr. Edison varies the productive power of his generator by modifying the resistance and consequently the current in the circuit of the field magnets. This is effected by an attendant, who, using a lamp and a photometer as a measure of the difference of electric potential between the two main leads, switches resistance boblbins in and out of the magnetizing circuit as required. Mr. Edison has also many patents dealing with the same subject, but in none, so far as our memory serves us, is the regulation effected without mechanical motion in some form. Dr. Siemens' method of accomplishing this object consists in making the magnetizing coils a shunt to the main leads and in so proportioning the diameter of the wire and the number of convolutions that the electromotive force of the current is usually constant. In the small machines adopted to large 20 to 25 lights this seems to have been very successfully carried out, as the number of lamps can be decreased to one or two without danger, but in the larger machines, feeding a hundred lamps and upwards, the safe variation is confined to 20 or 25 per cent. We have heard a rumour of a machine of much larger size by the same firm, with a modified form of shunt winding that is said to give very reliable results, but we believe that it has not yet been tested to actual every-day practice. The Swan Company have hitherto used the Siemens alternate current machine in their larger installations of incandescence lights, as have also Messrs. Siemens Brothers themselves. This is a separately excited machine, and consequently if its internal resistance be small as compared with the combined resistance of all the lamps and leads, the difference of potential at its terminals is pretty constant, and it will permit of a considerable proportion of the lamps being extinguished without unduly increasing the current supplied to the others.

So far none of these schemes have met with more than a partial success, and that in this country only in conjunction with incandescence lighting. A new dynamo, patented by MM. Chertemps and Dandeu, is now for the first publicly shown, for which it is claimed that it entirely solves the difficulty, and that whether it be employed to feed arc lamps arranged in series or incandescence lamps in parallel the number of lamps may be varied from the full number, corresponding to the maximum power of the machine, down to one, without any appreciable change in the illuminative power of each lamp. This is effected without any manipulation or mechanical operation whatever, the intensity or the electromotive force of the current automatically changing at each alteration in the circuit without any attention, and without any variation in the speed of rotation.

Referring to the illustrations on the present page, which show the machine inside and out elevation and also in perspective, it will be seen that it belongs to that class in which the armature bobbins are stationary while the field magnets revolve. The armature bobbins are fixed in a wooden frame erected on the saddle of the base-plate. Lengthwise of the machine, and passing through the centre of the armature frame, is a shaft having mounted upon it two metal discs, to each of which a set of field magnets, equal in number to the armature bobbins, is affixed. These magnets, as usual in alternate current machines, are alternately north-pointed and south-pointed, and each pole of one set is opposite to a contrary pole of the other set. The terminal wires of each of the armature bobbins are carried up to a grouping table and attached to separate binding screws. The pursuits of them being joined up in series or parallel, or divided into independent circuits as may be desired, even without stopping the machine. One of the armature bobbins is appropriated to the work of exciting the field magnets, its current being led first to a commutator, by which it is transformed into a continuous current, and then round all the magnet coils, the whole forming a closed circuit. The commutator is so constructed that one section does not leave the brush before the next section is in contact with it. It may be described as composed of two hollow cylinders, each with a closed end, their peripheries being cut away so as to permit of these interlocking to the full length of the cylinders. There are as many interlocking parts or teeth as there are magnets in each field, each part is cut into steps, as shown, so that at the junction the collecting brush can bear upon both of them, and thus short-circuit the exciting bobbin at the moment when the field magnets are passing the spaces between the armature bobbins. It will thus be seen that there are usually two circuits on the machine, one consisting of all the armature bobbins (except one) and the external or lamp circuit, and the other of the single remaining armature bobbin and the field magnet coils. Two of these machines, a small and a medium-sized one, have been tested by Mr. Robert Sabine. As regards the small one, he reports that it was employed to feed eight Jablochkoff candles which were added to the circuit two by two, and that whether it be employed to feed arc lamps arranged in series or incandescence lamps in parallel the number of lamps may be varied from the full number, corresponding to the maximum power of the machine, down to one, without any appreciable change in the illuminative power of each lamp. This is effected without any manipulation or mechanical operation whatever, the intensity or the electromotive force of the current automatically changing at each alteration in the circuit without any attention, and without any variation in the speed of rotation.

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MARINE BOILER.

CONSTRUCTED BY F. SCHICHAU, ENGINEER, ELBING, FROM THE DESIGNS OF MR. R. ZIESE, ST. PETERSBURG.

(For Description, see Page 580).

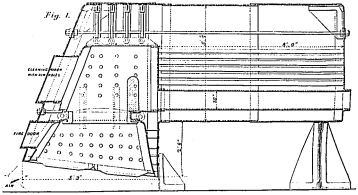

Fig. 1.

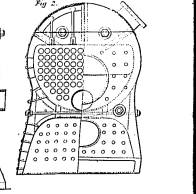

Fig. 2.

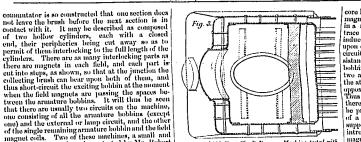

Fig. 3.

commutator is so constructed that one section does not leave the brush before the next section is in contact with it. It may be described as composed of two hollow cylinders, each with a closed end, their peripheries being cut away so as to permit of these interlocking to the full length of the cylinders. There are as many interlocking parts or teeth as there are magnets in each field, each part is cut into steps, as shown, so that at the junction the collecting brush can bear upon both of them, and thus short-circuit the exciting bobbin at the moment when the field magnets are passing the spaces between the armature bobbins. It will thus be seen that there are usually two circuits on the machine, one consisting of all the armature bobbins (except one) and the external or lamp circuit, and the other of the single remaining armature bobbin and the field magnet coils. Two of these machines, a small and a medium-sized one, have been tested by Mr. Robert Sabine. As regards the small one, he reports that it was employed to feed eight Jablochkoff candles which were added to the circuit two by two, and that whether it be employed to feed arc lamps arranged in series or incandescence lamps in parallel the number of lamps may be varied from the full number, corresponding to the maximum power of the machine, down to one, without any appreciable change in the illuminative power of each lamp. This is effected without any manipulation or mechanical operation whatever, the intensity or the electromotive force of the current automatically changing at each alteration in the circuit without any attention, and without any variation in the speed of rotation.

Chertemps' (Medium Size) Dynamo Machine tested with Jablochkoff Candles connected in Series.

Number of lamps in circuit n =	1	2	4	6	7
I. *Main Circuit.*					
Current in ampères = c	5.5	5.5	5.5	5.5	5.5
Internal resistance in ohms = r	1.3	1.3	1.3	1.3	1.3
Horse power necessary for internal resistance = $\frac{c^2 r}{736}$	0.3	0.3	0.3	0.3	0.3
Total wire resistance in ohms = R	1.7	1.7	1.7	1.7	1.7
External potential, difference of volts = e	120	231	454	676	898
Horse power necessary for in lamps = $\frac{c^2 R}{736}$	0.4	0.8	1.5	2.3	3.0
Total horse power necessary = $\frac{c^2 (R+r)}{736}$	0.7	1.1	1.8	2.6	3.3
II. *Magnetizing (Field) Circuit.*					
Current (tangent=i)	5.5	5.5	5.5	5.5	5.5
Resistance of wire (ohms=r)	7.4	7.4	7.4	7.4	7.4
Horse power necessary for in field circuit $\frac{c^2 r}{736}$ = w	0.3	0.3	0.3	0.3	0.3
Total horse power = $\frac{e c}{736}$	1.0	1.9	3.8	5.7	7.6
Speed of dynamo	1210	1210	1210	1210	1210
Full revolutions per minute = s	87	87	87	87	87
Speed of dynamometer, ebullitions per minute = n	602	606	611	624	618
Indicated horse power = $2.21 \times 10^{-7} \times (e-i)(i+r) \times s$	0.5	0.7	1.0	1.3	1.7
Horse power accounted for electrically =	0.8	1.8	3.6	5.4	7.2
Proportion of horse power electrically accounted for to indicated	1.7	2.5	3.5	4.1	4.2
Mechanical friction exerted by dynamo =	0.2	0.3	0.3	0.3	0.4
Total horse power of engine =	1.0	2.1	3.9	5.7	7.6
Efficiency	80	90	97	95	95

* The curious result in these measurements were apparently of inferior quality.

When the field magnets are in motion, each magnet, as it approaches one of the bobbins of the armature, exercises an inductive action on the core of the latter, inducing its corresponding extremity with an opposite polarity to its own, and generating a current within its convolutions. The direction of this current is such that it reduces the polarity of the core, and thus the magnetic intensity of the interior soft iron in the armature, of the two opposing actions of the armature coil and of the field magnet. At the same time the polarity of the core has an influence upon the polarity of the field magnets, and in this way affects the exciting current in a marked degree. To make this plain let us trace the action of one of the field magnets, indeed with, say, north polarity at its free end, upon one of the armature coils. When the external circuit is open, that is when it has an infinite resistance. As the magnet approaches the end of the bobbin core it induces a south pole in it, and the two are mutually attracted. As it leaves the core the attraction is still continued, but in a contrary direction as regards the driving power. Thus when the field magnet passes the core there is no action upon it except such as would be produced by the presentation and withdrawal of a piece of soft iron from its pole. But now suppose the external circuit be completed by the introduction of ten arc lamps in series. As the magnet approaches the core not only does the latter become magnetised, but a current is generated in its surrounding coils that opposes the increase of its polarity, consequently it no longer behaves like a piece of soft iron, but rather as a weak permanent magnet that must have its natural polarity reversed by the induction of the field magnet before it will fulfil its office. But this reversal distorts the lines of force around which the current coils are grouped, and in so doing sets up an opposing electromotive force within the conductors that reduces the exciting current, and consequently the intensity of the magnetic field. This reduction is a most exciting bobbin, and the magnetising current is further reduced, resulting in a decrease of current or of electromotive force in the external circuit. If the resistance of the circuit be again decreased by short-circuiting one of the lamps there will be a momentary increase of current, but this will further oppose the magnetisation of the cores, and will again effect the diminution of the intensity of the magnetic field. The process of reduction will be continued until the bobbins short-circuited, when, if it be properly proportioned, the influences of the armature and the magnets will be almost equal, and the exciting current will nearly disappear.

NOTES.

THE THOMSON EFFECT.

SIR WILLIAM THOMSON first discovered that when an electrical current passes through a piece of metal, the ends of which are kept at different temperatures, it exerts heat with it in a direction depending on the character of the metal, and the sending on the character of the metal, and the sending on the character of the current. This effect by M. Le Roux, the discoverer's name, was verified in 1871, and also gave a table of thermoelectric position with several different metals. Quite recently Mr. John Trowbridge and Mr. Charles B. Penrose, of the Physical Laboratory, Harvard, made further experiments on

ELECTRIC LIGHTING NOTES.

Last Friday the case of Phillips *v.* the Great Western Electric Light and Power Company was heard before Mr. Justice Chitty. It was an application by a holder of ten shares for the rectification of the register by striking his name from the list of shareholders, on the plea that the prospectus issued by the directors of the company was not answered and misleading, in that it stated that they had acquired the exclusive right to the use of the Brush system of lighting in a district that included a considerable part of the West of England and South Wales. It was affirmed in the affidavit supplied by his counsel, Mr. Waller, Q.C., and Mr. F. T. Prentor, that on July 29, 1881, Mr. St. George Lane-Fox assigned to the British Electric Light Company the exclusive right of using and granting licenses for its inventions in Great Britain and Ireland, and that on July 28, 1881, he executed a similar assignment to the Anglo-American Brush Corporation, subject, nevertheless, to the previous assignment, and that it was, therefore, incorrect to assert that the Brush Company were the sole possessors of the patent. For the defendants, Mr. Bonner, Q.C., and Mr. Pilgrim Beale, contended that the misstatement, if there were one, was immaterial, as the value of the Lane-Fox assignment is insignificant, and the plaintiff has suffered no substantial injury. In delivering judgment, Mr. Justice Chitty said that although there was no bad faith, but only some carelessness imputed to the framers of the prospectus, yet it was plain to an unprejudiced mind that there had been a misstatement that was material, and calculated to mislead the applicant. His lordship did not think that expressing any opinion himself one way or the other as to the value of the Lane-Fox invention, though he understood that many persons who had handed in prospectus, which began beginning to emit had recommended as one of its leading features this particular invention, to afterwards say for the purpose of upholding their prospectus that the invention was of little or no value, and therefore was not a chief attraction of the scheme. He ordered the plaintiff's name to be removed from the register, and the money that he had paid to be returned to him. We suppose that this decision will be appealed against, and therefore it appears idle to speculate upon the ultimate effect of the action upon the Brush companies, until the higher court has given its decision. It is, however, probable that the patent company, which has lately received and distributed among its many, been a large amount of money, has made a call of 20 upon each share. It is a struggle are the sinews of war more necessary than in a legal one.

Since the commencement of the month the Manchester Exchange has been lighted by ten new Brockie arc lights, of 3000 candle power each, and 400 incandescent lamps of fifteen candle power each. The installation has been effected by the British Electric Light Company, who have also just fitted the United Steamship Company's vessel, Kjobenhavn with a number of incandescence lamps and one arc light. The former are tastefully arranged in the different parts of the ship upon brass gilt fittings, representing mermaids. The same firm are lighting the British India Steam Navigation Company's ship Peera with 320 incandescence lamps and one arc lamp. They have likewise in hand, and approaching completion, installations at the oil mills of Messrs. Walker and Son, King's Lynn, and at the stores of the Civil Service Supply Association in Bedford-street, W.C.

The electric arc light is beginning to replace the limelight in the production of theatrical effects. On Saturday evening last the beam from a powerful arc regulator, supplied by the Duplex Electric Light Company, Storage Company, was introduced into the performance at Mr. Charles Reade and Mr. Pettit's drama "Leon and Nancy" at the Adelphi Theatre. In this thrilling melodrama of the old Adelphi school there is a villain, a scene and an explosion which entombs several of the characters. They are afterwards dug out by a rescuing party, and all the incidents of relief in such a case are represented. When the obstructing coal is cut through a flood of artificial daylight from the electric lamp and a reflector is poured through the gap into the crowd gallery. The luminous effect is far more powerful and like daylight than could be given by a lime-light. We may also add that the same company are, under the direction of their engineer, Mr. F. Crocker, and Mr. Harris, lessee of the theatre, at present engaged in fitting up the stage of Drury Lane with arc and incandescence lights for the forthcoming pantomime of "Sindbad," in which some novel effects will be presented.

Messrs. Farnley and Son, of Harmer-street, W., have, we believe, designed and manufactured the special fittings ordered for the Swan lamps that are being supplied to H.M.S. Himalaya. There are of a less fanciful type than those originally made by the same firm for the Soudan, the main requisite in a troop-ship being safeguards against tampering.

Further details are to hand regarding the contract recently entered into between the Gas and Lighting Committee of the Town Council of Aberdeen and the Scottish Brush Electric Light and Power Company for the experimental lighting. It has been decided that the trial shall be carried out in several of the most frequented thoroughfares in the centre of the city, including Castle-street, part of Union-street, and Market-street. Two lights will likewise be placed in prominent positions on the bridges over the railway in Guild-street and Union-street. It is anticipated that the streets selected will afford an excellent opportunity for testing the system. The distance at which the lamps will be placed apart from each other will vary according to circumstances and the position of cross streets; but the average distance will be from 70 to 80 yards. They will in each case be set on posts at a height of 20 ft. from the ground, and in clear glass globes. The house in which the engine and dynamos are placed is situated in College-street. Two Brush lamps of new design, for interiors, are also to be used in the illumination of the large public hall in the Municipal Buildings. One will be hung about 25 ft. above the floor of the hall, and the other will be suspended in the wall of the grand staircase in such a position that it will afford an abundance of illumination to the whole of the entrance corridors and portico.

At the last meeting of the Glasgow Corporation Gas Committee the town clerk reported that, on the conference of representatives of corporations, relative to the Electric lighting provisional orders to be applied for in the ensuing session of Parliament, had taken place in London on the 15th ultimo, and that, along with Mr. J. L. R. Jamieson, convener of the Gas Committee, and Mr. Fowlis, the general manager, he had assisted at the conference, as representing the Glasgow Corporation. It was largely attended by representatives of numerous towns, and all those who were present resolved to act in unison, and upon the same lines, so far as the interests of each particular body represented admitted of that being done. A copy of the resolutions passed at that conference having been read, it was explained that, under the remit made to them, the town clerks of Glasgow and Manchester had adjusted the terms of the provisional order, which was to be submitted to all the municipal corporations for their consent approval and adoption. The orders, as so adjusted, is to be considered at an aggregate meeting, about the end of the present month, and, when finally adjusted, it will be submitted to the Board of Trade at once in reference with the Provisional orders, when it is proposed to have the views of all the corporations represented by counsel retained. A copy of the draft provisional order as now prepared was submitted and explained in detail. It was further reported that at the last conference the general feeling seemed to be that if, after the case of the corporations had been fully placed before the Board of Trade, the Board were not disposed to grant orders to some of the corporations upon the lines of the draft order as finally adjusted, then the united corporations should agree to take orders, and represent their conjoint views to Government and to Parliament. In any case, it should be the endeavour of all the corporations to secure that no orders or licenses should be granted by

the Board of Trade to private persons or companies which did not contain stringent provisions obliging them to fulfil the obligations which they might undertake, and to find reasonable security that they should do so, before they were allowed to open streets or to acquire any vested or saleable interest under any such orders or license. The Gas Committee unanimously approved of what had been done at the conference in London, and also approved generally of the principles on which the draft order submitted had been based; and they gave further instructions to the town clerk as to his future actings. The subject came up for consideration at a meeting of the Town Council held on Thursday, the 7th inst., the principal speaker being Mr. W. Henry Wilson, a member of an engineering firm in whose works electric lighting is very extensively used; but the discussion was not continued as the Lord Provost urged that the matters referred to were of so delicate a nature that they had better be left in the hands of the Committee. He said, however, that if the provisional order as finally adjusted did not satisfy the Council they could drop it & not put it in operation.

this lamp is extremely simple in its arrangement and working. As regards the light produced, it should be pointed out, that owing to the construction of the lower part, and to the presence of the counterweight, a marked reduction of light is noticed beneath the lamp, though this does not amount to an actual shadow on account of the large size of the upper carbon. This disadvantage will probably be removed by modifying the details of the lower part, in which direction has been chiefly directed to the production of a direct light. The counterweight may be easily applied to the top of the lamp, and the interception of the light will be thus avoided.

GEOGHEGANS LOCOMOTIVE.

In our last number but one we illustrated and described (see page 529 ante) a small shunting engine, employed at the Cold-harbour brewery of Messrs. Guinness, Son, and Co., at Dublin, this little locomotive having been constructed from the designs of Mr. S. Geoghegan, the engineer of the establishment. In publishing an account of the working engine, we promised to illustrate some further details, and this we now do, our additional engravings appearing on page 573.

In the illustrations now published, figs. 30 to 40 show the details of the steam brake, this consisting of a cylinder fitted with two pistons between which the steam is admitted. The pistons when forced outwards by the steam exhaust cross-heads which extend right across the engine, as shown in the general plan, fig. 1, page 522 ante, each cross-head carrying at each end a vertical rod-iron brake block, which it can thus force directly against the corresponding wheel. Each cross-head is coupled by a pair of links to a cross-bar, which likewise carries brake blocks at its extremities. These four cross-beams when forced forwards by the pressure of the compressed steam, forces the two blocks at the extremities against the front pair of wheels, and draws another pair of brake blocks (by means of the links and cross-bar, as just mentioned) against the hind pair of wheels. The steam brake may be used by the engine alone, brake blocks being fitted to the hind pair of wheels, and draws blocks into contact with the front pair of wheels. Strong springs tend to force the two cross-beams together, and thus keep the pistons back in their central position, when the pressure in the brake cylinder is relieved.

Figs. 41 to 44 show the details of the connections to the brake frames of the long spring plates which are screwed to the top and bottom of the axle-boxes, as described by us in our former notice. The arrangement will be readily understood when comparing Figs. 41 to 44 with the general views on pages 522 and 573 ante.

The details of the firegrate, hollow bridge, and fire-door front, are shown by Figs. 45, 46, and 47, page 574. A reference to the longitudinal section of the engine, page 522 ante, will show that the grate is of the ordinary multitubular type, it being cylindrical with a cylindrical combustion chamber, 2 ft. 10 in. in diameter outside, and 2 ft. 10½ in. long between tube-plates, extended to the same length by the design of Mr. S. Geoghegan, the author of the establishment. In publishing an account of the engine, we promised to illustrate some further details, and this we now do, our additional engravings appearing on page 573.

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The last details we illustrate on page 574, are those shown by Figs. 48 to 52, these views representing the boiler mounting carrying the safety valves, whistle, steam-cocks, pressure gauge, &c. As will be seen from the engravings, the mounting is constructed so as to serve a variety of purposes, from the safety valves to the tests to the boiler, and it constitutes among other attachments, a convenient fitting. Altogether this boiler mounting is marked by much originality of design, and possesses many features of special interest.

THE WESTON SYSTEM OF ELECTRIC LIGHTING.

(Continued from page 560.)

In our next illustrations, 10 and 17, we show a form of feeding mechanism, which Mr. Weston has devised for the feeding of the carbons in his system of brake-wheel lighting. In this arrangement the carbon is attached by means of which the upper carbon receives a sliding lever M, which is provided with a suspension rod, and at the other end is fitted to an oval-

ing lever K. Two sidelevels, F and R, of peculiar form, are used for the purpose of regulating the position of the levers. One of these levers is included in the main circuit, and the other in a derived circuit between the upper and lower carbons at the ends of the lever by flexible metallic strips *f* and *h*. The wheel W is controlled by a brake A, which is pivotted to the lever M, but outside of the periphery of the wheel, and has a short arm at the right to which is attached a rod or wire at C. It also has a projecting arm at the left, extending over and resting upon the frame of the lamp at C. The working position of the wire rods is shown at the left, in Fig. 17, these rods shell and part of the coil are cut away to allow the arrangement. It will be seen that the solenoid has the ordinary over, and in addition, an iron shell surrounding the coil, and having a gap in one place with the core. Mr. Weston has found, that with a solenoid constructed in this way, an extremely long range of motion can be obtained with very uniform power; and that the solenoid is about as powerful as an ordinary fil-bunched electro-magnet, having double the amount of wire upon it. The great disadvantage of ordinary solenoids is their comparative feebleness in proportion to their size.

Supposing the lamps to be at rest, with the carbons in position, and burning, applying the current the solenoid of the oscillating lever, and draw down its end where the feeding levers are connected. The lever then tilts over, and in addition, as iron shell surrounding the coil, the lever 2 and the wheel up locally, so as to separate the carbons and form the arc. As the arc increases in length, the current through the solenoid is reduced, and the attraction of the iron shell upon the lever diminishes. It rests upon the wheel with sufficient force to retain the brake and allow the wheel to rotate. When the carbons burn away to the length of the arc will immediately set the brake, and the slightest increase release it. The wheel will rotate, and the lamps is so arranged with the carbons that the wheel, that the weight of the carbon not its carrier tends to rotate the brake when its detaching attached lever, and the current form, and is nearly is very positive; but the moment the arc is formed, the attraction of the solenoid becomes larger, and the lever over the brake, the device works with very great accuracy. The feeding is very simple and extraordinarily accurate, it is evident that it is impossible to detect the movement of any one lamp.

In Fig. 18 we shown the automatic cut-out, ordinarily used with these lamps. It is a modification of the well-known Weston cut-out, and consists of an electro-magnet in the same circuit with the lamps, which when the armatures is released by the magnet. This cut-out is attached to every convenient form, and is usually placed near the lamps, as shown at the left in Fig. 17, being included in the casing with the electrical connections. The diagram indicates clearly the method of connecting a few sets of bunched or famous silver wire, which are included in the shunt circuit, the current passing from the main conductors down in the same direction as in the lamps coil, and the object of the supplementary coil is to cause the armature to be held more quickly to open the circuit when the lamp is lighted. The resistance of the shunt coil is very great, when all the lamps are lighted, but when the carbons is reduced, it is much less, and the current closed, and the lamp circuit opened. The resistance of the cut-out is adjustable, and it is sometimes found necessary to increase or decrease the resistance, but from the fact that the magnet is also included in the circuit, the armature is held by its armature. Whenever the lamp circuit is closed, however, the current at first divides between the two circuits, as in the magnet, and built to operate. The resistance very quickly reduced the shunt is broken, and the current passes through the lamp. This cut-out is very simple, and is very efficient under ordinary circumstances, but where a very large number of lamps are used in the same circuit, a number of cut-out shunts is found necessary. For the sake of additional precaution to guard against any dangerous disarrangement of the arc.

J and N are insulated contact pieces, leading from the binding-posts of the lamp, and terminating in contact pieces, which form a spring switch, being shown in the illustration. The switch is opened by the pressure of a spring, but is usually held open by a catch, which is pivotted to the upper part of the switch, and arranged between the jaws of the switch, as shown in the plan view, in the lower upper section, but at a sufficient distance from the upper end to allow the hanging of the fusible plug which is attached to it. This arrangement is so simple as to require no description, and it will be seen that the switch is closed by the fusible plug is melted, and the switch is closed by the spring, and the lamp cut out. This switch arrangement is so extraordinarily sensitive, that the slightest variation, caused the united springs on the lever would close the battery circuit, by making contact with a stop-screw in the lower part of the lever, and ring a bell at the top to call the attention of the attendant to the means of this indicator, the attendant at the central station can see, upon starting the machines, that the proper current is sent to the lamps, and he discovers at once whether any accident occurs to the circuit, or when lamps are put out of circuit or switched out, can immediately adjust the machine to compensate for the change.

The Weston incandescent lamp has been long in use, and is already so well known that we need not give any detailed description of it.

The different incandescent lamps of the public safety devices which we have invented. With the multiple system, it is the custom that the diameters of the current are small. The internal dimensions depend upon their relative resistance. By the arrangement of one of the branches of current would be diverted to it from the main current, and this might be sufficient to dangerously heat, or even fuse the branch wire. A safety device, of the form illustrated in Fig. 29, is placed in each branch, to guard against this danger. It consists of a strip of easily fusible alloy introduced into the branch wire arranged in convenient form for removal. The alloy is composed of tin, lead, cadmium, and bismuth, and fuses at a temperature of 75 deg. The strip is made of sufficient size to support the normal current without heating it to its fusing point; but when the branch conveys a greater flow of current, the heat of the branch conveys a greater flow of current, the heat of the branch conveys a greater flow of current, the heat of

Electrical Review, July 19, 1883.

Experiments on Dynamo-Electric Machines.

THE ELECTRICAL DETERMINATION OF THE EFFECTIVE VALUES OF THE PASSIVE MECHANICAL POWER, THE INTERNAL RESISTANCE, AND THE MAGNETIC FIELD AT GIVEN DEGREES OF INTENSITY.*

The object of these determinations is to ascertain accurately the loss of power and the electrical results in various mechanical apparatus; I have made use of various methods of determination of which I shall only quote the following summary, which is general, correct and simple; the practical arrangement of two galvanometers, one of very low, the other of very high resistance, called electromotive force and intensity galvanometers, which I advocated in 1870, is adopted.

I would call attention to the fact that after having shown that the usual approximate laws and formulæ are, in several respects, insufficient to represent the working of the machines, and that it is necessary to take into account the important reactions which are by no means neglectable, I have proved that the most accurate and the most practical method is to sum up all the effects of various kinds, and to include them in one or the other of the following two effective quantities:

The effective magnetic field, the effective internal resistance; these two quantities having to be determined by experiment.

We shall represent the effective field by φ, the electromotive force which it produces with a given degree, for a given length or thickness of the induced circuit.

We shall call n, the degree $n\varphi^2$, the difference of potential at the terminals of the machine as generator and as receiver; t, t' the power in kilogrammeters that indicated at the brake as a receiver, and that absorbed by the passive mechanical resistance of the machine.

These are the data, all observed directly, except the last, r, which is assumed. (I shall show further on how it is determined.) The three unknown quantities to be determined are: First and second, the electromotive forces as generator and as receiver, e, e', which will be furnished by the forces of the fields, which may be equal, a little different, or very different, as I have pointed out upon several occasions (notably *à propos* of the experiments of ploughing at Semalay, and of the electrical transmission of power at Miesbach-Munich), according to the constitution of the static field; third, the effective or *dynamic* resistance, r, which must not be confounded with the *static* resistance, a, that is to say, with the ring at rest; r exceeds a relatively more as the speed, fineness and length of the circuit per pair of brushes are increased; r, therefore, takes into account, under the form, $t^2 \Delta \alpha$, the deficit of work of machines with a collector, a deficit of an electrical nature, of which I have had first the honour of giving to the Académie the indication and measurement.

From the three equations—

$$e_n = g\frac{(t+t')+\sqrt{(t+t')^2-4\,t\,t'\,r^2}}{2}, E_n = g(t+t')_m, E_m r^2 + I^2 = t\,t'$$

we find

$$r = \frac{t+t'}{I} - g\frac{t+t'}{I\,I_1}$$

$$E_m = g\frac{t+t'}{I} - I(r+a)$$

(gross electromotive force)

$$g = \frac{t}{I}$$

and $g = \frac{t'}{I}$ (nett force)

$$\therefore E = \frac{t+t'}{I} - I(a+r)$$

We have just assumed r to be known; here is a purely electrical method of determining it.

Separate the circuit of the electro-magnets from the induced circuit; excite successively the conductor with any two currents, provided that the forces of their respective magnetic fields be not equal; make to pass successively, by induction, a current, so that the speed becomes n, under the only passive resistant couples of the galvanometers, this current I and I' and the difference of potential at the brushes e and e'.

Calling e and e' the gross counter-electromotive forces, and p the effective resistance, have the equations—

$$t\frac{(e+I\,p)^2}{e}, \quad t'\frac{(e-I'\,p)^2}{e} = n\varphi^2,$$

and, as e here is equal to e', we have—

$$\frac{t-t'}{t+t'} = \frac{I^2-I'^2}{2\,e\,p},$$

$$p = \frac{e}{I+I'},$$

$$\frac{e}{I-I'},$$

and, finally, the value of e or e' or $n\varphi^2$, is—

$$e = \left\{\frac{t(t-t')}{t-t'\left(\frac{I-I'}{I+I'}\right)^2}\right\}$$

or

$$e' = \left\{\frac{t'(t-t')}{t-t'\left(\frac{I-I'}{I+I'}\right)^2}\right\}$$

*Comptes Rendus.—M. Cabanellas.

HOPKINSON AND MUIRHEAD'S DYNAMO ELECTRIC GENERATOR.

(For Description, see next Page).

FIG. 1.

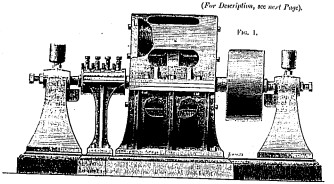


FIG. 2.

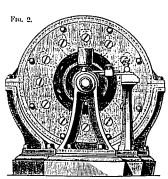


FIG. 3.

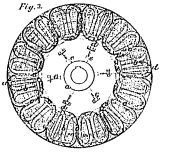


FIG. 5.

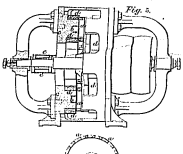


FIG. 9.

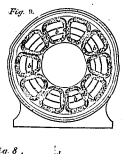


FIG. 4.

FIG. 7.

FIG. 8.

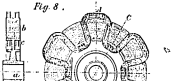


FIG. 6.

dent at the centre; no effect on the cracks; shot broke up.

No. II.—Just below crack *b*, 11 deg. from normal; slight indent as in former round; plate and cracks unaltered.

No. III.—Near crack *b*, 21 deg. from normal; as last round, small indent; plate and cracks unaltered.

These three rounds having shown that crack *b* had no injurious effect on the plate,

No. IV. was directed against crack *a* at bottom; angle to normal, 30 deg.; no result.

No. V. struck right on the centre of the crack; no result on crack or plate.

As five rounds, with a total striking energy of 1600 foot-tons, had produced no effect in widening or extending the cracks, it was shown that such superficial "chill-cracks" do not in any way diminish the strength or endurance of a plate. The trial also exhibited the high resistance of the shield, three rounds being delivered in a space of 56 square inches without producing any effect on the plate.

The trial was continued on the 19th of January, 1883.

Hitherto plates had been tested by spreading hits over the whole surface in accordance with the conditions prevailing on actual service; the object of the continued trial was to test the endurance of the plate under a series of rounds concentrated in a manner which in action could not be realised, *e.g.*, together on a small portion of the surface, and to observe in what way the clearage of the plate would be effected by such a fire.

No. VI.—Forged steel shell, weight 80 lb. Striking energy, 1220 foot-tons. Angle of impact 8 deg. from normal.

Result. Struck as in diagram, no effect on plate or cracks.

No. VII.—Forged and tempered steel shell, weight 79 lb. Striking energy, 1221 foot-tons. 48 deg. from normal. Fired against crack *a*, no result.

The remaining rounds were concentrated on the centre of the plate.

No. VIII.—Tempered steel, small cavity, shell, weight 86.5 lb. Striking energy 1323 foot-tons. 11 deg. from normal. Slight hair crack formed, 6 in. long (*e*) in diagram.

No. IX.—Same projectile. Angle of striking 12 deg. to normal. No effect on plate, hair cracks unaltered.

No. X.—Forged and tempered steel shell 85.5 lb. Striking energy 1257 foot-tons. Angle to normal 11 deg. Slight hair crack 3 in. long in bottom of (*e*).

No. XI.—Same projectile. No result, plate and cracks unaltered.

No. XII.—Same projectile. Hair cracks, *c*, unaltered. A fine crack 15 in. long formed (*d*) in diagram.

No. XIII.—Same projectile *d* lengthened to 28 in. The trial was suspended in order to procure from Austria a supply of projectiles which it is intended to test. It will then be continued.

The result so far may be considered very satisfactory. It should be remembered that the plate under trial had been rejected as faulty; moreover, being a "side" plate, and consequently not exposed in action to direct fire, it was only 17.7 in. thick, whereas the front plates of the shield, which are designed to withstand the direct attack of the 5.9-in. R. L. gun are 20.9 in. thick. The plate withstood 13 direct hits with a total striking energy of 16,000 foot-tons, without appreciable cracks notwithstanding that most of the rounds were concentrated on a small area. The crack developed by round No. VIII. remained unaltered by subsequent rounds, although X. and XI. struck right upon it, and XII. close beneath it. The hair crack *d* was so small that for a long time it escaped observation under a close scrutiny of the surface of the plate. It is not probable that it injuriously affected the shield, as experiments have shown that the production of such hair cracks, which do not reach the soft iron lying under the chilled face no influence in hastening the final destruction of the plate. Moreover the fact of the hair crack *d* crossing instead of prolonging the "chill crack" *b*, and the absence of any result from round VII., show that such cracks are in casting are not injurious.

It should be noted that 7 shots struck in an area 24 in. wide by 15 in. high with a total energy of 11,301 foot-tons. The longitudinal effect of these rounds exhibits in a striking manner the high resis-

NATURE

THE PROPER PROPORTIONS OF RESISTANCE IN THE WORKING COILS, THE ELECTRO-MAGNETS, AND THE EXTERNAL CIRCUITS OF DYNAMOS?

FOR the electromotive force

Let L be the length of the wire,

B = bulk of the whole space occupied by wire and insulation,

w = ratio of this whole space to the bulk of the copper alone (that is, let $\frac{1}{w}B$ the bulk of the copper),

A = the external area of wire and insulator,

K = the resistance of the wire.

For the working coil, let the corresponding quantities be L', B', w', K'. Lastly, let v be the specific resistance of the copper. We have—

$$B = AL \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$B' = \sqrt{w w'} B = \frac{K}{K'} B \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Hence, $A = \sqrt{w w'} \frac{K}{K'} A' = \frac{K}{K'} A \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$

and similarly, $A' = \sqrt{w w'} \frac{K'}{K} A' = \frac{K'}{K} A \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$

where K and K' denote coefficients.

Now, let r be the current through the magnet coil, and r' that through the working coil, and let v be the velocity of any chosen point of the working coil. Denoting by f the average electromotive force between the two ends of the working coil, we have—

$$f = \int \frac{1}{A'} v r \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where f is a quantity depending on the forms, magnitudes, and relative positions of B and B', and on the magnetic susceptibility of iron; divided-ring as the susceptibility diminishes with increased strength of current, or with any change of B and B' which gives increase of magnetic-ring forces.

In the simple-circuit dynamo (that is, the ordinary dynamo) r is equal to r', but not so in the shunt-dynamo. In each, the

* "On the Present Position and Prospects of Political Economy" (Dutch Association, Dublin, 1868).

† Quoted by Mr. Grant Duff, Presidential Address to Section F, 1868.

‡ Paper read at the British Association, York, 1881, by Sir William Thomson, F.R.S.

whole electric activity (that is, the rate of doing work) is fr'; or, by (3)—

$$\frac{r r'}{A' v} \int v \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

But, by (1) and (2)—

$$\frac{1}{K K'} \int v (A' E' r' + A E r) \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Of this whole work, the proportion which go to waste in heating the coils and to work in the external circuit are—

$$\frac{A' E' r'}{K K'} \int v \quad \text{and} \quad \frac{A E r}{K K'} \int v \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

If $A' E' r' = A E r$, the ratio of (6) to (5) is a minimum, and the useful work (7) by making $\frac{1}{K}$ sufficiently great, the ratio of (6) to (5) (waste to useful work) may be made as small as we please. Our question is, how ought K and K' to be proportioned to make the ratio of (6) to (5), or the work a minimum, with any given speed v, or, what comes to the same thing, to make the speed required for a given ratio of waste to useful work a maximum? Let m be the ratio of the whole work to the waste. We have, by (3) and (6)—

$$r = \frac{A' v (E' R' r' + E r)}{E' r' R' K'} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

For the single-circuit dynamo we have $r = r'$, and (8) becomes—

$$r = \frac{A' v (E' R' + E)}{E' R' K'} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

or

$$r = \frac{A' v (E' R' + E)}{S K K'} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

where

$$S = R + \frac{K}{K'} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

Suppose now K' to be given, and suppose r for a moment I to be constant. The problem of making r a maximum with a given v, or a minimum with r given, requires simply that $\frac{K}{K'}$, the resistances in the working coil and the electro-magnet are equal. But in reality I is not constant; it diminishes with increase of the magnet-ring force. As it generally depends chiefly on the soft iron of the electro-magnet, and comparatively but little on the soft iron of the moving armature, or on lost magnetism of the current through the moving coils, it will generally be the case that I will, *cæteris paribus*, be diminished by increasing K and diminishing $\frac{K}{K'}$. Hence the maximum of r is shown by (10) to require $\frac{K}{K'}$ to be somewhat greater than $\frac{1}{S}$; how much greater we cannot find from the formula, without knowing the law of the variation of I.

Experience and natural selection seem to have led in most of the ordinary dynamos, as now made, to the resistance in the electro-magnet being somewhat less than the resistance in the working coil, which is in accordance with the preceding theory.

Whether the useful work of the dynamo be light-giving, or power, or heating, or electro-metallurgy, we may, for simplicity, reckon it in any case as done by applying to the current standard of a dynamo a resistance E in addition to the current resistance E connecting the working terminals of the dynamo. This conductor, in accordance with general usage, forms the "external circuit," which is no abbreviation for the part of the whole circuit which is external to the dynamo. In the case of the single-circuit dynamo the current in the external circuit is equal to that through the working coil and electro-magnet, or r of our notation. Hence, by Ohm's law—

$$r = \frac{A' v E'}{E K' (E + R + R')} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

or, by (3), (4), and (2),

$$r = r_{\prime} \frac{f \sqrt{(E E')} v}{K K' (E + R + R')} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

Hence either

$$r = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

or

$$I = \frac{K K' (E + R + R')}{f \sqrt{(E E')} v} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

The case of $r = 0$ is that in which

$$v = \frac{K K' (E + R + R')}{L \sqrt{(E E')}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

where I denotes the value of I for $r = 0$. To understand it, remember we are supposing that no residual magnetism. For any speed slighter to (16), the dynamo produces no current. When this limit is exceeded the electric equilibrium in the circuit becomes unstable: an infinite-small current started in either direction rises rapidly in strength, till it is limited by repulsion (15), through the diminution of I, which it produces. Thus, regarding I as a function of v, we have in (15) the equation to mathematically expressing the strength of the current maintained by the dynamo when its regular action is excited. Using (15) in (10) we find—

$$r = \frac{E + S}{I} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

which we all have forty years ago from basic.

In the shunt-dynamo the whole current, r, of the working coil branches into two streams, through the electro-magnet, and r through the external circuit, whose strengths are inverse-ly as the resistances of those channels. Still calling the resistance of the external circuit E, we there re have—

$$r E = (r' - r) E_{\prime} \text{ which gives } r = \frac{E}{E + E'} r' \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

Hence, by Joule's original law, the expenditure of work per unit of time in the three channels are respectively

$$K r^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{working coil}$$

$$K \left(\frac{E}{E + E'}\right)^2 r^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{Coils-magnet}$$

$$E \left(\frac{E}{E + E'}\right)^2 r^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{external circuit.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

Hence, dividing as above by r the ratio of the whole work to the work developed in the external circuit, we have—

$$r = \frac{A \left(\frac{E}{E + E'}\right)^2 + A \left(\frac{E}{E + E'}\right)^2 + E}{\left(\frac{E}{E + E'}\right)^2 E} \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

whence

$$K r = \frac{K R' E + E' E + E' (E + E)}{E} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

$$= \frac{R' E + (E + E') E + E' (E + E)}{E} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

Suppose now K and E' given, and $E + E$ to be found; to find r a minimum. The solution is—

$$E = \sqrt{K E'} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

and this makes

$$r = 2 \sqrt{E'} (E + E') = 2 K + R \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (24)$$

But now

$$\frac{K}{E} = r \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (24)$$

(22) and (23) become

$$E = \sqrt{K E'} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

and

$$r = 1 + 2 \sqrt{r (1 + r)} + 2 r. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (26)$$

For good economy r must be but little greater than unity; hence r must be very small, and therefore *approximately*

$$r = 1 + 4 \sqrt{r} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

For example, suppose the resistance of the electro-magnet to be 400 times the resistance of the working coil—that is $r = 400$—and we have, approximately,

$$E = 20 E', \text{ and } r = 21 + \frac{1}{21}.$$

That is to say, the resistance in the external circuit is twenty times the resistance of the working coil, and the useful work in the external circuit is approximately $\frac{21}{22}$ of that lost in heating the wire in the dynamo.

October 4, 1883

ELECTRICAL REVIEW

MAGNETO-ELECTRIC APPARATUS.

Magneto-electricity—*i. e.*, electricity generated by magnetism, has of late years received much attention; and as great improvements have been introduced in the apparatus that, for certain classes of practical applications, it bids fair to supersede the voltaic cell. Through its agency mechanical energy may be transformed into electricity of almost any desired potential and quantity.

The fundamental principle upon which this mode of generating electricity depends is identical with voltaic induction. Indeed, according to the accepted theory, the phenomenon of magnetism is due to a series of electrical currents, circulating, around the molecules in a common direction, and the resultant of the effects of such a system is equivalent to that of a single current encircling some central axis.

Facing the north-seeking pole, the direction of the resultant current is contrary to that of the hands of the watch; facing the south-seeking pole it accords with their direction.

Adopting this theory, let the north-seeking pole of a magnet be inserted by successive movements into a continuous ring of wire. According to the laws of voltaic induction, an instantaneous current of electricity will be induced in the ring at every motion, their direction when looked at from the side in which the magnet is inserted being the reverse of that of the hands of a watch. Withdrawing the magnet in the same manner instantaneous currents will be excited in the same direction as that of the hands of a watch.

If the south-seeking pole be approached to or withdrawn from the ring, similar currents, but reversed in direction, will be induced. If, now, the single ring be replaced by a special coil, and the magnet be moved as before, the currents induced will be enumerated by higher potential, their direction being the same as before.

If, instead of moving the magnet, a piece of soft (unmagnetized) iron be permanently inserted in the spiral, and by rapid contacts with the pole of a magnet be successively magnetized and demagnetized, instantaneous electrical currents will circulate as before. If the poles of a permanent magnet be extended by soft iron rods, surrounded by bobbins of wire, and the armature be applied, or withdrawn suddenly, currents in these bobbins will be developed by the resulting change in the locus of maximum magnetic intensity.

Upon these fundamental principles are based all the varieties of magneto-electric apparatus, their differences consisting simply in different mechanical devices for effecting magnetic changes within or near a coil of insulated wire.

If currents of high potential are desired the coils are made of fine wire, while if large quantity is secured coarse wire is used. In either case it must not be forgotten that the *direction* of the current is very short, and that, if a continuous succession of waves is to be produced, a very rapid succession of contacts and breaks must be provided. The current will then consist of a succession of waves in opposite directions, which, however, by the aid of what is called a commutator, may, if desired, be caused to coincide in direction. Thus modified, magneto-electric currents become very similar in their effects to those of ordinary voltaic battery.

The electricity generated by magneto-electric machines has a lower potential than that given by frictional and voltaic induction apparatus; indeed, it more nearly resembles, both in potential and in quantity, the voltaic current from many cells coupled through defects of insulation in the leading wires than that obtained from the machines already described; but, on the other hand, it exerts more attention to guard against small breaks in the continuity of the current.

Magneto-electric machines may be classified according to the form in which the force is utilized. Thus, in the progress of invention, instruments were made which united (1) by a single wave; (2) by a succession of waves alternating in direction; (3) by a current more or less unvarying. It may be added, that by the device called a commutator, an alternating current may always be changed into one pulsating in a single direction, thus transferring the instrument from class (2) to class (3).

The following tabular classification, based on the foregoing analysis, exhibits the magneto-electric igniting machines in most common use:

I. Acting by single electric wave.	{	Bisquet. Jorgensen. Marcus.
II. Acting by a succession of waves alternating in direction.	{	Wheatstone. Bearsdien.
III. Acting by a continuous current.	{	Clows II., with com. added. Gramme.

It may be remarked, in general terms, that Clowes I. and II require medium tension, and Class III. low tension force; but each kind of instrument, as a rule, has peculiarities which render it important to select its type with judgment. High tension forces can hardly be used with any variety.

In order to secure a fair idea of the relative power and convenience of these several machines for different classes of practical work, the following description of them is added. It will enable the officer to select the one best suited to his needs in any special case. The dimensions refer to complete instruments belonging to the school of Submarine Mining at Willets Point, and are the results of careful measurements. The plates are designed to explain the electrical principles, not the mechanical details of the apparatus.

THE BISQUET MACHINE.

This instrument consists of a horseshoe magnet, the poles of which, prolonged with soft iron, constitute the cores of two bobbins of fine coils of very fine insulated wire, having a resistance of 9,400 ohms. A soft iron armature in contact with the ends of these cores is attached by a brass plate to a lever extending outside the case. This lever is so pivoted as to have such a short and a smart throw will separate the armature suddenly from the poles and thus create a current; induced by the change in the forces of magnetic polarity, to circulate through the coils. The current is greatly intensified by an extra quantity caused by the following ingenious device: The coils are united in series, and the circuit is extended to two terminal posts outside the case; another circuit, forming a shunt between the coils and the terminal posts, consists in part of a spring attached to the lever and moving with it. After moving a certain distance, this spring breaks the shunt circuit, thus producing a strong extra spark by the interruption of the current at its maximum. It is chiefly this spark which passes through the exterior circuit and fires the fuses.

The instrument is encased in a neat box, 18" by 12" by 9" high, the whole weighing 21 lbs. A sliding key blocks the lever when not in use, and thus guards against accidents from careless handling. A switch and two posts on the cover allow any one of five torpedoes to be fired at will.

A tension fuse possessing a decided conductivity, like those of Abel or Von Ebner, is required with this machine; and to effect simultaneous explosions it is well to select fuses nearly alike in this respect. This may be done by noting the deflections of a delicate galvanometer included with the fuse in the circuit of a small battery. Of course, fuses must be coupled in series with this class of machines, but where more than one fuse is used some other class should be selected. Torpedoes at one time adopted the Bisquet apparatus for naval uses, but ultimately decided it to be deficient in quantity—especially for submerged cables, in which electrification largely reduces the volume of the spark. It is stated that on a land line, in 1869, a fuse was fired at a distance of 300 miles by this machine.

It is not easy to establish a standard by which to compare different kinds of igniting apparatus acting by a single wave, for the reason that the instruments differ both in the quantity and the potential of the charge; and the latter element passes from zero through an unknown maximum back to zero in a time immeasurably short. If, however, fuses having a suitable conductivity are to be employed, an approximate idea of the relative power of two machines may be derived from a galvanometer measurement based upon the following principles:

If the currents to be compared be instantaneous, and the needle be so heavy as not to move sensibly during the passage of the waves through the coils, the observed swings of the needle may be regarded as the effect of blows.

In this case the mechanical work is pro-

portional to the versine of the angle of swing (α), i.e., to $2 \sin^2 \frac{\alpha}{2}$. The electrical work is measured by the product $C^2 R T$, in which C denotes the strength of current, R the resistance of the circuit, and T the time. Hence, for two currents through the same circuit,

$$C_1 = C_2 \frac{\sin^2 \frac{\alpha_1}{2}}{\sin^2 \frac{\alpha_2}{2}} \sqrt{\frac{T_2}{T_1}}.$$

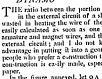
Now, if λ known wave (C_1), of such a nature that the ratio between the square roots of the two times may be assumed to be unity, be sent through a galvanometer, and its swing (α_1) be noted, and a like observation be made with the machine to be tested (giving α_2), this formula will furnish an approximate measure of the power of the latter in known electrical circuits.

This method has been applied to the Hregnet apparatus, using for the standard a known condenser charged by a battery of known potential. The latter was 828 volts. Two condensers were employed, the first having a capacity of 1,510 microfarads, and the second 2,341 microfarads. The galvanometer was a fine instrument made by Siemens Brothers, of London, and well suited to this use. The mean results of several measurements, differing but slightly among themselves, were the following:

The first charge (892 microfarads) deflected the needle 0.0 degrees.

A GEOMETRICAL CONSTRUCTION GIVING THE RELATION BETWEEN THE WASTE AND USEFUL WORK IN A SHUNT-DYNAMO

THE ratio between the portion of electrical energy utilisable in the external circuit of a shunt dynamo and the portion wasted in heating the wire of the armature and field magnet is easily calculated as soon as one knows the resistances of the armature and magnet wires, and the resistance equivalent to the external circuit; and I do not know that there is any great advantage in putting it into a geometrical form. Still there are people to refer a constant ratio to a formula, and the following construction is easily made, especially with the use of squared paper.



In the figure annexed, let O A represent the resistance of the armature between the points where the branching wires l O k are soldered on to it, and let O B represent the resistance of the field magnet wire; and O C the resistance of the external circuit, or its equivalent.

Now from B, as a diagonal, complete the rectangle O A D B, and from C, producing O C to meet B D in E.

Then if O C is equal to $\frac{1}{2}$ O E; then E G and E F, drawn parallel to O A and O B, will cut off O G and O F, which are the resistances of the two branches of the shunt.

The length H K is determined represents the waste portion of the total electrical energy, on the same scale as H O or C E represents the useful.

In the figure the effect of the armature resistance in tilting up the line C A and so increasing the waste is very manifest; the increase of waste by decreasing the resistance O A is somewhat less striking, but quite distinct; the effect of a change in O C is, as it should be, not so obvious. It may be noted that the most economical value for O C is very nearly indeed a geometric mean between O A and O B—O A; which is an easy rule to apply in practice.

Liverpool, July 19 OLIVER J. LODGE

To The Editor of Times:

SIR,—I really cannot understand how any one can find fault with gas companies, or their bills. To me, these companies seem to be the personification of uprightness and modesty, whose only aim is to accommodate the public, and have pleasant, steady rises to posterity an unblemished reputation. I get my gas from the Metropolitan-the-Company. I live in a country house between Fifth and Sixth avenues, and, as you can imagine, require a large supply of gas. Yet, looking over my bills for gas I find that for the past six years, the average is only 60l and the highest for any one year was only 68l.

Yours, truly,

A CONSUMER.

This scheme has much to commend it, it revives the drooping confidence of consumers and assumes for the gas company the role of benevolent saint. But, unfortunately, like most schemes it has its defects. A very liberal factor had been left out in the calculation. This was the liability of the bona-fide consumer to answer back, until the ridiculous tendency on the part of the consumer has, it is to be feared, completely spoiled the newspaper-letter-from-consumer-market.

Here is one of the letters brought out by the original communication:—

THE COST OF GAS-LIGHT.

To the Editor of the New York Times:

In the perusal of your paper this morning I read the article headed "Satisfied with his Gas Bills," and was surprised to hear the amount he paid yearly for gas. Living as he does in a four-story house, between Fifth and Sixth avenues, and obtaining my supply of gas from the same source—the Metropolitan Gas Company—I feel the curiosity to look over my bills for gas during the year 1882, and find they amounted to $211.06. When this "Benschcher" states that his average for the past six years is only $61, and that his highest for any one year was $68, and that at all times he had an abundance of light, this discrepancy seems unaccountable, particularly as I am living very quietly, giving no entertainments.

ELECTRICITY.

New York, Monday, Jan. 28, 1881.

Is the Dynamo a Failure?

One contemporary, *Engineering*, the leading scientific authority in Great Britain, discusses, in a recent leading article, the relative merits of electricity and gas as illuminants. After traversing the subject at some length it would seem, if we correctly interpret its meaning, to arrive at the following conclusions: 1st. That electricity, as distributed from a central Station, is far more costly than gas, and hence cannot compete with it. 2d. That the primary batteries, considered from a commercial standpoint, are, for the same reason, a failure.

It says that inventions relating to dynamo machines are no longer in demand in the city, by which it means London, and that whether the electric light can, or cannot, be supplied at the price of gas is a question which has been much discussed, and one that most people have decided must now be adjourned until the truth has been demonstrated on a grand scale. It is but, it goes on to say, difficult to estimate the expenses of an electric lighting station under certain assumed conditions, and if the lamps can only be taken up in sufficient quantities, and be burned a large number of hours each day, a very fair pro-cent can be made out.

"But everything depends upon a large and continuous consumption of current, for the annual expenses are enormously swollen by the items of interest on depreciation, and these go on whether the lights are burning or not.

This is a point, however, which is liable to escape notice, and people forget that the engines, boilers and dynamos will only be working at their full capacity, as a rule, for four or five hours a day in the Winter and never in Summer; and when a comparison is made between this form of electric lighting and others, they are apt to be led astray."

Now, without further ado, we will grant the premises adopted by our contemporary, but we must confess we find no little fault with its conclusions, which by no means tend how as a logical sequence of those premises. That is to say, granting that the "items of interest and depreciation" are more important in the electric than in the gas plant, it does not follow that the public will prefer gas to electricity as an illuminant. Those who are engaged in estimating the relative cost of producing electricity and gas are wasting their time; they are wasting the public and it is a useless search. And why? Because in a normal condition of the market, when the rebutments of gas manufacture are in active demand, carburetted hydrogen gas can be delivered to the consumer at a cost to the gas company of twenty-five cents—say a sane intensity of electricity to the consumer at such a figure. Assuredly not.

The contemporary will pardon us for the contradiction, we will assert that, under the circumstances, this person nothing at all. You can put coal tea for a tithe of what good tea will cost; you can get pinchbeck beer for less than a small part of the sum pure lager beer will cost; you can get loaded sherry and fortified wine for a mere trifle, compared with what the genuine product of the vineyard will cost. Does that make spurious tea and ale and wine to be preferred to the pure article? Does the public evince for them an amount in paid yearly for gas. Living as he does in a four-story house, between Fifth and Sixth avenues, and obtaining my supply of gas from the same source—the Metropolitan Gas Company—I feel the curiosity to look over my bills for gas during the year 1882, and find they amounted to $211.06. When this "Benschcher" states that his average for the past six years is only $61, and that his highest for any one year was $68, and that at all times he had an abundance of light, this discrepancy seems unaccountable, particularly as I am living very quietly, giving no entertainments.

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rates, while, at the same time, encouraging the use of the telegraph. Besides this, we have only the ward of the Western Union Telegraph Company to assure us that the rates are cheaper here than abroad.

In France you can send twenty words for twenty cents of our money, and the average in European countries is only one-half a cent a word. You can send twenty words from France to Algiers, a distance of two thousand miles, for twenty cents of our money. Surely, this is much cheaper than the rates which now rule in this country.

The Relentless Gas Consumer.

All else having failed them, the gas companies, with an ingenuity which those who know them will by no means be surprised at, have hit upon a novel scheme for decreasing that their charges are not exorbitants. It might not inappropriately be called the new-paper-letter-from-consumer-racket. The game is played in this wise. Here is a gas company, the meters of which are so accurate that their faces will not indicate any difference between the gas consumption in a house when the inmates are in Europe or in town, burning fifteen burners hour hour per diem. Now, let it be supposed that the Secretary wishes to manufacture a little cambric in gas consumers. He sits down at a table and writes to a morning journal a letter that reads:

To The Editor of Times:

SIR,—I really cannot understand how any one can find fault with gas companies, or their bills. To me, these companies seem to be the personification of uprightness and modesty, whose only aim is to accommodate the public, and have pleasant, steady rises to posterity an unblemished reputation. I get my gas from the Metropolitan-the-Company. I live in a country house between Fifth and Sixth avenues, and, as you can imagine, require a large supply of gas. Yet, looking over my bills for gas I find that for the past six years, the average is only 60l and the highest for any one year was only 68l.

Yours, truly,

A CONSUMER.

This scheme has much to commend it, it revives the drooping confidence of consumers and assumes for the gas company the role of benevolent saint. But, unfortunately, like most schemes it has its defects. A very liberal factor had been left out in the calculation. This was the liability of the bona-fide consumer to answer back, until the ridiculous tendency on the part of the consumer has, it is to be feared, completely spoiled the newspaper-letter-from-consumer-market.

Here is one of the letters brought out by the original communication:—

THE COST OF GAS-LIGHT.

To the Editor of the New York Times:

In the perusal of your paper this morning I read the article headed "Satisfied with his Gas Bills," was surprised to hear the amount he paid yearly for gas. Living as he does in a four-story house, between Fifth and Sixth avenues, and obtaining my supply of gas from the same source—the Metropolitan Gas Company—I feel the curiosity to look over my bills for gas during the year 1882, and find they amounted to $211.06. When this "Benschcher" states that his average for the past six years is only $61, and that his highest for any one year was $68, and that at all times he had an abundance of light, this discrepancy seems unaccountable, particularly as I am living very quietly, giving no entertainments.

ELECTRICITY.

New York, Monday, Jan. 28, 1881.

Is the Dynamo a Failure?

One contemporary, *Engineering*, the leading scientific authority in Great Britain, discusses, in a recent leading article, the relative merits of electricity and gas as illuminants. After traversing the subject at some length it would seem, if we correctly interpret its meaning, to arrive at the following conclusions: 1st. That electricity, as distributed from a central Station, is far more costly than gas, and hence cannot compete with it. 2d. That the primary batteries, considered from a commercial standpoint, are, for the same reason, a failure.

It says that inventions relating to dynamo machines are no longer in demand in the city, by which it means London, and that whether the electric light can, or cannot, be supplied at the price of gas is a question which has been much discussed, and one that most people have decided must now be adjourned until the truth has been demonstrated on a grand scale. It is but, it goes on to say, difficult to estimate the expenses of an electric lighting station under certain assumed conditions, and if the lamps can only be taken up in sufficient quantities, and be burned a large number of hours each day, a very fair pro-cent can be made out.

"But everything depends upon a large and continuous consumption of current, for the annual expenses are enormously swollen by the items of interest on depreciation, and these go on whether the lights are burning or not.

This is a point, however, which is liable to escape notice, and people forget that the engines, boilers and dynamos will only be working at their full capacity, as a rule, for four or five hours a day in the Winter and never in Summer; and when a comparison is made between this form of electric lighting and others, they are apt to be led astray."

Now, without further ado, we will grant the premises adopted by our contemporary, but we must confess we find no little fault with its conclusions, which by no means tend how as a logical sequence of those premises. That is to say, granting that the "items of interest and depreciation" are more important in the electric than in the gas plant, it does not follow that the public will prefer gas to electricity as an illuminant. Those who are engaged in estimating the relative cost of producing electricity and gas are wasting their time; they are wasting the public and it is a useless search. And why? Because in a normal condition of the market, when the rebutments of gas manufacture are in active demand, carburetted hydrogen gas can be delivered to the consumer at a cost to the gas company of twenty-five cents—say a sane intensity of electricity to the consumer at such a figure. Assuredly not.

The contemporary will pardon us for the contradiction, we will assert that, under the circumstances, this person nothing at all. You can put coal tea for a tithe of what good tea will cost; you can get pinchbeck beer for less than a small part of the sum pure lager beer will cost; you can get loaded sherry and fortified wine for a mere trifle, compared with what the genuine product of the vineyard will cost. Does that make spurious tea and ale and wine to be preferred to the pure article? Does the public evince for them an amount in

Feb. 1, 1883]
NATURE

Trial of the electro-magnetic engine, aërial screw, and bichromate elements constructed by MM. Thunmler for their directing balloon took place in their aëronautical work-shop at Point du Tour, on January 26, before a large number of electricians and aëronauts. It was shown that the twenty-four elements, each of which weighs about six kilogrammes, give during almost three hours a current which rotates a screw of 2·85m. diameter, and about 5 metres of path, with a velocity of 190 turns in a minute. The motive power really developed may be estimated at that of four horses per hour. The weight of all the machinery and elements is a little less than 250 kilogrammes. The real effect on the air can only be found by experiments in the air, but according to measurements taken with a dynamometer of the horizontal tendency to rotation, it is about the same as in the experiment tried by Dupuy de Lome. The motive power of Dupuy de Lome having been obtained with eight men working his large screw, whose diameter was 9 metres, it may be inferred that the results in the present case will be more advantageous in the ratio of *two and a half to one*. These results are not very powerful when compared with the immense power of aërial currents. But MM. Tissandier have no intention of directing their balloon against strong winds. Their object is to organise an apparatus with which universal experiments may be made in the air, and they have taken advantage of the most recent improvements of science. If their elongated balloon answer their wishes, a real advance will be registered in the history of aëronautics.

ON THE DYNAMO-ELECTRIC CURRENT AND ON CERTAIN MEANS TO IMPROVE ITS STEADINESS.

BY C. WILLIAM SIEMENS, D.C.L., F.R.S.

The author, after alluding to the early conception by Dr. Werner Siemens of the dynamo-electric or reconstructive principle of generating currents, makes reference to the two papers on the subject by himself, the one by Sir Charles Wheatstone and the other by himself, to the Royal Society in February, 1867. The machine then designed by him, and shown in operation on that occasion, is again brought forward with a view of indicating the progress that has since taken place in the construction of dynamo-electrical machines, particularly those by Gramme and Siemens and Alteneck. The paper next points out certain drawbacks to the use of these machines, both of them being subject to the disadvantage that an increase of external resistance causes a falling off of the current; and that, on the other hand, the short circuiting of the outer resistances, through contact between the carbon electrodes of an electric lamp, very much increases the electric excitement of the machine, and the power necessary to maintain its motion, giving rise to rapid heating and destructive sparks in the machine itself.

In an observation in Sir Charles Wheatstone's paper is referred to, pointing to the fact that a powerful current is set up in the shunt circuit of a dynamo-electric machine, which circumstance has then been taken advantage of in some cases, as by Mr. Ladd and Mr. Brush, in constructing current governors.

The principal object of the paper is to establish the conditions under which dynamo-electric machines worked on the shunt principle are made to give maximum results. A series of tables and diagrams are given, the results of experiments conducted by Sir Charles Wheatstone, employed at the author's works, which lead up to the conclusion that, in constructing such machines as are most applicable, the resistance on the exciting helix has to be considerably reduced by increasing the thickness of the wire employed, and that as the magnets due to be increased more than tenfold, not by the employment of thin wire, but by augmenting the length and weight of coil wire employed.

The results of this mode of distributing the resistances is summarized as follows:

1. That the electro-motive force, instead of diminishing with increased resistance, increases at first rapidly, and then more slowly towards an asymptote.

2. That the current in the outer circuit is actually greater for a unit and a half resistance than for one unit.

3. With an external resistance of one unit, which is about equivalent to an electric arc, when thirty or forty webers are passing through it, 2·24 horse power is expended, of which 1·29 horse power is actually employed, proving an efficiency of 53 per cent., as compared with 45 per cent. in the case of the ordinary dynamo-machine.

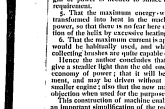
4. That the maximum energy which can be demanded from the engine is 2·6 horse power, so that but a small margin of power is needed to suffice for the greatest possible requirements.

5. That the maximum energy which can be injuriously transformed into heat in the machine itself is 1·3 horse power, so that there is no fear here of destroying the insulations of the coils by excessive heating.

6. That the maximum current is approximately that which would be habitually used, and which the commutator and collecting brushes are quite capable of transmitting.

Hence the author concludes that the new machine will give a steadier light than the old one, with greater average economy of power; that it will be less liable to derangement, and may be driven without variation of speed by a smaller engine; also that the new machine is free from all objection when used for the purposes of electro-deposition.

This construction of machine enables the author to effect an important simplification of the regulator to work electric lamps, enabling him to dispense with all wheel and clock work in the arrangement. The two carbons being pushed onward by gravity or spring power, are checked laterally by



appointed metallic abutment situated at such a distance from the arc itself, that the heat is only just sufficient to cause the gradual wasting away of the carbon in contact with amorphic ate. The carbon holders are connected at the iron core of a solenoid, of a resistance equal to about fifty times that of the arc, the ends of which coil are connected to the two electrodes respectively. The weight of the core (which may be varied) determines the force of the current that has to pass through the exciting coil in order to keep the weight in suspension, and this in its turn is dependent upon the resistance of the arc. The result is that the length of the arc is regulated automatically, so as to maintain a uniform resistance signifying uniform development of light.—*Engineering*.

THE HELIOGRAPH.

The English Government is again indebted to the Heliograph for the receipt of an important dispatch received from the seat of war in Afghanistan, announcing the result of an attack on British troops, in which their enemy suffered severely. The message was sent Camp Ghuzni, April 22d, and was received in London on the following day.

The value of the heliograph in military operations is becoming more apparent every day; in this instance the message probably could not have been delivered in time by the electric telegraph. The Heliograph does not require the route to be kept open. The line of communications can not be cut, for the simple reason that the signalling takes place over the heads of the enemy, and the stations required are few and far between.—A ten inch mirror, and this is the size of the ordinary field heliograph, is capable of reflecting the sun's rays in the form of a bright spot or flare to a distance of fifty miles, the signal at this interval being recognizable without the aid of a glass. That it is so by unwinnied eyesight, each provided with a mirror can readily speak to one another, provided the sun is shining, within a interval of fifty miles between them, provided their stations are sufficiently high, and no rising ground intervenes to stop the rays. The adjustment of the sufficient heliograph is a very simple matter.—An army lowering its heliograph as a heliograph station is located, and after travelling even a miles desires to communicate with those they have left. A hill in the locality is chosen and a sapper accords with his heliograph, which is simply a stand bearing a mirror, swung like the ordinary toilet glass, except that besides swinging horizontally, it is also pivoted, so as to also move vertically. Behind the mirror in the very centre a little of the quicksilver is removed, so that the sapper can go behind the instrument and look through a tiny hole in it towards the station he desires to signal.

Having sighted the station by adjusting the mirror, he next proceeds to set up in front of the heliograph a rod, and upon this rod is a movable rod. This rod is manipulated like the foresight of a rifle, and the sapper, again standing behind the instrument, directs the adjustment of the rod, until it is in the mirror, the rod, and the distant station are in line. The heliograph is then ready to work, and in order to flash signals, so that they may be seen at a distance, the sapper has only to take care that his mirror reflects the sunshine, on the rod just in front of him.

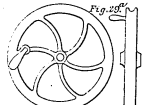
ENGLISH MECHANIC AND WORLD OF SCIENCE. No. 988. FEB. 29, 1884.

THE DYNAMO: HOW MADE AND HOW USED.—XIV.*

By SILVANUS P. THOMPSON.

§ 29. IN order to communicate the motion from the flywheel to the armature, a small pulley wheel, either of iron or brass, is fitted to the back trunnion, just outside the bearing. Such a pulley wheel may be made at any ironmonger's, and should be about 3in. in diameter, and rather over 1in. thick, with a central hole somewhat smaller than the diameter of the rod which serves for the armature trunnion. This may be attached to the trunnion in either of the two following ways:—1st. By "keying," which consists in filing the trunnion along its length, in one direction only, so as to produce a flattened side; then keying, with a rod's ball file, cleaned out the central hole of the pulley to such an extent that the said trunnion will only just enter, to deepen one side (corresponding to the flattened side of the trunnion) so as to admit of a small steel wedge or "key" being inserted (see Fig. 26). Only, by filing the trunnion rod to a slightly conical shape, and producing a similar conical "ring" in the interior of the pulley hole, which may then be driven on (see Fig. 28A, where the conical "ring" of the trunnion is exaggerated, to render this mode of attachment more plainly visible). Whichever mode of attachment is adopted, care in addition must be taken—viz., that the distance between the back of the field magnets and the pulley should not be less than 1in.; otherwise, when the limits of magnetic are wound with wire, the flywheel will run too close to them to be altogether safe.

§ 30. The flywheel which gives motion to the armature, should be a pretty heavy wheel, about 24in. in diameter, with a groove in the rim to take the band which conveys the pulley, furnished with a wooden handle, for convenience of rotating. Such wheels may be obtained ready made in cast iron, from most ironmongers, as they are sent out with "rusty tiresses" for portable forges, &c. Fig. 29A gives an idea of the kind of wheel necessary, on a scale of 1in. to a foot. The central hole is turned, and only requires fitting with an iron pin, on which it turns. Since the



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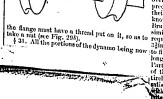
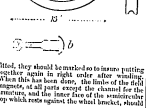
aperture in three wheels is about 3in. in diameter, the pin must be filed down to half an inch in diameter where it has to fit in the hole in the flange at the top of the dynamo.

The flywheel and should have a rounded boss to prevent the wheel from working off, while the portion which passes into the eye at the top of

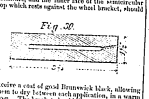


the flange must have a thread put on it, so as to take a nut (see Fig. 28B).

§ 31. All the portions of the dynamo being now



fitted, they should be marked so to insure putting together again in right order after winding. When this has been done, the brake of the field magnets, at all parts except the channel for the armature, and the inner face of the commutator, up which rests against the wheel bracket, should



receive a coat of good Brunswick black, allowing them to dry between each application, in a warm oven. The bracket should be painted on the rear or two of the same varnish, except where the semicircular bore clutch it. This portion need be left metallic, so as to insure magnetic contact; otherwise, much unnecessary leakage will be lost. Two strips of silk (before immersed) 10in. long and 1in. wide, should now be carefully brushed over with Brunswick black, and wrapped, while still wet, round the one limb, and the other round the other limb of the field magnets, at the place between the armature channel and the lead at the top. See Fig. 15, where the portions indicated by the letters respectively s and [illegible]. The object of this silk wrapping is to insulate the wire thoroughly from the iron, and to prevent any accidental abrasion of the covering wire, which may take place during the coiling round the limbs. When this has been laid smoothly and tightly on, the ends may be returned into the oven, and allowed to dry at a gentle heat. In precisely the same manner, the interior face and their central portion of the armature (to be finally turned down to the "ash") must be varnished with Brunswick black, and wrapped with one layer of similarly prepared silk. Three pieces will be required to do this effectually—viz., two pieces 20in. long by 1in. wide, shaped as in Fig. 30, to fit against the inner faces, and one piece 6in. long by 2in. wide, to wrap round the web. Particular care must be taken that every portion of the inside of the armature channel be completely covered in silk. When this has been satisfactorily performed, another coat of [illegible] black may be given [illegible] to seal the [illegible], and the armature allowed to dry thoroughly in a warm oven.

Your dynamo is now ready for wiring, [illegible] purpose we shall require about 2lb. of [illegible] cotton-covered copper wire for the [illegible] and for the armature. The smallest size useful is 20 [illegible] wire, of the highest conductivity [illegible]

April 6, 1882] NATURE 539

little volume ("A Year in Manitoba, 1880-81") is published by Messrs. W. and R. Chambers, and contains a full and concise statement of the experience of an officer and his sons on a small farm which they took ten miles from Winnipeg. There were not a few hardships certainly, and these are clearly brought out; but the other side is quite as clearly and fairly stated, with a considerable balance in its favour. For any one contemplating emigration to the Canadian North-west, this is the book to get.

Bishop Mr. O'Neill's paper on his three months' journey inland from Mozambique, the *April Proceedings* of the Geographical Society contain a *résumé* of the information just laid before Parliament on the subject of the Nyassa-Tanganyika frontier and of the Congo, accompanied by a map, which can only pretend to reproduce the Russian view of the question. The other paper describes the journey of a Russian officer from Gondokoro to the Kheddive's dominions, and is a translation from the Russian. Perhaps the most valuable matter in the geographical news is the treaty which M. Leroy-Beaulieu imposed on the Sultan of Stanley Pool, and by which they interested, to almost none but Frenchmen; some late news has been given in speaking Dr. Junker's journey in Central Africa, and Mr. J. M. Scharzer's progress to the south-west of Abyssinia. We are glad to see, too, that the international polar meteorological expeditions are not neglected, some very interesting information having reached respecting those of the Danes to Godthaab, in West Greenland, and of the Dutch to the mouth of the Yenisei. Another is also devoted to the recent Finnish expedition to Lapland, the Finns born Finns. The French Geographical Society's meetings are very fully reported, as, indeed, they generally are.

A NEW Geographical Society was formed last month at Greifswald, in Pomerania.

A CORRESPONDENT points out, in reference to Dr. Rae's correction of less weeks, that a gold medal was awarded to Nain Singh in 1877, as will be found by reference to the *Proceedings* of that year, or in the *Proceedings* cold extracts, vol. xxi. A gold watch had previously been awarded to Nain Singh in 1868, for the route-survey from Leh to Mussoorie to Lhasa.

MR. E. ARTHINGTON, of Leeds, who is well-known as the manufacturer here of Mr. Abbott's mi-meter, has just presented to the Baptist Society a further sum of 1000*l.* for the use of the Upper Congo.

THE Constantine gold medal of the Russian Geographical Society was not awarded this year; the medal at Count Lütke was awarded to Mr. Seebohm, Fairfield and Col. Lefroden, for their geological and topographical work in the Balkan Peninsula; the great gold medal of the Edinburgh Geological Society was awarded to M. Tarnuis for his explorations in North-Western Mongolia; that of the Scottish Geographical Society to Nordenskjöld, and the gold medal of the Government of Vyatka. The small gold medals were awarded to Lieutenant Schwatka, Lieutenant Lasar-ef Eastern Siberia, for his determinations of positions in Turkestan; to Lieutenant Aden to M. Hunnejhoff, for astronomical observations on board of ships; to M. Mokhatoff, for ethnographical explorations in Perm, Ural; and to M. Yadrintsef, for explorations in Northern Siberia and on the Altai." Silver medals were awarded to Mydmar L. Pahmakoloyev, for his album of photographs from Western Siberia; to M. Lakhmayer, for photographs of Caucasus and Ural; to M. Keilig, for the same between Kazan and Jekaterinburg; to M. Ivanof, for explorations of the Zeravshan glacier; to M. Agafonoff, for explorations of the black earth and Ural, in the Government of Irkutsk; to M. Rostisch, for topographical observations on the Amur; and to M. Gedyk and Jagodsky, for his works on the Caucasian languages and his biography of the well-known explorer of these languages, K. K. Gedyk; and to M. Stevenovsky and Rudinsky, for collections of Russian songs.

THE first number of the *Izvestia* of the Russian Geographical Society contains, among other interesting materials, two lists of points whose latitudes and longitudes were determined by the unfortunate explorer of Eastern Siberia and Turkestan, F. F. Sidorenkoff, the Pooyat astronomer, during the years 1879 and 1880. The latitudes were determined, in 1879, by the positions of ten points in Eastern Turkestan, he now publishes a list of twenty-four points in the Akmolinsk territory, from Sofia along the two long valleys of the Kisch and of the Kinghes rivers, which cross this territory from east to west, that of Kinghes having been explored in its source, and the most eastern point reached by M. Schwarz being the Ulutau Peak, at the south-eastern frontier of the Kirkh territory. A series of determinations between Veryni and the Issik Kul, lying along the Tekes river, were made during the same year. The numerous magnetic observations made by M. Schwarzof during these two journeys, will be published as soon as calculated.

MATTER AND MAGNETO-ELECTRIC ACTION[1]

[1] Into Prof. Clerk Maxwell, in his work on "Electricity and Magnetism" (vol. ii. p. 148), has drawn as a principle that a mechanical force which urges a conductor carrying a current across the lines of magnetic force, acts, not on the conductor as a whole, but on the conductor which carries it. If the conductor be a solid rod or a fluid it will move in obedience to this force, and this motion may or may not be accompanied with a change of position of the electric current which it carries. But if the current shall be free to choose any path through a fixed solid conductor, or through a bath of water, then when a constant magnetic force is made to act on the system, the path of the current through the conducting mass permanently alters, but after certain transient phenomena, called induction currents, have subsided, the distribution of the current is found to be the same as if no magnetic force were in action. The only force which acts on electric currents is electromotive force, which must be distinguished from mechanical force which is the subject of this chapter.

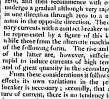
In the investigation on electric discharges, on which Mr. Stokes and myself have been long engaged, we have met with some phenomena of which the principle above enunciated throws the best light, not the only explanation. But whether they be regarded as fairly accounting out of that investigation, or as experimental illustrations of a principle laid down by so great a master of the subject as Prof. Clerk Maxwell, I have ventured to hope that they may possess sufficient interest to form the subject of my present discourse.

The experiments to which I refer, and of which I now propose to offer a summary, depend largely upon the mechanical effect of exciting an induction-coil. The method was described in two papers, published in the *Philosophical Magazine* (November, 1879, and in the *Proceedings* of the Royal Society (vol. xxx. p. 172), respectively; but as its use appears to be still mainly confined to my own laboratory, and to that of the Royal Institution, I will, with your permission, devote a short time to a description of it, and to an exhibition of its general effects.

The method consists in connecting the primary circuit directly with a dynamo-or magneto-machine giving alternate currents. In the present case, I use one of Mr. de Meritens' excellent machines driven by a Thomson-Houston gas-engine. The speed of the armature, making, as shown, about 1100 revolutions per minute.

In this arrangement the current is in the secondary coil once or alternately in a contrary direction, and in the primary, at each make, there arises a current which tends to oppose the main current, during the working of the machine, to be the case at both ends.

The currents in the primary are also alternately in one direction and in the other, but momentarily, at each make, between their value passes through zero. But they differ from those delivered in the primary coil with a direct current and current breaker in an important particular, namely, that while the latter, at breaking, fall suddenly from their strength to zero, and then recommence with equal suddenness, the former undergo a gradual although very rapid change from a maximum in one direction through zero to a maximum in the opposite direction. Roughly current-with a contact breaker would be represented by a figure of this kind, while those from the alternate machine approximately by a curve of the following form. The rise and fall of the latter are, however, sufficiently rapid to indicate a very high tension and of great quantity in the secondary.



From these considerations it follows: first, that as the machine effects its own variations in the primary current, no contact breaker is necessary; secondly, that as there is no sudden rupture of current, there is no tendency in the extra current to produce a spark or any of the inconveniences due to an abrupt opening of the circuit, and consequently that the condenser

[1] Lecture at the Royal Institution, March 30, by Sylvanus P. Thompson, F.R.S.

AN IMPROVED ELECTRO-MOTOR.*

By THEODORE WIESENDANGER.

While recently many minds have been at work, with more or less of success, to produce improvements in dynamo-generators of electric energy, very few have given their special care and attention to the development of the electro-motor. Experience has taught us hitherto that the efficiencies of one and the same machine for action and reaction, or for use either as a generator, or by the inverted process as an electro-motor, stand in a certain and direct proportion to each other, or that our most efficient generators, such as the Siemens, Brush and Gramme, machines prove also the most effective motors, and on the other hand that inferior dynamo-machines invariably are inefficient motors. It would, however, be hazardous to conclude from these results that this rule should hold good for all future machines, and from the results of researches I have recently made, I come to the conclusion that the motors which are to supersede those now in use could not be employed as generators. Dynamo-machines, such as now constructed, only prove efficient when their field-magnets are able to retain at all times (*e. g.*, even when the machine stands at rest) a certain and very considerable amount of residual magnetism, and for this reason their cores are made of retentive material, hard cast iron, as is the case in the Brush and Gramme machines; or if the cores consist of soft iron they are attached to large masses of hard cast iron. In such a manner that the latter are inclosed in the magnetic circuit, and form part of the cores.

Generators of the same kind, when made small in size, have cores much larger and heavier in proportion, and, moreover, baseplate, or, as in the Weston machine, a heavy retentive cylinder, is made to form a portion of the field-magnets. But all efforts hitherto made to produce efficient small dynamo-machines with cores of soft iron only, have resulted in absolute failure, although some of the highest genius have made repeated and prolonged efforts to solve the most difficult of problems.

These curious facts conclusively prove that the theory explanatory of the action of dynamo-machines, as now universally adopted, viz., the theory of inductive action and reaction between the field-magnets and the armature, can not any longer be considered complete or satisfactory; for even wrought iron, especially when occurring in large masses, always contains an appreciable amount of residual magnetism, more especially after it has once been subjected to strong magnetization, and if the above theory were correct and complete, then the smallest possible amount of residual magnetic energy, augmented by repeated action and reaction, would be sufficient for the starting of such a machine in action. This, however, experience proves *not* to be the case, and the theory, although mostly adhered to, must be either abandoned or amended.

The inventors of the most recent electro-motive engines have worked—perhaps unconsciously)—upon the idea that the construction and action of electro-motors are based altogether upon the same laws as those of dynamo or magneto-machines, and, in accordance with that assumption, the field-magnets of the Deprez motor are made to consist of large and heavy masses of magnetized steel.

Experimenters have also for a long time past clung to the idea that the efficiency of an electro-motor—or the amount of energy to be obtained from such a machine by means of a current of given strength circulating in the coils of its armature only—bears a definite and direct proportion to the magneto-inductive power of its field-magnets, and that an increase of power in the field-magnets alone must necessarily give greater capabilities of the machine.

This, however, is a mischievous theory, because erroneous in its very principles, and development would only lead to the hypothesis of perpetual motion. On the contrary, starting from the consideration of the fact that a very small magnetic needle, if acted upon by one of the poles of another and very powerful magnet, has its polarity destroyed or reversed, and that if one of its poles, say the N pole, is presented to a similar (N) pole of the larger magnet, the former will instantly lose its characteristic qualities and be attracted by its overpowering opponent, we can only come to the one rational conclusion that the power or the field-magnets of an electro-motor, as compared to that of the magnet or magnets constituting its armature, should not surpass the limit of some certain ratio, to be determined yet by experiments carefully conducted, and that, if it surpasses the limit, the capabilities of the machine must be impaired. Acting on this principle, I have constructed a motor in which the power of the field magnets is as nearly as possible equal to that of an armature, the core of the former being very light and made entirely of soft iron; and the satisfactory results obtained from this machine are a sure sign that further investigation of the subject and experiments made with a view of determining the exact ratio of power between the magnets and armature will result in further improvement.

Another and very important consideration in the construction of dynamo-machines and electro-motors has not yet received that care and attention from scientific investigators which would lead to immediate progress. It is the method of motion of the revolving armature with regard to its approaching to, or receding from the poles of the field-magnets. In nearly all the machines now constructed the polar faces of the cores of the field-magnets and those of the armature are of such a shape, and the latter is caused to revolve in such a manner, that only in a small portion of the revolution its poles either approach the poles of the field-magnets or recede from them. But the most successful production of induced currents will be achieved, and the greatest amount of power will be derived from a motor, if attention is paid not merely to the one condition, that the armature should revolve in the most highly concentrated magnetic field possible, but also that nearly the entire motion of the revolving armature should be either one of approach or of withdrawal. Let us first of all consider the case of a machine with two poles only of field-magnets and two poles of the revolving armature.

It is usual to give the active faces of the former such a shape that a section of the same represents a portion of a true circle. See Fig. 1.

In the ordinary machines now in use the radius of the circle described by the outline of the revolving armature, and that of the larger circle described in portion by the outline of the inner or active faces of the poles are nearly the same, and the two circles are concentric. (See Fig. 2.) The poles *g f* of the armature only approaches the pole A of the field-magnets while moving *from e to d*, or where the intensity of the magnetic field of A is at its minimum. When continuing its motion *from d to e* and to *f*, the pole *g* can no longer be said to approach A, because the distance between the respective surfaces remains constant.

I therefore propose that the devices shown in Figs. 3 and 6 should be adopted. The radius of the circle, part of which is formed by the section *d, r, e*, is considerably larger than that of the circle described by the outline of the field of motion of the armature; *d, e, r* is, moreover, considerably less than the half of a circle and the three circles *d, r, e, f, r, A*, and that described by the outline of the field of motion of the armature are not concentric. The pole *g* of the armature, when in motion, approaches the pole A, not only in its course from *d* to C, but also when in the most intense magnetic field of A, viz., whilst moving from C to *s* and *f*. *Fig. 11* represents a section of the field-magnets' cores E F and G H, and pole's pieces N and S cast in one piece with cores and mounted on a base board, to which they are fixed by the two bolts R and T. The same principles may be applied to machines with field-magnets of more than two poles (see Fig. 2); or the armature itself may be made of polar faces shape as to work under the conditions above stated (Fig. 4). But even if the poles of the armature and those of the field-magnets are of the ordinary shape, a machine with more magnets will be more perfect in its action than one with two poles only. Fig. 10 illustrates a machine in which the armature during nearly the whole of its motion either approaches to or recedes from

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 9.

FIG. 10.

FIG. 11.

WIESENDANGER'S IMPROVED ELECTRO-MOTOR.

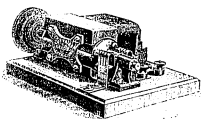
*A paper read before the British Association.

107 Cutlish Machines
& Models of Science
Sept 1, 1852

THE CUTTRISS ELECTRO-MOTOR.

ONE of the objects of interest to be seen at the exhibition now being held at Stratford is a small electro-motor, called the "Singer" sewing-machine, a description of which will doubtless interest many of our readers.

The accompanying engraving will almost



explain itself. The total weight of motor, with tools—keys, &c.—is 7lb.; the armature, "a Siemens," is 1in. diam. by 2¼in. long, which, with a current from six cells, attains a speed of about 2,000 revs. per min., when running light. The motor has been so applied to any sewing-machine, the power being transmitted to the periphery of a hand-wheel by means of a rubber friction-ring on the motor-shaft, which makes a very simple and effective means of driving.

When not required, the motor may be disconnected, leaving the sewing-machine capable of being driven in the usual way. The average speed obtained by the one under notice is 150 stitches per minute, which may be increased as required by the simple pressure of the foot upon a treadle connected with a battery of six Schumacher cells, each size being 2½in. by 2in. It need scarcely be added that the motor is capable of being applied in various ways, such as the driving of fans, light lathes, &c.

The motor, which are of various sizes, are manufactured by Messrs. Cuttriss, electricians, Leeds.

Edward A. James
C. Henry Gordon
Dec 7. 52

DYNAMO ELECTRIC MACHINERY.

ON Monday night Professor Silvanus P. Thompson, B.Sc., delivered the first of the Cantor lectures for the Session. Dynamo-electric machinery in the hall of the Society of Arts. Professor Thompson said that the name "dynamo-electric machine" was first applied by Dr. Werner Siemens to the magneto-electric machine in January, 1867, to the Berlin Academy. He there described a machine for generating electric currents by the application of mechanical power, the currents being induced in the coils on rotating an armature. The principle of electro-magnetic rotation which were then employed by the currents so generated. Since the great application of electric lighting it had been found convenient to use the generating machines in certain combinations in which the self-exciting principle was abandoned. The main principle of the dynamo-electric machine was the following:—If a coil of wire be rotated in a magnetic field, caused currents to be excited with those conditions. If the term was now applied, dynamo-electric machines were machines for converting energy in the form of mechanical power into energy in the form of electric currents by the operation of setting conductors in the field of force of a magnet. If a wire be made in a magnetic field. The machine might be divided into three classes. The first was that in which one pair of the coils took the place in a uniform field of force upon an axis in the plane of the coil and parallel to it. The second consisted of machines in which were was the translation of the coils to different parts of the field of force, or opposite sides of the field. The third class, which had not yet come into practice, was, we understood, a modification of the first, accompanied by an endless increase in the lines of force cut, the latter being caused by one part of the conductor sliding on or round a magnet. If he were asked what dynamo-electric machine was the best he would say that none was theoretically perfect, one might be better for one class of work and another for a different description. This being so, he might say that everything was in favour of his machine, which he was then illustrating by diagrams and by experiments. The subject of the succeeding lectures is to be the dynamo in practice and the dynamo as a motor.

DYNAMO-ELECTRIC MACHINERY.*

By Prof. S. P. Thompson, B.A., D.Sc.

(Continued from p. 625.)

Commutators, Collectors, and Brushes.

61. COMMUTATIONS and collectors being liable to defects, should be passed through inspection, and if any sparking should be made of very substantial good workmanship.

62. In the case of a collector made of parallel bars of copper, ranged upon the periphery of a cylinder, the separate bars should be capable of being removable singly, to admit of repairs and renewals.

63. The brushes should touch the commutator or

* Extracted from the Cantor Lectures, delivered before the Society of Arts.

the collectors at the two points, the centralities of which are respectively the highest and the lowest points of the circumference. In a properly arranged machine, these points will be at opposite ends of a diameter.

64. The armatures of the armature itself, when traversed by the currents, should be parallel to the magnetic lines of force of the field will not run straight across, from pole to pole of the field magnets, but will take, on the whole, an angular direction, being twisted a considerable number of degrees in the direction of the rotation. Hence the diameter of armature (which lies at right-angles to the resultant lines of force in machines of the Siemens and Gramme type and parallel to the resultant lines of force in machines of the Alliance type) will be found to be the axis of the coils which form a certain angular lead. The amount of this angular lead depends upon the relation between the strength of the magnetic field and the strength of the current in the armature coils, and this relation varies in the four different types of field-magnets. In the series-wound types of field-magnets (mostly on the other), the angle of lead is nearly constant, whatever the external resistance, the speed, and the current may be, for the reason that the same, because the variations of resistance in the external circuit do not affect the current in the field-magnet coils, and hence the variables which determine the angle of lead.

65. Hence it is not always desirable to have an adjustment, enabling the brushes to be rotated through a considerable angle, so as to suit the position of the diameter of commutation for the time being. Otherwise there will be sparking at the commutator, and a part of the energy of the current will be wasting itself by causing sparks, instead of doing electrolytic force.

66. The arrangements of the collector, or commutator, should be such, that as the brushes pass from one bar to the next, no coil or section in which there is a powerful current at the time is short circuited, otherwise work will be lost in heating that coil. For this reason, it is well to arrange the collector that the several coils are not or rule on either side of the neutral position (where the effect but very slightly is produced) from one another.

67. The number of contact points between the brushes and the collector, or commutator, should be as numerous as possible, for by increasing the number of contacts, the energy wasted in each coil will be diminished inversely as the square of that number. The brushes might, with advantage, be constructed, in each of parallel lines striped of copper, each being edgewise on the collector.

Relation of Size to Efficiency.

The efficiency of a dynamo-electric machine is the ratio of the useful electrical work done by the machine to the total work supplied to the machine for driving it. Every cause which contributes to wasting the energy of the machine contributes to efficiency of the machine. In the preceding paragraphs it has been shown what the chief electric sources of waste are, and how they may be avoided. The precautions needful to obtain foremost efficiency are also pointed out. Foremost of all is that of resistance, resistance opposing electromotive force, have been delineated. The modifications of the existing parts can be introduced also by due mechanical arrangements. But one thing cannot be suddenly altered, because even the best conductors employed have a certain resistance. We have seen that the resistance of a conductor varies, and the power wasted by that resistance varies with the square of the current. In large dynamo-electric machines, the more important dimensions remain the same. There is but one way to reduce this, and that is by increasing the size of the machines. For some dimensions we have been fundamentals of large dynamo machines, not because I have any fancy for large machines, but because I have found by experience in dynamos, the largest machines may be made more efficient than the small, and more profitable to their owner. In discussing the relation of size to efficiency, I shall assume, for the sake of argument, that the machines are similar in every respect, but in size. It is assumed that though the diameter is increased, the number of turns of wire remains the same, and that the density of the magnetic field, per square centimetre, remains also constant. If the linear dimensions be three or four times greater in the machine as in the smaller, the surface of the field-magnets will be nine or sixteen times greater, and the weight of them will be more than 27 times but greater than 64 times. If the same increase of dimensions in the coils be observed (the number of lines round of turns remaining the same as before), the length of wire on the armature will be three or four times as great, and the area of cross-section of the wire will be 9 or 16 times as great as before. The resistance of these coils will, therefore, be but $\frac{1}{3}$ or $\frac{1}{4}$ part of the original resistance of the smaller machine. The field-magnets will be magnetized to the same strength as before, and the resistance of these will be unaltered. Moreover, seeing that while the speed of the machine is the same, the arm cut through by the rotating coils is increased 3 times, these coils will in the same time cut 3 times as many lines of force, or the electromotive force will be increased 3 times. Supposing the whole of the circuit to be similarly magnified, its resistance will be 3 times $\frac{1}{3}$ of the previous value.

If its magnetism is a "series"-wound dynamo, an electromotive force will be produced 9 times $\frac{1}{3}$ or 3 times greater than before. Such a current will, therefore, work more than suffice to bring up the magnetic field to the required strength—viz., 3 times the former strength. The magnetized to the same average strength, will require excitement, as slightly more than the sum of 3 times as great, is needed to produce the same magnetic field. Here an economy may be effected, by reducing not only the number of coils, and therefore the wasteful resistance of the field-magnet coils, but also the number of turns of wire in the field-magnet coils. Even if this were not done, by the former, the machine will be improved in efficiency of a "series" dynamo, the machine working through a constant external resistance. For if the speed be increased 3 times, and the electromotive force 3 times, and the external resistance remain constant, the current will be 3 times as great as before, and the power wasted in the coils will be 9 times as great as before. But the power wasted in the small machine, and it will be 3 times as much power to drive it. It is clearly an important economy if a machine costing less than x^3 per horse-power, will do 3 times as much work for any multiple of the increased ratio of efficiency. A machine which will do 3 times as much work as another, costing 3 times as much, and which can be electrically thirty-two times as powerful a machine.

Suppose the machine to be "shunt" wound, then it produces the field of force of 3 times as great as before, and the electromotive force will require 3 times as great (or 9 times as great) that the electromotive force will require 3 times as great (or 9 times as great) that the electromotive force will require 3 times as great (or 9 times as great) that

THE DYNAMO: HOW MADE AND HOW USED.—II.

By Silvanus P. Thompson.

(Illustrated.)

We have now succeeded in making and using a magnetic needle. In so doing we have learnt two important facts: (a) that steel becomes permanently magnetic when placed in proximity to a magnet; (b) that each pole of the new magnet thus formed attracts a polarity of opposite kind to that possessed by the pole of the original magnet which induced its magnetic condition—in other words, the end of the original magnet induces end polarity in that portion of the steel nearest to it, while the north pole induces south polarity.

Our next step is to surround the needle with a coil of insulated copper wire. To this end a piece of wood (Fig. 1), say 8in. thick, and of convenient breadth to hold in the hand, is prepared as a form, the edges being slightly rounded to admit of the wire being stripped off; this is then wound with about 100 ft. of No. 20 silk-covered copper wire, as shown at Fig. 2a, leaving about

6in. of wire projecting at each extremity. The four corners of the rectangle thus formed should be bound with silk, so as to prevent unwinding when the two ends are drawn out of the wooden form. The coil, on removal from the form, should present the appearance shown at A, in which the ends of the silk-lined hole in the centre are perfectly concentric in length, breadth, and height. The ends of the coil being finished off by means of a blunt pin (see

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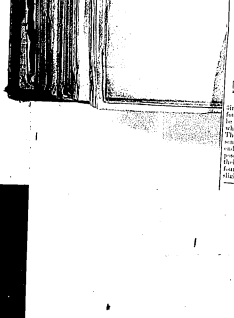
being taken not to disturb the silken covering), and the coil passed over the pin point pointed in the centre of the little boxwood chuck described (Fig. 2, and attached thereto with a little dab of hot sealing-wax, or better still with Prout's elastic cement. The needle is then replaced, and tried, to see whether it oscillates freely without catching at any point in the coil. The two free ends of the wire are now to be drawn out of their silk covering, cleaned with a bit of sand or glass paper, and attached to two small binding screws (those known as telephone binding screws, and sold at 6d. per dozen, will do admirably), inserted one at each corner of the base-board. The *commencement* or *outgoing* wire is now complete, in two steps or sections, from the coil to the binding-screw from which binding—as also from the *finishing* or *returning* wire—we shall presently take off the current. The commencement or outgoing wire is now carried from the binding-screw to the right-hand corner of the base-board, and there bent up at right angles, so as to form a stout upright, which is provided with a binding-screw at its top. The finishing or returning wire is carried from the binding-screw at the left-hand corner of the base-board to the right-hand corner, and there bent up at right angles, so as to form a stout upright, which is provided with a binding-screw at its top. The current-supplying wire is now connected to these two uprights, and the current is at once found to flow round the coil in the direction of the hands of a watch, when looking at the face of the dial. The coil is now placed in the centre of the base-board, so that the lower bend round each end passes north and south, and the needle will immediately start out from its position of parallelism with the coil, and take up a position which will approach nearer to right angles with the coil, in proportion as the current is stronger. To test whether the galvanometer just made is fairly dead-beat, attach a piece of copper wire about 12in. thick and 6in. long to one of the binding screws (to the other attach a similar piece of iron wire. Now bring the free ends of the wire (by bending within 1in. of each other. Turn the base-board round until the north end of the needle points between the two ends of the wire, perfectly parallel to the coil. Put a single drop of water on to a little piece of glass, and bring it under the two ends of the wires, which must be bent downwards for a inch to the shape of a gap, but not touch each other. By the action of the wire gap the current is now led, in the form of a thread of water, to the needle, which produces a second "current" which passes from the iron, down through the wire, along the copper wire, across into the iron, this action being continuous as long as the wire gap is in the iron. Simultaneously with this, the needle is seen to deflect from the line of the coil, and if our galvanometer is a perfect one, should stand out at 90° from the central line of the coil. Faraday's great discovery, on which all dynamos are based, consisted in proving that a magnet could be caused to excite a current, similar to that produced by the action of acids on metals. We can now repeat his experiment with the aid of our galvanometer. Let A, Fig. 3, be a rod of Ins.



soft iron, about 4in. long, bent to the shape of the letter U, and wound round its central portion with about 100ft. of No. 24 cotton-covered copper wire, the two ends of which (about a yard each) are left hanging loose. This U-shaped rod must be attached to the finishing screws of the galvanometer. If a good lasting current is required, the U-shaped rod should be a pair of coiled U's, the latter being kept continuous.

(31, 2.) It will be perceived that there is given a difference of only one 12in. between the Flat-Parallel and the Concave-Parallel Boards. The really correct addition, for Gamaging, to a Board of such Compass as the present, is 1 on 3in., but the 2in. has been here preferred because (among other reasons, given with *Import.* of Penal-Boards) as the nearest area of the Concave-Parall. Board in—for the sake of uniformity—adopted also for the Flat-Paral. Form, there should obviously not be, with the latter, too great a gap between the Shank and the extreme (end) Pitch Key. (All liability of the end Pitch Key to "drop out" is removed by the latter, by the author, obviated by the simple expedient of *running* the latter to *enter* into—not into the Frame Check. This latter thus being of course fully gone into in said *Department* of Penal-boards.)

(b.) It must thus be understood that the above Width for the Flat-Parallel Pedals is given chiefly as a matter of information, and that it is always best to make the *Actual* dimensions of any circuit, through which a Board is to be passed as a *fixture* in working, are such—somewhat less—as the limiting Stress will allow. If a correct guess be made (which previously must be made) for the parallel width of coil, by turning the base board round until the coil points north and south, the needle will immediately start out from its position of parallelism with the coil, and take up a position which will approach nearer to right angles with the coil, in proportion as the current is stronger. To test whether the galvanometer just made is fairly dead-beat, attach a piece of copper wire about 12in. thick and 6in. long to one of the binding screws (to the other attach a similar piece of iron wire. Now bring the free ends of the wire (by bending) within 1in. of each other. Turn the base board round until the north end of the needle points between the two ends of the wire, perfectly parallel to the coil. Put a single drop of water on to a little piece of glass, and bring it under the two ends of the wires, which must be bent downwards for a inch to the shape of a gap, but not touch each other. By the action of the wire gap the current is now led, in the form of a thread of water, to the needle, which produces a second "current" which passes from the iron, down through the wire, along the copper wire, across into the iron, this action being continuous as long as the wire gap is in the iron. Simultaneously with this, the needle is seen to deflect from the line of the coil, and if our galvanometer is a perfect one, should stand out at 90° from the central line of the coil. Faraday's great discovery, on which all dynamos are based, consisted in proving that a magnet could be caused to excite a current, similar to that produced by the action of acids on metals. We can now repeat his experiment with the aid of our galvanometer. Let A, Fig. 3, be a rod of 1in.

(c.) The additions and mod necessary by the Pedal Frame possessing a Check which is thicker than its, is easily calculated. (For the actual amount of Thickness desirable under various circumstances, see again the *Import.* of Penal-Boards.) Observe: the dimensions of the circuit have been assumed, throughout, although it is not necessary, to be 12in. wide. The Check which is 1in. thick will necessitate a Board of 13in. wide; and a fraction as taken across in the *foregoing* section; and it is equally manifest that such increase will go on augmenting as the angle of Radiation is made more obtuse, or that is to say, as the length of the Radius-line is shortened. Considering, however, that the employment of Checks of 1 inch *practical* may sometimes be contemplated, and that even if the full inch be noticed on, a very slight *paring off* of the Check corner will bring the Check thickness to the exact inch, the said precise inch is always to be made the basis of the calculation. Under my *additions* to the Check-thickness the same rule is observed; thus a Check which is 12in. thick is allowed for between the Plinth-Projections as 12in., but not more.

(d.) Three remains now the Addition by the Stances of the Frame-Check, in *Reference* Pedals, beyond the point of necessary-ment stated in the foregoing (6c., 6in. from the front-rise of the Key-Comb). This Spool will amount to from 2in. to 3in.—at each end of Circumference, according to the Angle of Radiation adopted, and by the actual length which each Check-portion extends beyond the 6in. point mentioned (see same *Import.* of Penal-Boards, Penal-mount). It will not, however, be necessary to take any account whatever, in this matter, for in all Instruments of which the Plinth is a complete Framing, and the Pedal-board is consequently obliged to be pushed horizontally through the middle of Getting for the Plinth (see at * next for a *departure* as respects such obligation, when a Side-frame is present), the question of non-fit only can arise when the said Cutting needs wider than the Pedal-Frame is at the point given,—for otherwise an unsightly *gap* will be visible after the Pedal-board has been pushed through into its place. In all Instruments, therefore, which possess a *complete* Pedal-Board, the Checks of a *Zig-zagged* Pedal-Frame (see Semitone or only Pedal-Frame) will never extend beyond the 6in. point given. (If there be Composition Pedal-pieces like the Combs for the Bearings of which is the chief object of this elongation of the Board-Check) they must be carried on a separate piece of Construction. Such separate piece is, remember, already a *necessity* even with Parallel Pedals, wherever the Pal.-Board is a *Detachable, Hinged, Folding, or Sliding* one.) In some instances the entire Pedal-Frame Redd may have to enter the Plinth one inch less Head of Pasty, by *Import.* of Penal-mounts, but the resultant gap is of too little dimension to be of practical importance.

(e.) It is necessary to consider the Concentric of the Manual with the Pedal-board. Hitherto it has been assumed that both Manual and Pedal Keys may be made of exactly the same respects right and left, of the Case, and yet a correct Path of both the Centres be obtained. This, however, is not so in fact, for it has been found by long practice and the wisdom of such a rule will be sidelined that a given Pedal Key must always be set in some exactly certain way beneath a given Manual Key,—whatever be the Compass of either the Keyboard or that of the Pedals.

This matter also is fully gone into under Head of Pasty, in *Department* of Penal-mount. It will be sufficient to say here that the *Manual* will—naturally—be always set at the exact right and left Centre of the Case Pedals; and that with a C Pedal-board either the CC or the CC sharp Pedal Key (preferably the latter) should be caused to fit directly beneath the Middle C of the Manual.

h. In order to aid to the utmost the correct Setting, Pedals, Manuals, and Stances, I especially the fundamental Pin of the Case as a whole—I here subjoin the exact amount of the divergences of Pedal-board from central path,—, which divergences have to be accommodated in the determination of the spaces which shall exist between the Front Projections of the Pedals. As the Manual is in all cases considered to be made to Normal Scale (*see Department of Manuals*).

i. With the Compass and Scale of the Pedals being as already understood, (at end of work), and the Pedals, Form of Board adopted, the Dimensions of the Pedal Circles will be as follows:—

With the Pedals placed C under G, and the Manual extending from CC to F' (Two Oct. and a Fourth), the Pedal-board will be 1in. too far to the *left*. This will small-ly interfere that the space between the Plinth-Projections be extended to double this amount; as a gap of 2in. will appear on the *right* of the Pedal-Frame.

If the F-sharp and G'in added to the top of the Manual, the latter, and of course the Pedals and the left hand Projection of the Plinth with it, will be driven one half of a Manual-Natural Key-distance still further to the left; and this will necessarily involve the setting of the right-hand Plinth-Projection at a half of such Key-distance to the *right*. Thus the dimension of 2in. will have to be added to the previous amount, making the clear length-distance between the Plinth-Projections to be 12in. full more than is required for the actual entry of the Pedal-Frame, and involving a gap of 2in. and 12in. full at the right hand of the said Frame.

k. If the Pedals be placed C sharp under G, the left-hand Plinth-Projection will obviously be driven 12in. yet more to the left; and the right-hand Projection must consequently be set the same amount to the right. Thus there is likewise involved an addition of 2½in. to either of the two previously given dimensions for C under G.

l. With the Stance of the Pedals set as already understood (at end of work), and the Pedals, Form of Board adopted, the Dimensions of the Pedal Circles will be as follows:—

With the Pedals placed C under G, and the Manual extending from CC to F' (Two Oct. and a Fourth), the Pedal-board will be 1in. too far to the *left*. This will small-ly interfere that the space between the Plinth-Projections be extended to double this amount; as a gap of 2in. will appear on the *right* of the Pedal-Frame.

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k. If the Pedals be placed C sharp under G, the left-hand Plinth-Projection will obviously be driven 12in. yet more to the left; and the right-hand Projection must consequently be set the same amount to the right. Thus there is likewise involved an addition of 2½in. to either of the two previously given dimensions for C under G.

l. With the Stance of the Pedals set as already understood (at end of work), and the Pedals, Form of Board adopted, the Dimensions of the Pedal Circles will be as follows:—

With the Pedals placed C under G, and the Manual extending from CC to F' (Two Oct. and a Fourth), the Pedal-board will be 1in. too far to the *left*. This will small-ly interfere that the space between the Plinth-Projections be extended to double this amount; as a gap of 2in. will appear on the *right* of the Pedal-Frame.

If the F-sharp and G'in added to the top of the Manual, the latter, and of course the Pedals and the left hand Projection of the Plinth with it, will be driven one half of a Manual-Natural Key-distance still further to the left; and this will necessarily involve the setting of the right-hand Plinth-Projection at a half of such Key-distance to the *right*. Thus the dimension of 2in. will have to be added to the previous amount, making the clear length-distance between the Plinth-Projections to be 12in. full more than is required for the actual entry of the Pedal-Frame, and involving a gap of 2in. and 12in. full at the right hand of the said Frame.

k. If the Pedals be placed C sharp under G, the left-hand Plinth-Projection will obviously be driven 12in. yet more to the left; and the right-hand Projection must consequently be set the same amount to the right. Thus there is likewise involved an addition of 2½in. to either of the two previously given dimensions for C under G.

THE DEVELOPMENT OF THE PACINOTTI RING.

In our last number we had the pleasure of bringing before our readers Hulsebrink's new dynamo-electric generator, in which he employs the now classic ring armature, and, as we said on that occasion, it is rather remarkable that the most successful dynamo machines at present in use are all based on the principle of the armature ring-armature first applied by Dr. Antonio Pacinotti, of Florence, in 1860, which was first described in the *Nuovo Cimento*, which can be seen at the British Museum Library. We shall now, in this article, show the next improvement in the ring armatures in use, and Figs. 3c, 3d, 3e, 3f, 3g, 3h, 3i, 3j, 3k, 3l, 3m, 3n, 3o, 3p, 3q, 3r, 3s, 3t, 3u, 3v, 3w, 3x, 3y, 3z, 3a, 3b,

THE BRUSH SYSTEM OF ELECTRIC LIGHTING.

By CHARLES F. BRUSH, M.E.

The Dynamo-Electric Machine.

THE most prominent peculiarities of the Brush dynamo-electric machine are embodied in the armature, the arrangement of field magnets, and the commutator. The armature consists of a flat ring of soft cast iron, revolving in its own plane. Upon the periphery of this ring are a number of projections, or masses, of iron, insulated from each other, all in such a manner as effectually to prevent the formation of any complete circuit of iron around which when it is revolved in a magnetic field. On this ring are wound eight ribbons of armature conductor, whose places radiate from the axis of rotation. The ribbons are wound in the same direction, and each lies in the plane of the armature. The ends of its conductor are exposed to the direct inductive influences of the magnets. This arrangement of armature and magnets differs radically from that adopted in the Gramme machine, the only other machine of any commercial importance in which armature conductor is employed in which the conductor exposes polarity as applied to dynamo-electric machines. The armature is composed of a large number of thin plates of soft annealed iron, each insulated from the others by a thin coating of paper, and held together by two polished bronze heads. Each of these laminæ is punched with eight slots, and would have in this condition eight projecting masses of iron, corresponding to the eight slots of the armature, which would be magnetized by induction from the field magnets. To avoid this, and to secure the greatest possible efficiency of the armature, each plate is punched with eight additional slots, which are so placed as to bisect the projecting masses of iron, and thus to divide each of them into two parts. The armature is then built up of these plates, with the slots in each plate exactly opposite those in the plate next to it, and the eight ribbons of armature conductor are wound in these slots. The armature, when built, is in the form of a cylinder, with eight longitudinal slots in its surface, in which the armature conductor is imbedded. The ribbons of wire are wound in the same direction, and each lies in a plane at right angles to the axis of the armature. The ends of the ribbons are connected to the commutator (the contrivance in the dynamo-electric machine for changing the direction of the current which is generated in the armature), in such a manner as to form a continuous circuit around the armature, in which the electromotive forces generated in the several ribbons are added together. The commutator is composed of a number of copper bars, insulated from each other by sheets of mica, and held together by a metal ring at each end. The ends of the armature conductor are connected to the commutator bars in such a manner as to form a continuous circuit around the armature, in which the electromotive forces generated in the several ribbons are added together. The commutator, corresponding to the number of armature ribbons, has eight bars, and is so placed upon the shaft with reference to the field magnets, that each bar is in contact with the brush when the plane of the armature ribbon connected with it is at right angles to the lines of force, and each armature ribbon is thus commutated when it is in the position in which it is most powerful, and when no current is developed in it by its passage through the field magnets. The commutator, corresponding to the number of armature ribbons, has eight bars, and is so placed upon the shaft with reference to the field magnets, that each bar is in contact with the brush when the plane of the armature ribbon connected with it is at right angles to the lines of force, and each armature ribbon is thus commutated when it is in the position in which it is most powerful, and when no current is developed in it by its passage through the field magnets. The commutator is constructed with great care, and is one of the most important parts of the machine. Each bar is insulated from the shaft and from the adjacent bars, and is connected to the armature conductor at the proper point. The brushes which collect the current from the commutator are made of fine copper wire, and are so placed as to touch the bars when the armature conductor connected with them is in the position of most powerful induction. The brushes are supported upon a brass arm, which can be moved around the commutator, and secured in any position. The position usually adopted is that in which the brushes are in contact with the bars when the armature conductor connected with them is in the plane of the lines of force. In this position the current developed in the armature ribbons is directed entirely around the armature, and does not pass across from one brush to the other. The brushes are connected with the binding screws on the base of the machine, which are connected with the external circuit.

The Field Magnets.

The field magnets are of cast iron, and consist of two parts, the base and the cores. The base is a single casting, and consists of a flat bed, with two upright projections, which support the ends of the cores, and which are bored out to receive the bearings of the armature shaft. The cores are also castings, and are secured to the base by screws. The pole pieces are of cast iron, and are secured to the cores by screws. The coils of insulated copper wire which surround the cores are wound upon bobbins, and then drop over the cores, and are secured in place by the pole pieces.

The Commutator.

The commutator, which is one of the most important parts of the machine, consists of a number of copper bars, insulated from each other by sheets of mica, and held together by two metal rings, one at each end. The ends of the armature conductor are connected to the commutator bars in such a manner as to form a continuous circuit around the armature, in which the electromotive forces generated in the several ribbons are added together. The commutator, corresponding to the number of armature ribbons, has eight bars, and is so placed upon the shaft with reference to the field magnets, that each bar is in contact with the brush when the plane of the armature ribbon connected with it is at right angles to the lines of force, and each armature ribbon is thus commutated when it is in the position in which it is most powerful, and when no current is developed in it by its passage through the field magnets. The commutator is constructed with great care, and is one of the most important parts of the machine. Each bar is insulated from the shaft and from the adjacent bars, and is connected to the armature conductor at the proper point. The brushes which collect the current from the commutator are made of fine copper wire, and are so placed as to touch the bars when the armature conductor connected with them is in the plane of the lines of force. In this position the current developed in the armature ribbons is directed entirely around the armature, and does not pass across from one brush to the other. The brushes are supported upon a brass arm, which can be moved around the commutator, and secured in any position. The position usually adopted is that in which the brushes are in contact with the bars when the armature conductor connected with them is in the plane of the lines of force. In this position the current developed in the armature ribbons is directed entirely around the armature, and does not pass across from one brush to the other. The brushes are connected with the binding screws on the base of the machine, which are connected with the external circuit.

It will now be seen that only one pair of armature ribbons is out of the general circuit at one time, and that the number of armature ribbons in series in each section of the circuit between the points of attachment of the brushes to the armature, and are not in multiple arc, with relation to the general circuit. Now, if it were not for the "insulation" above described, the idle bobbins would afford an easy passage for the current that is in the active bobbins, and thus destroy the efficiency of the machine.

The Operation.

The operation of the commutator, which is employed for the purpose of changing the direction of the current developed in the armature ribbons, is as follows: The brush, moving from the position in which it receives the current from one of the armature ribbons, comes in contact with the bar which is connected with the next ribbon in advance, and thus establishes a circuit from one of the terminals of the machine, through the armature ribbon, and thence to the

Total power developed with the 16-light machine at 775 revolutions "closed" ..... 18·73 H.-P.
Less friction load of engine "light" ..... 2·11 "
Less friction due to increase of load (19·73—2·11 = 17·62) at 5 per cent. ..... 0·81 "
Total power consumed by 16-light machine at 729 revolutions "closed" ..... 15·81 "

Total power developed with the 16-light machine at 775 revolutions "open" ..... 4·23 "
Less friction load of engine "light" ..... 2·11 "
Less friction due to increase of load—(4·23—2·11 = 2·12) at 5 per cent. ..... 0·05 "
Total power absorbed by 16 light machine at 729 revolutions "open" ..... 1·70 "
Total power consumed by 16-light machine at 729 revolutions in the production of current (15·81—1·70) ..... 13·73 "

Note.—The terms "closed" and "open" refer to the external circuit of the machine. Thus when the machine was "closed," the current was working through the normal external resistance—the sixteen lamps. When "open," no current was generated.

These results agree very well with those obtained by other engineers with other machines of the same normal style. On February 6, 1878, Mr. Schuyler Hatton, of the Lowell Water Power Co., measured the power absorbed by one of these machines, which maximum tested in the Merrimac Print Works, and found that it required 2·5 H.-P. for the unexcited machine, and 7·5 H.-P. when the machine was operating sixteen normal lights, and the total power absorbed under these circumstances was found to be 11·93 horse-power, including friction of large pulleys and belts.

On March 26, 1878, another machine was measured at the Franklin Institute, Philadelphia, Pa., by Mr. Charles Bullock, Jr., and Mr. Leo Daft, of the Bullock-Daft Engine Co., of New York. Mr. Bullock employed the method of indicator diagrams, and obtained as a result 13·5 horse-power for the total power absorbed in the production of the sixteen lights. The speed of the machine was 1,200 revolutions per minute, and the total number of revolutions per minute of the two armatures (which was the speed at which the machine should run) was 2,400.

The higher results obtained by Mr. Bullock are probably due to the exact speed at which the machine was driven, and the abnormal friction at the journal bearings of the engine.

Referring to the experimental measurements already recorded, we find that we have a resistance of 1·5 ohms, with a total electromotive force sufficient to give the value in foot-pounds of any current in C.G.S. units. The total resistance in the circuit is 9·62 ohms. The total resistance in the circuit in ohms, the time in seconds, and the current in amperes, the product of one value per second by the other gives the energy value in foot-pounds per second. Hence, the energy from the total-circuit machine is found as follows:

$$9{\cdot}62 \times (4{\cdot}16)^2 = 9{\cdot}62 \times 17{\cdot}30 = 166{\cdot}42 \text{ foot-pounds per second.}$$

$$166{\cdot}42 \times 746 = 124{,}153{\cdot}32 \text{ ergs per second.}$$

$$124{,}153{\cdot}32 \times 10{,}000{,}000 = 1241{,}053{,}200{,}000 \text{ ergs per second.}$$

$$1241{,}053{,}200{,}000 \div 746 = 1{,}663{,}610{,}455 \text{ foot-pounds per second.}$$

$$1{,}663{,}610{,}455 \div 33{,}000 = 50{,}412 \text{ horse-power.}$$

Again,

$$\frac{16 \times 746}{33{,}000} = 0{\cdot}3618$$

horse-power required to drive the sixteen lamps, 72·9 per cent. of the total power applied in the motive power of the machine was converted into current. We have also found that 50 per cent. of the current was converted into light. Multiplying these two percentages together, we have 36·45 per cent. as the percentage of the total driving-power appearing in the arcs.

The other frictional and resistance of air-friction are power absorbed, and consider only the power actually employed in the production of current, as usually done in determining the efficiency of dynamo-electric machines, we have

$$\frac{16 \times 746}{19{,}773} = 0{\cdot}6039;$$

or 60·39 per cent. of the absorbed power converted into current. As before, 50 per cent. of this current appearing in the arcs, we have $0{\cdot}50 \times 0{\cdot}604 = 0{\cdot}302$ per cent. of the power absorbed in the production of current, present as heat and light in the sixteen arcs.

RECAPITULATION.

Resistance of dynamo-electric machine	1·05 ohms.
Resistance of external circuit	7·26 "
Total resistance of circuit	8·31 "
Resistance of 16 volatile arcs	1·00 "
Total resistance of circuit available for external work	8·31 "
Percentage of current appearing as heat and light in the volatile arcs	84·02
Electro-motive force of current	42·042 volts.
Volume of current	10·01 webers.
Energy of current expressed in foot-pounds	17·62 H.-P.
Deduct power absorbed by production of current	1·74 "
Energy of current expressed in horse-power	15·88 "
Percentage of gross power converted into current	72·90 "
Percentage of absorbed power converted into current	89·93 "
Percentage of gross power appearing in arcs	49·24 "
Percentage of absorbed power appearing in arcs	59·79 "

These results require no comment. Their excellence is apparent. They have not yet been surpassed by those of any other dynamo-electric apparatus operating multiple lights; or even by those operating single lights.

The following results are excellent "Recent tests of the Brush system of electric lighting," printed London Nov. 1, 1878, Mr. Brush's machine, of advanced power upon any in the electric lamp, in the cases of four dynamo-electric machines. The lowest result given was 84·02, the highest 87 per cent., the latter with a machine of Mr. Brush's own. This is much the highest efficiency we have yet seen reported authentically of any dynamo-electric machine, and it has been obtained only under the most favorable circumstances, as pointed out by Mr. Schwendler, with a machine fitting it single light, and developing a large volume of current (270 webers) of a comparatively low electro-motive force.

The Brush machine, developing a much smaller volume of current, and a much higher electro-motive force, and operating sixteen lights, yet shows a much higher efficiency, 84·02 per cent.

From the peculiar nature of the Brush system of lighting, it is very important advantages over other systems, not yet touched upon. We refer to the great variety in the lights which may be employed in connection with the dynamo-electric machine, and the small loss of effect occasioned by change.

When a separate dynamo-electric machine is employed for each light, according to the system which appears to be most in favour in England and France, the failure of any one machine involves the extinction of one light. Hence, in these countries a lamp must be independently regulated, with the object to keep the supply of current consumed by the resistance of the arc of consistency, and not upon each single lamp. There are, therefore, many complete sets of conductors as there are lamps.

In the Brush system, one pair of conductors is sufficient for all the lamps, no matter what their number may be; and the loss due to these conductors falls not on each lamp, but is equally divided between all. Hence, in order to maintain each light due to the conductors in the circuit, it is only necessary to add to the power of the machine in the multiple-light system, the current due to the conductors in the circuit, and that is very small. And, since the multiple-arc system requires as many sets of conductors as there are lamps, while the multiple-light system requires but one set of conductors, the total weight of conductors required in the former system, for keeping the total loss of effect due to this cause the same in both systems) bears a relation to the multiple-light system to the square of the number of lamps for the single-light system. To illustrate: Suppose sixteen lights are operated at a given distance from the dynamo-electric machine or machines, and the loss of effect due to resistance of conductors is limited by a certain amount, and let the weight of conductors required in the multiple-light system be represented by 1, then the weight of conductors required in the single-light system would be $16 = 256$. Hence, in operating a large number of lights at a long distance from the source of power by the single-light system, either an enormously expensive system of conductors must be employed, or else a great part of the whole energy of the currents will be wasted in overcoming the resistance of the smaller conductors.

This objection to the single-light system in fatal when any considerable separation of the machine and lamps becomes necessary.

The main system of lighting being free from this defect, the lights may be maintained at a great distance from the source of power with very little loss of effect, and by means of conductors of moderate and inexpensive size. For example, No. 10 (B&S gauge) copper wire measures nearly in about 0·6 ohm per thousand feet; therefore 1,000 feet of such a conductor will equal in resistance only one of the sixteen lamps already described:

$$\frac{1{,}000}{0{\cdot}6} \times 1{\cdot}5 = 1{,}666 \text{ feet.}$$

1,666 feet of such conductor would be exercised by breaking through such a conductor more than 11 miles in length (11·3611), and this loss might be lessened one-half by doubling the size of the conductor, which would still be of very inexpensive dimensions.

No reference has yet been made to the arc of more than sixteen lights. The machine No. 7 will operate over 100 arcs; but 17 or 18 lamps are often employed with the machines running at its normal speed of 720 revolutions per minute, and with good effect, although the total light produced is less than with sixteen lamps. At the speed at which the above recorded measurements were made, viz., 729 revolutions per minute, twenty lamps may be burned with tolerably good effect, although the maximum amount of light is obtained with sixteen lamps.

At any rate, thirty-three lamps have been operated simultaneously in the circuit of a No. 7 machine running at a speed of 850 revolutions per minute. The current was somewhat irregular in such lamps, but the total light produced was less than half that obtained when the machine was driven at its normal speed. If the number of lamps operated by the No. 7 machine, running at full speed, is reduced below sixteen, the brilliancy of the remaining lights is of course increased, but not in proportion to the reduction in number. Hence the full amount of light is diminished. The quantity will be increased by the current as much as to produce the maximum effect of the arc.

At the time Mr. Hollister measured the power required to drive the six-light machine, he also ascertained that required by a six-light machine of the new and style known as "No. 5."

This machine furnishes six beautiful light in single circuit, similar to those of the No. 7 machine, but with somewhat shorter arcs. (It will be remembered that the No. 7 machine was since altered to several new forms.) The total power required to drive the machine at its normal power was Mr. Hollister's figures:

Total power developed with the 6-light machine at 952 revolutions "closed"	7·13 H.-P.
Less friction load of engine "light"	2·11 "
Less friction due to increase of load (7·14—2·11 = 4·79) at 5 per cent.	0·24 "
Total power required by 6-light machine	4·79 "

No measurements of the current from this machine were made.

Remarks.

Much has been written by eminent electricians and others as to the enormous loss of total light, efficiency of arc, when the use of more than one light is made of the current from a single machine. It is true that the total light diminishes as the number of lights increases; others that the total light per arc is one of the number of lights.

These extraordinary assertions are made without any reference to the energy or character of the current employed, and are never supported by any exact measurements.

The experiments of the writer have uniformly shown that when a small amount of electrical energy is expended at several points, very little or no light results; while if the same energy be properly expended at one point, a large amount of light may be obtained. On the other hand, when a large amount of energy is properly expended at a number of points not too great, the total light produced may nearly equal that obtained when the whole energy was concentrated at one point.

A certain amount of energy is required before the light will fall to produce, and if the division falls below this, nothing in the way of light results. But after this point is reached, at which a good light is produced, then the increased light appears to be almost directly as the number of lights employed in the arc, the length of the latter remaining constant. Mr. Schwendler's experiments have appeared to coincide with our own, as he expressly declares, he says: "If the main current be divided into several branches, that the resistance of an arc of constant length is nearly proportional to the current which passes through them the light produced would be proportional to the current. This appears to be the case." Again he says: "Although the light must be nearly proportional to the total energy consumed by the whole number of lights, it is almost always the case that the current is reduced that the light is not nearly proportional to the number of the current."

It is argued by many that an increase of energy in the arc causes a corresponding increase of temperature in the crucen, and that, according to the laws of heat, the light will be more intense and better than the temperature. But, in fact, when certain point is reached, the temperature of the positive or light-giving carbon does not increase with increase of current, but the area of surface heated to maximum increases almost directly with the current. The "certain point" several times mentioned is that at which the volatilization of the carbon takes place over a considerable area on the positive carbon. Obviously, when rapid evaporation has commenced, the temperature of the carbon cannot be increased in that point, and an increase in the amount of heat evolved can only result in an increase in the rapidity of vaporization, and in the area of surface heated.

A careful study of the volatile arc, and of the carbon points after being used with currents of various strengths, cannot fail to convince the unprejudiced of the truth of these assertions.

Quite contradictory to the spirit of these portions of Mr. Schwendler's report already quoted, he says in another place: "The light of the arc is found to be almost in the same circuit by the same current, the external or available light becomes rapidly greater with increase of the number of lights attached. For this reason already, if not for many others, the division of light must result in an engineering failure."

Here we recently results that Mr. Schwendler has apparently established the fact that a current expending a given amount of energy, and adapted to produce the maximum light from one center, may, by having its dimensions radially reduced, have its cross-section increased and its volume diminished, while the energy remains the same, be adapted to produce its maximum light from several small centers, retaining the same total energy expenditure, and the energy of each center is not reduced below the "certain point" before defined. Yet he seems to be unconscious or entirely ignored this fact.

The performances of the No. 7 Brush machine, with its sixteen lamps thereby detailed, proves unquestionably that the division of a large current energy among many lights in the same circuit, or, more properly, the multiplication of lights on a single circuit, has resulted in a great engineering success.

The victories of the single-light system would advocate in place of the No. 7 Brush machine, the use of sixteen small machines, with their costly system of conductors. Each of these would require as much attendance and as frequent repairs as would be required by the single machine. At least 50 per cent., and probably 100 per cent. of the driving power would be required to produce the same lights of the same size, and the first cost of the separate machines would be vastly greater. Further, if the lights were required at any considerable distance from the source of power the single-light system must prove entirely impracticable.

Since writing the above, a later machine than the

English Mechanic & World of Science, p. 115, 1882.

GRISCOM'S DYNAMO-MACHINE.

WE have previously given general descriptions of Griscom's little dynamo-machine, which has, however, been chiefly exhibited as a motor driving sewing machines, lathes, &c. Some improvements have been recently patented in this country, and the descriptions, with the illustrations, will afford useful information to those who wish to construct small dynamos or electric motors. The invention relates to improvements in armatures for magneto-electric and dynamo-electric machines and motors, and has especial reference to armatures of the type known as Siemens; but it is applicable to the poles of all other magnets or armatures. It consists in dividing the bipolar circumflex of such armatures into two or more sections concentric with each other, one or more of such sections being at such a distance as to utilise the magnetic lines of force which fill the space between the two poles of the field-magnets, whilst the other section or sections are arranged so as to pass in close proximity to the poles of the field-magnets, and thus utilise the powerful attraction between the poles of the armature and magnet as the one approaches the other.

Figs. 1 and 2 represent a transverse section

FIG. 1

FIG. 2

of a magneto-electric dynamo or electro-magnetic armature and its field-magnet constructed according to the invention. Referring to Fig. 1, A is an armature of the before-mentioned type having its bipolar circumflex divided into two or more sections concentric with each other, one or more of which, as shown at M revolving or working at such a distance within the field-magnets B and C (see Fig. 2) as to utilise the magnetic lines of force which are generated and disseminated in the magnetic field or space between the two poles of the magnets.

The other section or sections P before referred to, are longitudinal ribs or projections concentric with, but extending or protruding above or beyond, the peripheries of the other sections M, so as to bring the whole armature in revolving, in close proximity to the poles of the field-magnets B and C therein. Between X, so as to concentrically utilise the lines of magnetic force between the poles of the field-magnets. The interior surfaces of the field-magnets B and C are formed or provided with projecting ribs or pieces arranged so as just to clear the projections P upon the armature A when it is revolving. In this manner the poles are caused to utilise certain magneto- or electro-inductive influences upon the extremity over approach of lines of force, while the polar surfaces are arranged so as to utilise the powerful lines of force existing between the magnetic field of the magnets B and C. The form and symmetry of size applied to the armature and field-magnets obviously depend on the dimensions of the machine to a certain extent, and absolutely only on the resistance, &c. The best size and form of parts we will therefore be a matter of calculation and experiment; but possibly some of our readers may even give the results of practical trials.

DYNAMO-ELECTRIC MACHINERY.—V.

By Prof. S. P. Thompson, B.A., D.Sc.

(Continued from p. 675.)

Armatures.

THE armatures or dynamos of the first class may be roughly classified in three groups, according to the manner of arranging the coils. These three groups are—

(1.) *Ring armatures*, in which the coils are arranged round a ring, whose principal axis of symmetry is the axis of rotation.

(2.) *Barrel armatures*, in which the coils are wound longitudinally over the surface of a drum or cylinder.

(3.) *Tide armatures*, having coils wound on separate pole-pieces, projecting radially round the periphery of a circular central hub.

(To these we shall add a fourth form, namely,

Disc armatures, in which the coils are flat, and lie in one plane, parallel to the face of the disc.

In all of these armatures the individual coils occupy a diametrical space, and when there is a cylindrical core, but the mode of connecting up the separate diametral sections is not the same in all. In the older of the Alliance-Siemens windings the sections were not connected together symmetrically, but in succession (for an eight-part reflector) being on the plan first in the more recent machines a symmetrical plan has been adopted, as shown in Fig. 20.

FIG. 20.

Alliance-Siemens Winding (new).

In this system, as in the Gramme ring, the successive sections of coils ranged round the armature are connected to successive bars of the collector. Each section and the beginning of the next being both united to one segment or bar of the collector. A symmetrical arrangement is, of course, preferable, not only for ease of construction, but because it is important that there should never be any great difference of potential between one segment of the collector and the next. In the present case this effect will be produced feebly at each, and force pass across the intervening gap. In Edison's modification of the drum-armature, the winding, though symmetrical in one sense, is singular, inasmuch as the number of sections is an odd number. In the first machines there were seven poles, as shown in Fig. 21. In his latest machines the number

FIG. 21.

Edison's Winding.

of sections is forty-nine. One consequence of this peculiarity of structure is that if the brushes are set diametrically opposite to one another, they will not pass at the same instant from one coil to the next, but from one coil to one which will be shortcircuiting one of the sections, whilst the other is at the middle or the opposite collector. The armature of those kind of Edison's dynamos, which is not wound up with wire, but, likewesise of Siemens's electro-plating machine, has a number of bars or blocks of copper arranged around the periphery of the core. The coils are symmetrical arcs by washers or disks of copper, insulated from each other, and having projecting lugs, to which the copper bars are attached. Each bar thus connects the terminal arcs from more straight coils. The connections are made in the following order:—Each of the forty-nine bars of the collector is connected to one of the forty-nine discs at the anterior end of the drum, which is connected by a lug-piece on one side to one of the ninety-eight copper bars. The current proceeds in this bar near to the further end of the machine, enters a disc at that end, crosses the lugs, and returns along a bar diametrically opposite that along which it started. The anterior end of this bar is attached to a lug-piece of the next disc to that which received the current, and the current thus crosses this disc to the lug to which the coil is attached, and so round again. The two lug-pieces of the individual discs at the anterior end are, therefore, not exactly opposite each other, diametrically, as the consecutive advance through $\frac{1}{49}$th of the circumference at each of the forty-nine discs.

Before passing on from the subject of armatures it is worth while to mention the peculiarity of form of the Hopkinson armature, which has already been spoken of as consisting of eight, or in the newest Hopkinson machines, as constructed by Mr. R. E. Crompton, of ten rings, set side by side. Each ring is built up of thin annular plates of iron, separated by open light metal spaces, which meet the centre of the hexagon. Over this hexagonal frame-work coils of covered copper wire are wound, being thicker at the six points intermediate between the spokes, thus making up the form of each ring to nearly a circle. Each of the six coils is separated from its neighbour by a space of $\frac{1}{6}$th of the circle, and each $\frac{1}{6}$th of the circumference in advance of its neighbour, so that the six separate coils are in fact arranged equidistantly and symmetrically, as viewed from the end round the axis. There is, however, a slight defect in which is unsymmetrical, and which is of importance, and that is that the coil that is one-sixtieth in advance—that is, to the anticlockwise coil of the next ring. The armature has the great practical advantages of being easy to construct, light, and with plenty of ventilation.

In the Elphinstone-Vincent dynamo there is a three-armature of a somewhat ballet order, the separate coils being made of a rectangular form, and their ends upon the sides of a hollow pagoda[1] drum in an overlapping manner, and curved to fit it. The field is a complex one, with an external and six internal poles, and is very powerful magnetically. The coils are wound in two parallel lengths about each, and are connected together as to work as three machines, and feed three pairs of brushes; which may again be worked, either in series or in parallel, or may be used to feed three separate circuits.

Collectors.

In a well-arranged dynamo of the first class, the sections of the collector are insulated by cement, or by mica, from the axis, and are also insulated from each other by mica, or by air, and great at that part of the collector which touches the positive brush, the potential is equal to that of the circle formed by collecting cylinder, in both directions, becoming a maximum at the opposite side where the positive brush is. This can be verified by connecting one terminal of a voltmeter to the axis of the drum, and touching the rotating collector at different points with the other terminal, a small metallic brush resting attached by a wire to the other terminal of the voltmeter. If the indications thus obtained are plotted out round a circle corresponding to the circumference of the collector, the values give a curve like that shown in Fig. 22, which is obtained from observations taken upon a Gramme machine.

If this curve be then, taking the negative brush as the lowest point of the circle, the potential rises perfectly regularly to a maximum at the positive brush. The same values are also plotted rectangularly in the curve shown in Fig. 23, in which the ratio of distance shown very nearly that the rise of potential is not equal between each pair of bars, otherwise the curve would consist merely of two oblique straight lines, sloping right and left from the central point. It is the existence of these small little differences of potential between the collector bars which causes the brush on its right and left respectively. The greatest difference of potential occurs where the curve is steepest, at a position nearly 90° from the brushes, in fact, at that part of the circumference of the collector which is midway between the brushes, or at the end of the insulation which separates the two field positive brushes. When the field positive brushes. When the field positive brushes. When the

DYNAMO-ELECTRIC MACHINERY.

ON Monday night Prof. Silvanus P. Thompson delivered the second of the Cantor lectures for the session 1882-3 on Dynamo Electric Machinery in the hall of the Society of Arts, Adelphi. Dealing with the dynamo in practice, he said that the first point to consider was the forms of combination used for producing either constant strength in the current or constant difference of potential. Next, as to the principles of construction, the action of the machine must be entirely automatic, so that the removal of lamps from one part of the circuit should not in the least affect any other part. Turning to various points in which theory had been put into practice in different developments of dynamo-electric machines, he commenced on the forms of the magnets, the pole-pieces, and the methods of construction of same. He then pointed out the essential differences between the continuous current machine and an alternate current machine, and the peculiar arrangements of the more interesting types, such as those of Zilliwell, Brush, and Gülcher, and the distribution of potentiality on the commutators of dynamos he had particularly examined, and he referred to the theory of the alternate current machine, and to the best form for the construction of armatures and field magnets. He might observe that science had now advanced so far that it could point out how machines could be constructed with a full knowledge of what their actual performances would be. The subject of the succeeding lectures is the dynamo as a motor.

DYNAMO-ELECTRIC MACHINERY.—VI.*

By Prof. S. P. Thompson, B.A., D.Sc.

(*Continued from p. 491.*)

The Brush Dynamo.

BEFORE passing on to the dynamos of the second class, in which currents are branched off from main non-continuous or non-annulated armature machine, the Brush dynamo. In this machine the ring is form, not simply the overwound with coils, but having projecting teeth between the coils like the Pacinotti gramme wheel. Though it thus resembles Pacinotti's ring, it differs more from the Pacinotti machine than the Pacinotti machine differs from the Siemens machine. The coils are connected in pairs, each to that diametrically opposite, and the junctions are connected to the segments of the commutator, which, in the case of a ring of eight coils, there are four distinct segments, future side by side upon the axis—one for each pair of coils. The brushes are arranged so as to touch at the same time the commutators of two pairs of coils, the diameter of two adjacent pairs; the adjacent commutators being always connected to two pairs of coils that lie at right angles to one another in the ring. The arrangement is best studied graphically from the diagram given in Fig. 25. In this figure, the eight coils are numbered as four pairs, and each pair has its own commutator, the two halves of the outer end of the wire of each coil, the four ends of the two coils being united across to each other, and to the four segments of the commutator. Each pair of coils, as it passes through the position of least action, is then in the plane at right angles to the direction of the lines of force in the field, and when the number of lines of force passing through it is a maximum, and the rate of change of these lines of force a minimum, the current in the coils is zero. This is occasionally by causing the two halves of the commutator to be separated from one another by a greater breadth of the circumference at each side. In the figure it will be seen that the coils marked 1, 1, are "cut out." Neither of the two halves of the commutator touches the brushes. In this position, therefore, the coils 2, 2, at right angles to 1, 1, are in the position of greatest action, and the current powerfully induced in them flows round the coil marked A, which is, therefore, the negative branch into that marked A'. This branch is connected across

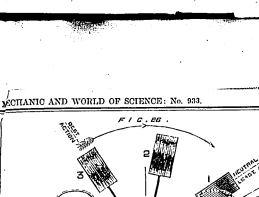


DIAGRAM OF THE BRUSH DYNAMO.

to the brush marked B, where the current re-enters the armature. Now, the coils 2, 2, have just left the position of best action, and the coils, 1, 1, are beginning to approach that position. Through both these pairs of coils, therefore, there will be a partial current flowing as yet. Accordingly it is arranged that the commutator, on passing into this phase, is going through a gap in the brush, and, while the coil connecting at the brush B, whereto the current flows round the coils of the field-magnets to earth and then round the external circuit, and back to the brush A. (In some machines it is arranged that the current shall go round the field-magnets after having brush A, and before reaching brush B.) Now, in this position of the machine, in succession, though not theoretically described as causing its coils, as they rotate, to cut the field-magnets and the external circuit alternately. The rotation of the armature will then bring coil 2, 2, into the position of least action, when they will be cut out, and the same action is repeated again. Only a slight change in the order of operations is needed, following table summarises the successive order of connections during a half-revolution:—

First position. (Coils 1 cut out.)

$$A - 3 - A; B \lessgtr \frac{}{} B; \text{Field-magnets}$$

$$\text{— External circuit —} A.$$

Second position. (Coils 2 cut out.)

$$A \lessgtr \frac{}{} A; B - 4 - B; \text{Field-magnets}$$

$$\text{— External circuit —} A.$$

Third position. (Coils 3 cut out.)

$$A - 1 - A; B \lessgtr \frac{}{} B; \text{Field-magnets}$$

$$\text{— External circuit —} A.$$

Fourth position. (Coils 4 cut out.)

$$A \lessgtr \frac{}{} A; B - 2 - B; \text{Field-magnets}$$

$$\text{— External circuit —} A.$$

From this it will be seen that whichever pair of coils is in the position of best action, is delivering its current into the circuit; whilst the two pairs of coils into the positions of least action positions are always joined in parallel, the same pair of brushes touching the respective commutators of both.

One consequence of the peculiar arrangement thus adopted is, that measuring the potentials round one of the commutators with a voltameter gives a wholly different result from that obtained with other machines. For example, when the circumference on either side of the positive brush, there is no sensible difference of potential. Then these coils remain in which the potential appears to fall off; but the falling off is only partly due to the shorter time during which the adjustable coils remain in contact with the volameter and the fixed positive brush as both in contact with the same part of the commutator. There is a certain short region in which the voltmeter gives no indication corresponding to the cut out position; and upon on each side of the negative brush, there is a region where the potential is the same as that of the negative brush. Fig. 27 is a diagram of the results that are taken at one commutator, the main—brush being, as before, supposed to be on the usual position, in contact with both the commutator and the adjacent one.

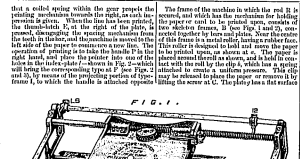
From the foregoing considerations it will be clear that the four pairs of coils of the Brush machine really constitute four separate machines, each delivering alternate currents to a commutator, which commutator is in its turn split into a number of current-bits in the brushes; and that these independent currents are subsequently united in parallel arc, the device of bringing pairs of brushes into contact with the commutators of two pairs of coils. Further, that these joined machines are then connected in series, by bringing a connection round from brush A to brush B.

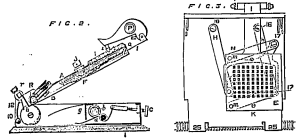
The following experiment illustrates the independence of the four pairs of coils in the Brush dynamo.* The usual commutators of a small

Brush dynamos were removed and replaced by eight insulated segments, two for each coil, and the brass collars, to each of which was united one end of one of the four pairs of coils. And upon these rings pressed eight separate brushes, and the eight

that a coiled spring within the gear propels the printing mechanism towards the right, as each impressing stroke is made, the line has been printed, the thumb-stud, A, at the right of the plate, is pressed, disengaging the pinion-wheel, and allowing the teeth in the bar, and the machine is moved to the left side of the paper to commence a new line. The operator of printing is to take the handle P in his right hand, and place the pointer into one of the holes in the index-plate (shown in Fig. 2—which will bring the corresponding type at P (see Figs. 2 and 3), under the pointer. The printing-action of type-frame, I, to which the handle is affected opposite

The frame of the machine in which the rod R is secured, and which has the mechanism for holding the paper or card to be printed upon, consists of two skeleton frames, B (see Figs. 1 and 2), connected by the bars, C, supported by the feet, D. Portions of this frame is a metal-rolled, hardened rubber face. This roller is designed to hold and move the paper to be printed upon, as shown at e. The paper is placed around the roll as shown, and is held in contact with the roll by the slip, d, which has a spring attached to create a uniform pressure. This slip can be released by the two levers, f, and g, when lifting the screw at G. The platen has a flat surface





to the post J, and over a small opening in the bottom plate B; so that a slight pressure carries down the whole plate A, swinging on hinges O, O, and the post J presses the type to be used through the opening, and on to the paper, which rests on our flat-topped bar p, while all the motion is given to the type-bearing plate A, and the bottom plate B is at the different characters on each. The types are continually changing their position on the post, and the ink is continually distributed and re-applied. Two spring-arms, Q, raise the plate A, and type-frame with it, from the paper until the next stroke or impress is removed.

Form F (see Fig. 3) containing the type and other characters for which there are 72 in all, is made of brass material, especially prepared for that purpose.

This form is attached by screws to the frame-plate. Each individual type and character in the form to be printed is brought under the type-bar, and in front of the paper, by the index-plate by a very ingenious piece of mechanism. The printing of the paper is effected to regulate the pressure upon the types to the greatest nicety, the plate A going down in a step.

The mechanism above mentioned may be understood by an inspection of Fig. 3, where the under side of the plate A is shown. The letter F is pivoted to the main plate at one or links at so, so. These links are also pivoted at 17, 17, to the frame K, having a curved slot to admit the post J. This frame is pivoted to one end of the links H H, while the other ends are pivoted to the plate A at 16 16.

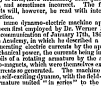
From this it will be seen that a pantographic motion is produced when the plate A is moved vertically upon the frame K, allowing it to move freely in all directions. When a word has been completed, a space is made by depressing the key S with the little finger without letting go of the handle.

DYNAMO-ELECTRIC MACHINERY.—II.*

By Prof. S. P. Thompson, B.Sc., D.Sc.

THE brief records of the lectures recently delivered by Prof. S. P. Thompson, before the Society of Arts, have successfully been quite inadequate, and sometimes incorrect. The following extracts will, however, be read with interest and advantage.

The same dynamo-electric machine appears to have been independently made by Mr. Varley, and in his recent lecture of January 12th, 1867, to the Berlin Academy, in which he described a machine for generating electric currents by the application of mechanical power, the currents being induced in the coils of a winding armature by the action of electro-magnets, which were themselves excited by the same currents. Mr. Varley's machine was, in fact, a self-regulating dynamo, with the field-magnets and armature united "in series" to the external circuit, or what we now call a "series-dynamo," a diagrammatic representation of which is given in Fig. 1. But the term dynamo-electric machine,



THE SERIES DYNAMO.

then introduced into electric technology, has not remained then restricted to its successful meaning. It was extended to machines of kindred nature, in which, though self-excited, only a portion of the current was utilised externally, the remainder was applied to excite the field-magnets (see Fig. 2).

THE SHUNT DYNAMO.

This principle of working (now known as that of the "shunt-dynamo"), first introduced by Wheatstone, is but a variation of the former arrangement in detail, and no violence is done to the original meaning if we apply it to both cases. In fact, the name was evidently so being convenient in practice for distinguishing between machines in which the whole current was utilised, and those which either used magnets or self-excited machines in which the current was divided between the external circuit and the magnetic field.

Since the great development of electric lighting has been found necessary to use generating machines in certain combinations, in order to obtain the best results. Thus, in machines where systems of electric light involve alternating currents, produced in machines which cannot excite their own magnets with a continuous magnetisation; and there are other systems where continuous currents are employed, in which also practice has shown that the currents are better regulated when they are not employed to excite the magnets which by currents derived from an outside source. Then, a third class of dynamo-electric machine, the "separately-excited dynamo" (Fig. 3), which was indeed earlier than either of the preceding, having been brought out by Wilde in 1864. A

combination of bones. Continuing the subject of compound eyes for a short space, he would make two experiments with a solar microscope. To some present they might be familiar, but they would be new to most of them. In the sunshine saw before the microscope a piece of glass, on which were illuminated there some the picture in the sunshine, and body, the lenses which produced the vastly magnified image of that picture. In one experiment the solar microscope would enable them to see how the insects preserved by the infiltration in the pounds of chloride of ammonium, which was used for the purpose. The action of hot waters carried on. Numerous experiments were perfectly successful, and as the chloride began to crystallize in the course of the experiment, and in the latter the broken trees or trees were dropping their fronds into the water as they grew too heavy to stick to the magnetic pole, and again when, as required by the electric current, they floated away in misty clouds of green. Another experiment was with platinum wire as branches of a new stem, there was loud clapping of hands. The whole business, as the lecturer did not forget to remind his young friends, was conducted in the darkened theatre, and was exercised with a certain amount of such as photographers used. His own apparatus, he said, would interest them, for it was the first time it had been publicly used. The human eye optically acted on the principle of the lens, and was illustrated with the aid of a lens. The position of the lens was pointed out that of the screen on which the image to be formed, and due reference was made to inversion of the image. The picture which Murray was allowed to exhibited was a very fine one of the Lion Gate of Mycenæ, and was thrown upon the white sheet or screen, and next forgotten to point out in that since the white picture Mr. Cottrell's pallid face was lighted with an Ethiopian hue. To occupy minutes while the image was further developed Mr. Murray showed a few slides which were of the photographer's friend Dr. Tyndall and his family, and the audience recognized the features in a manner that showed a sufficiently accurate section of the eye, as the most interesting subject of all. He proceeded to give, in the most popular style, the theory of vision, and the action of the lens, and of the various living acres, the retina. By way of illustrating the inverted action of the organ of vision was thrown shown in a model. This done, those present were necessary to distinct vision. A large bird-cat was filled with water to represent an artificial human eye, with tracing-paper behind for a retina, and a lens in front. The lens was in a movable pasteboard tube, and the lecturer, by moving this in the animated water-door, the hands before the eyes of the audience. A luminous explanation was given of both short and long sight, and of the means by which the errors of vision thus caused might be rectified. The lecturer, in illustration of the conditions of short-sightedness, threw the water-lens nearer to the retina, and with a more thick was all that was to be seen; and in that of long-sightedness, by making paper away the image was brought behind it. The same purpose was answered by introducing a lens of shortness, which reduced the image to be fairly sharp. By drawing the water-lens too far from the retina there was again a blurred image. The lens falling within its rod. The introduction of a lens of greater length than the eye required threw the image before it, thus remedying the defect. The luminous rays surrounding the image were seen on the screen was due, he said, to the divergence of the rays which was caused by spectators of that kind. He was specially struck by one of the produced exceedingly sharp images of the coloured rings, and the illustration of peculiarities of vision among persons was discovered by Dr. Tyndall the day before. The paper was pierced with a number of holes, each a luminous circle was seen.

Professor Tyndall's fourth lecture dealt with sound, as it is produced apparatus, was capable of conveying impressions made upon it by the human ear, and of re-uttering them the sensation of light. There was a phonograph at the back of the stage, and the lecturer began by explaining how sound when the ear was produced. He showed that the vocal and nasture pulsations had been applied in one of Edison's vocal tones into socket to render the image visible. Standing general view upon a new and interesting subject, as the lecturer said, he could not do better than refer his audience to the pages of Dr. Rowton, by which he discussed the constitution of light. Newton made a hollow-shutter, and allowed a sunbeam to fall and thereby itself as a round disc of light. Dr. Young, by the use of two pinholes, made two discs, which overlapped, and by refraction, but by the introduction of a third piece he found that the refracted image would be white. What in really saw, as a repetition of the experiment showed, was the prismatic spectrum with its seven colours, into which white light had, in fact, been analysed. The colours they saw on the screen were red, orange, yellow, green, blue, indigo, and violet. Then a prism was put in the pinhole, and they were commonly styled prismatic. Newton found that when the mixture was properly made the original white light appeared. They would follow the great philosopher in the synthesis, as he had in the analysis; and to make the experiment successful, the lecturer allowed the light to fall from a pinhole on a prism, and then on a lens, and without going into the question of the colours by means of a cylindrical lens, which, as he graphically expressed the effect, screwed them together, producing a rectangle of perfectly white light. Having proved the matter to their entire satisfaction, he built up from the coloured spectrum the white light. Besides of the electric light, which produced it. Besides of the common glass prism for Thallium, a slide which far more brilliant display, leading up to an examination of how the colours of mineral objects—foliage, flowers, grass, and dyes—were produced. When the spectrum fell upon a red-stained screen, they saw that it was the only colour given back by the element. What became of the other coloured rays? They were absorbed by the screen, and the electric current, and had been produced, as light, by the flannel. The red light plunged into the flannel, struck on the fibres, was reflected back to the eye. The fibres of the flannel were transparent to the red, and reflected red, while the green and blue were opaque to all the other colours of the spectrum, and so absorbed the rays. A coloured body was chosen and looked to the eye the particular light in which it was transparent. Thus, a green body looked in the light which was transparent to it, and appeared black when the light fell upon them. Dr. Tyndall then produced the effect of green as the result of red light, to which he appeared in succession red, yellow, green, blue, and violet. What, he asked, must be the result? There was neither green nor red, but simply white light. The lecturer then threw the green and blue through a prism, and the resulting white. How, then, must these appear when the green and blue were thrown on the screen? The green and blue showed black, red, on the contrary, being redder than green, and the remainder of the rays glow blackness at once vanished, being replaced by the true colour.

THE EAR IN HEALTH AND DISEASE.

DR. R. J. BLAIR CUNNINGHAME, Superintendent of Statistics in the Local Government Department, delivered a lecture on "The Ear in Health and Disease," before the Edinburgh Health Society on Saturday last. Diseases of the ear were responsible for a large number of deaths annually. Their consequences were often very serious. Many cases of deafness, and not a few of blindness, were due to aural affections, to success in business, his intellectual powers, and even his moral character might be seriously damaged by the disease. The researches of the last few years had thrown much light on the causes of deafness, but it was not so; and inattention to the simplest rules was strongly impressed upon his hearers that pricking of the ear with a pin, or anything else, often caused great injury being done to the drumhead, which caused deafness. There were two kinds of deafness—nervous and mechanical—the former being caused by the brain and the ear. Forgiveness or hardening of the wax in the ear was accompanied by noises in the head, pain, and deafness, an easy remedy was to be found in the use of soft soap and a little tepid water. If they found the wax hardening, a little clean water, or with a little soda in it, might be put into the ear, and then any foreign bodies got into the ear, the simplest remedy was to syringe it out. Whatever was put into the ear, except the finger, should be of the same temperature as the body. If the wax was not affected, the syringe must again be used. The best way of treating deafness in the nervous form was to fill the ear with warm water from a spoon, or by means of a syringe, but plugging must be carefully avoided. To avoid injury to the ear when bathing, and especially when diving, the best way was to put a small bit of wadding in the ear. Alluding to the drumhead being often ruptured by a blow, the lecturer pointed out that the opening of the mouth, as was done by persons discharging large guns, allowed the air to reach the ear through the air-valve in the throat, and thus prevented injury. Another way was to extend the tube of the ear, and the effect of the wave-sound was then equalised and prevented injury. Speaking of the effect of blows on the side of the head and ear, he adopted pounds and shillings as the usual fine that fell here as punishment. If punishment was actually necessary, he would suggest that the fine be in the form of a blow from the prisoner's own hand. The blow was to be delivered on the part in question, and the striking power was calculated by the lecturer. Cunningham, speaking of running cars, said that these cars were already fitted for the use, on account of the close contact with the brain, was especially dangerous of inflammation as early as it. One cause of this disease was the practice of "boxing the ears," which he pointed out how extremely careful it was to give careful attention to the ear, especially if the slightest symptom of pain in the head or ear. Another result of this inflammed condition was the perforation of the membrane. This perforation was as a consequence of running ears; so by attending to the ear in time, they might save it. He also referred to the connection between the ear and the eye. Cases had come under his notice of the syringe to perforate the membrane. The most common cause of deafness was the result of cold, perhaps neglected for a time, but which was the source of great suffering to the thoughtful ought to be avoided. In conclusion, the lecturer said that a person who was deaf in one ear of the ears, and neither of the ears could be used, and there was no reason why they should not live a long and happy life. Cunningham moved a vote of thanks to the lecturer, which was seconded by Mr. Cunningham, and supported in a few remarks by the chairman, Dr. Littlejohn, who expressed the German method of training them by listening by speech to make them useful members of society.

DYNAMO-ELECTRIC MACHINERY.—No. 2.

By PROF. S. P. THOMPSON, B.A., D.Sc.

The Relation of Speed to Power.

THEORY shows that, if the intensity of the magnetic field and the resistance of the circuit remain constant, the electromotive force should be proportional to the speed of the armature. Numerous experiments, by me, and by other workers, have shown that this is the case. Hence, in a machine in which the strength of the field and the resistance of the circuit remain constant, the speed for magnets and separately-excited machines. It is not, however, quite easy to maintain the resistance of the circuit be increased proportionally to the speed, because the current also calls itself exerts on the magnetic field, and alters the strength of the field. In fact, as the current in the coils of the machine is itself, it is positive to the "distance of commutation." If altered coil, the effective number of lines of force is reduced. So that, with a constant resistance in circuit, the electromotive force, and consequently the current, are slightly less at high speed than they would be at low speed. It is usual to use to cancel this effect by the use of extra field-coils, whose motive force gives a number proportional to the

* Extracted from the Course Lectures, delivered before the Society of Arts.

electric work of the machine, it follows that, for "independently excited" machines, the electric work done in generating is nearly proportional to the square of the speed, and the work drawn from the steam-engine by the machine is nearly proportional to the square of the speed.

Hence, in such machines, whether "series" or "shunt" coil machines, the efficiency is nearly somehow constant. If the iron of the field-magnets is not saturated, the efficiency is nearly constant, on account of current consequent on increase of speed produces a nearly proportional increase in the strength of the magnetic field, this increase will not be proportional, because the iron cores will be in proportion of saturation, and so cause a loss of velocity, which again will cause the current to increase in the proportion. But since the magnetisation of the iron is, even when far from saturation-point, not exactly proportional to the magnetising force, but somethings less, it is in practice found that the increase of the electromotive force is proportional to the fourth power of the speed, and even less proportional to the third power of the speed. This is generally the case with Siemens machines.

As mechanical considerations forbid too high a velocity in the moving parts, it is usual, in Siemens machines, to make the armature of the shape which it is safe to run any speed, the speed of the armature of work will be done in the armature, and the remainder will be done in the field-magnets, which are therefore made as large as possible.

Field-Magnets.

The coils of the field-magnets of a dynamo can not be considered of no resistance. In a Siemens machine, always make some of the energy of the current to be wasted in the coils, for although that it cannot be economised to one electro-magnets is somewhat unfavourable to economy, yet it is practically safe to be neglected, even for all Siemens machines of moderate dimensions. Hence, in a well-formed electro-magnets, the weight of copper in the coils should be about equal to the weight of the iron in the cores, and the weight of the iron in the yokes and pole-pieces should be about equal to the weight of the iron in the cores. But if we do not get our magnetism for nothing, and that is one very common error. Let us take a current upon the electro-magnets, economy dictates that we should so construct that the number of convolutions may cost us as little as possible. To magnetise the iron to a given degree of saturation, we require a certain number of ampère-turns. The product of the current into the number of turns in the coil, perhaps neglected for a time, but which was the source of great suffering to the thoughtful ought to be avoided. In conclusion, the lecturer said that a person who was deaf in one of the ears, and neither of the ears could be used, and there was no reason why they should not live a long and happy life. Cunningham moved a vote of thanks to the lecturer, which was seconded by Mr. Cunningham, and supported in a few remarks by the chairman, Dr. Littlejohn, who expressed the German method of training them by listening by speech to make them useful members of society.

Field-Magnet Coils.

If, in order to be of the greatest possible service, the coils of the field-magnets should be so constructed that the whole of the copper be evenly and distributed uniformly along its length, not put round about the yoke. The power of a magnet is proportional to the square of the magnetic flux through the cross-section of the magnet before the pole-pieces, and to the square of the number of turns of wire round the magnet. Accordingly, the magnetisation of the magnet is greatest at its middle, and least at the ends. Hence the following practical rule:—

Wind the field-magnets as much iron as possible. The greatest number of turns should be at the middle, and the least at the ends. If this rule is not observed, it is the case of Siemens machines which are constructed with the armature in the middle of the field-magnets, and the coils are wound equally all along the magnets. In such machines the

DYNAMO-ELECTRIC MACHINERY.

IV.

By Prof. S. P. THOMPSON, B.A., D.Sc.

(*Continued from p. 447.*)

The Dynamo in Practice.

IT was pointed out, at the conclusion of the former lecture, that none of the four fundamental methods of exciting the field-magnetism of a dynamo was perfect in theory, since none could enable a machine either to generate a constant electromotive force, or a constant current, of any form, whatever the resistance of the external circuit for the time being. Now, as the first function of a dynamo in practice is to work with efficiency and regularity a system of lamps, and as these lamps are always in practice arranged either in series or in parallel, it is clear that in the former case a constant current, and in the latter a constant electromotive force, is required.

Combination Methods.

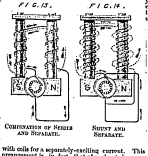
As this matter promises to be of utmost importance in the future practical considering dynamos, a summary of the principal methods may be worth tabulating.

(1.) *Series and Separate (for Constant Current), Dynamo.*—This method, illustrated in Fig. 15, can be applied to any ordinary dynamo, provided the coils are such that a separate current from an independent source can be passed through a part of them, so that these shall act initial magnetic field, independent of the main current current of the dynamo. When the machine is running, the electromotive force generated will depend partly on this independent excitement, partly on the current's own excitement of the field-magnets. If the machine be run at such a speed that the quotient of the part of the electromotive force due to the self-excitement, divided by the strength of the current, is numerically equal to the external resistance, then the whole electromotive force in the circuit will be constant.

* Extracted from the Cantor Lectures, delivered before the Society of Arts.

However, the external resistances are varied. M. Deprez has further shown that this velocity can be found by direct experiment, and that, when the required velocity has once been determined, the machine can be adjusted to give any desired electromotive force, by varying the strength of the constantly-exciting current to the desired degree.

(2.) *Shunt and Separate (for Constant Current), Dynamo.*—When cases arise, as for a set of arc lamps in series, it is desired to maintain a constant current in the circuit at one constant strength, the following arrangement may be made, and is described in Fig. 16, by combining a shunt-winding



COMPOUNDING OF SERIES AND SEPARATE.

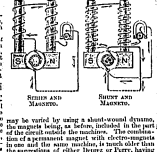
SHUNT AND SEPARATE.

with coils for a separately-exciting current. This arrangement is, in fact, that of a shunt-dynamo, with an initial magnetic field independent of the strength of the current in the circuit.

Seeing that the only object in providing the coils for separate excitement is to secure an initial and independent magnetic field, it is clear that either means may be employed to bring about a similar result.

(3.) *Series and Magneto (Constant E.M.F.).*—The initial electromotive force in the circuit, required by Deprez's theory, need not necessarily consist in the making an initial magnetic field of independent origin. It is true that the addition of a permanent magnet, to give an initial portion of magnetism to the pole-pieces of the field-magnets, would meet the case to a certain extent; but Deprez has shown that it is better to secure the solution of introducing into the circuit of a series dynamo a separate magneto machine, also driven at a uniform speed, such that it produces in the circuit a constant electromotive force equal to that which it is desired should exist between the leading and return mains (supp. 529, Vol. XXXV).

This arrangement, which is shown in Fig. 15,



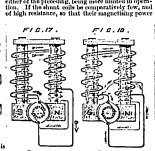
SERIES AND MAGNETO.

SHUNT AND MAGNETO.

may be varied by using a shunt-wound dynamo, the magneto being, as before, included in the path of the circuit outside the machine. The combination of a permanent magnet with both series and shunt windings, as described by other inventors, is the suggestion of either Deprez or Perry, having been described by Hjorth in 1854.

(4.) *Shunt and Separate (Constant Current), Perry.*—Perry's arrangement for constant current is given in Figs. 16, and consists in some way combining a shunt dynamo with a magneto machine of sufficient power to maintain the field-magnets of the machine together either in the armature, or in the magneto-shunt coils of the machine. As before, a certain critical speed must be found from experiment and calculation.

(5.) *Series and Shunt.*—A dynamo having its coils wound, as in Fig. 17, so that the field-magnets are excited partly by the main current, partly by a current derived from it by a shunt of higher resistance, will have its dynamic properties greatly modified by having been used in dynamos for some years past. The arrangement is used as perfect as either of the preceding, being more limited in operation. If the shunt coils be comparatively few, and of high resistance, so that their magnetising power



SERIES AND SHUNT.

SERIES AND LONG-SHUNT.

is small, the machine will give approximately a uniform electromotive force; whereas, if the shunt be relatively a powerful magnetiser, as compared with the few coils of the main circuit, the machine will be better adapted for giving a constant current; but, as before, each case will correspond to a certain critical speed, depending on the arrangements of the machine.

(6.) *Series and Long Shunt.*—I propose to give this name to a combination closely resembling the preceding, which has not yet, so far as I am aware, been actually tried. If, as in Fig. 18, the magnets are excited partly by a few coils in series with those of the armature, and partly by a shunt current of high resistance, from the combination should be found, Edison's dynamo, indeed, are still remarkable in this feature; the pole-pieces and the yoke connecting the iron cores of the coils are made bluntly heavy. This is not more noticeable in the giant dynamos, than in the smaller machines of the reduced installations for sixty and for fifteen lights.

The principle of shaping the outpoint so that their external form approximates to that of the magnetic curves of the lines of force, is to some extent carried out in such widely differing types of machine as the Siemens with "Zenith" magnet, the Jürgensen dynamo, and Thomson's "mouse-trap" machine. In the last-named machine I noticed several curious contrasts. In the Jürgensen the field-magnets have heavy pole-pieces; in the Thomson there are none; and in the Thomson machine the iron core is thicker at the middle than at the ends. In both there are auxiliary internal electro-magnets, fixed within the rotating armature, to help to excite and augment the intensity of the field. In the Thomson machine these are disposed as more thickly at the middle of the field-magnets; in the Jürgensen, the coils are crowded up around the poles. If we may judge from a report on this machine by Professors Ayrton and Perry, the armature is not satisfactory in practice, as there are more core coils than suffice to magnetise the magnets. It is possible that the mistake is the other way in the Jürgensen coils, but in having them in the wrong place.

Another suggestion, which was indicated from theoretical considerations, was that of insulating the pole-pieces, so as to prevent the production in them of wasteful Foucault currents. Here I find that but one machine has been designed in which this precaution has been taken, viz., the Mordey dynamo of Bro. Hopkinson and Muirhead, the field-magnetsof which are made up of laminæ of iron, cut into a solid iron backing.

Another matter in which, up to the present time at least, there is nothing but empirical practice to guide us, is the form to be given to pole-pieces, in order to produce the best effects. It is clear that the object of the designer in practice as to suggest the thought that little importance has been attached to the matter. Yet upon the form and extent given to the pole-pieces depend considerations of no low importance than the reduction of idle wire in the armature, the reduction of sparking at the commutator, and the production of the best electromotive force in the armature. If the pole-pieces are badly shaped for their work, or approach too near to the round the armature, they may completely pervert the approximate uniformity of the field, and may cause the rotated portion of the field to be of much weaker intensity than the two lateral regions of the field, because of the pole-pieces. In such a case, the armature coils, actually moving in a double field, and it is even possible that, in consequence, the direction of the currents induced in the individual coils may be reversed four or six times on their passage rotation. In such a case the distribution of potential round the separate bars of the commutator will be abnormal, as we shall see later on.

(To be continued.)

amount of iron employed in the field-magnets would be quite insufficient if it were not of high quality. As it is, I am of opinion, the mass of it (especially in the polar parts) might, with advantage, be increased; in some of the early machines of Wild, Ferranti, Siemens's well-known dynamos, long field-magnets with large cores had been found. Edison's dynamo, indeed, are still remarkable in this feature; the pole-pieces and the yoke connecting the iron cores of the coils are made bluntly heavy. This is not more noticeable in the giant dynamos, than in the smaller machines of the reduced installations for sixty and for fifteen lights.

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(To be continued.)

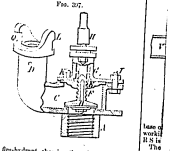
* Since the above was written, an account of a similar combination by the 5th mentioned above has appeared under the name of Crompton's Compound Dynamo. Mr. H. Crompton, jun., has also described to me privately a somewhat similar arrangement for charging accumulators with a constant electromotive force.

In Siemens's machine the two classes of machine. In the first, we have usually two pole-pieces on opposite sides of a rotating armature. In the second, a couple of series of coils, or of independent magneto-coils, are used, the coils which rotate being at equal distances between two such courses of poles.

Confining ourselves, at first, to the first-class of machines, we find that in practice, their magnets differ widely in construction and design. In very few of the existing patterns is there much trouble taken to secure steady magnets, by using a good, long, heavy, and solid, of with very heavy pole-pieces. Even in the powerful Gramme dynamos, last report tried an unnecessary amount of wire had been wound upon the field-magnets; and I find that the usual reply is that with less wire the machine does not work so well. If, however, it is found necessary to wind so as many coils upon the magnets as to bring these practically to saturation, it is clear that either the iron is insufficient in quantity, or it is deficient in quality. In the Hefner machines, where cast-iron field-magnets are employed, the smaller magnetic susceptibility of this metal is made up for by employing a good weight of it. In Siemens's smaller dynamos, the

by so doing the aperture over the seating T is opened, and the water allowed to run during the time that this diaphragm remains off the seating, or falls which causes the water to flow in a small fo ks passage at A, which allows the water to pass freely from between the bottom diaphragm C, or vice versa; that is to say, when the top diaphragm is depressed, and the lower diaphragm down, the water will be forced back through the small aperture A. Sometimes the falling piece or pallcen is worked in conjunction with the diaphragm, a modification of which is shown at C in L and G (Figs. 206, 207, &c.). Sometimes the outlet valve is formed on the diaphragm, and a piston made to actuate the diaphragm, whilst at other times the diaphragm is made to actuate the falling plug, &c. At Fig. 207 is a section of

FIG. 207.



the fire-by-draut, showing the valve to be of the beam-valve kind (as in the Rotherham cock, the difference being the plate B, and round the spindle a stuffing-box with glands, G holds the face of the diaphragm and features to the valve-

lat. Because the wires of the armature, second heated, conduct less freely; hence loss of curr 2nd. Because the armature itself is not exp of such intense magnetisation when hot as w cold (a red-hot mass of iron is hardly affecte the magnet); hence another loss of current.

Heating of the armature consequent on the wir impaired, even if not actually ruined, if temperature rises to a very moderate limit.

For these reasons it is important to keep temperature of the armature as low as possi The first step and step in this direction taken by Dr. Pacinotti, of Florence, in 1 who constructed an armature of soft iron, in shape of a ring, around which were coiled successive sections, before it was insulated coa wire, the ends of which were joined up t divided ring commutator. The ring armatur soft iron, with its covering of wire, was supp on a central axle, and rotated before the pole a magnet, either permanent or electro, part of the revolution in such a way that whole further from, or nearer to, the poles of magnet; and although its magnetism is c stantly changing, yet the change is not abr but gradual and continuous: as will be explai in the following paragraph.

Pacinotti's Ring Armature.

[17. The description and illustration of machine is to be found in the *Nuovo Cimento* the year 1864, under the heading of "Descrizione d'una Piccola Macchina Elettro-M netica." The machine itself, as described, be used either as a motor, or as a generato electricity; and its adaptability to either p pose was specially dwelt upon by Dr. A. F notti, in his communication; but it is only as the aspect of a generator that we shall str consider it here.

Two electro-magnets S, N, Fig. 13 (s upy, or may not, be united together below),

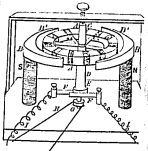


Fig. 13.

fastened to a base-board, and so arranged the upper extremity of one is a north pole, w the other is a south pole, are placed in front of the poles of a ring armature, A A, which is mounted on a horizontal axle, and is capable of being rotated by a band and pulley, or other convenient means, in a direction from right to left, or vice versâ. The armature is made to rotate at a high speed, the different effects will be so aggravated that it will be unnecessary to consider further upon them.

In these three *leads* we have three that are principally used with this instrument for Cox duck; they are, of course, a large variety of sizes of different patterns, such as round-nose, bullet, or barrel fashion, and rounds. These are used for working up moulding and many other purposes.

(To be continued.)

DYNAMO-ELECTRIC MACHINERY.—VII.*

By Prof. S. P. Thompson, D.Sc., &c.

(Continued from page 584.)

Alternate-current Dynamos.

Electricity for the most important of the dynamos of this second class are those of Siemens and Wheatstone, *alternate-current machines*. The type of alternate-current machine first invented by Wilde, in 1867. The field-magnets are arranged as those of fixed coils, with iron cores, arranged so that their free poles are opposite to one another, with the armature between, sufficiently wide to embrace the armature. The poles taken in order round each groove in the armature are north and south polarity, and opposite north pole of one crown faces a south pole of the other crown. The same rules will apply to the magnets of the alternate-current machines of Wilde and Siemens as to those of the Gramme machine, and, with certain modifications, to Dr. Siemens's and Ladd's machines. The armature, as in the Gramme, is a ring of soft iron, bearing at least two coils of wire, but usually a number of coils, whose ends are parallel to the plane of rotation. The machine itself, as described, may be used either as a motor, or as a generator of electricity; and its adaptability to either purpose was specially dwelt upon by Dr. A. F. Pacinotti, in his communication; but it is only as the aspect of a generator that we shall at present consider it here.

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Alternate-current Dynamos.

Electricity for the most important of the dynamos of this second class are those of Siemens and Wheatstone, *alternate-current machines*. The type of alternate-current machine first invented by Wilde, in 1867. The field-magnets are arranged as those of fixed coils, with iron cores, arranged so that their free poles are opposite to one another, with the armature between, sufficiently wide to embrace the armature. The poles taken in order round each groove in the armature are north and south polarity, and opposite north pole of one crown faces a south pole of the other crown. The same rules will apply to the magnets of the alternate-current machines of Wilde and Siemens as to those of the Gramme machine, and, with certain modifications, to Dr. Siemens's and Ladd's machines. The armature, as in the Gramme, is a ring of soft iron, bearing at least two coils of wire, but usually a number of coils, whose ends are parallel to the plane of rotation. The machine itself, as described, may be used either as a motor, or as a generator of electricity; and its adaptability to either purpose was specially dwelt upon by Dr. A. Pacinotti, in his communication; but it is only as the aspect of a generator that we shall at present consider it here.

Two electro-magnets S, N, Fig. 13 (s[illegible]upy, or may not, be united together below),

Fig. 13.

fastened to a base-board, and so arranged the upper extremity of one is a north pole, w the other is a south pole, are placed in front of the poles of a ring armature, A A, which is mounted on a horizontal axle, and is capable of being rotated by a band and pulley, or other convenient means, in a direction from right to left, or vice versâ. The armature is made to rotate at a high speed, the different effects will be so aggravated that it will be unnecessary to consider further upon them.

In these three *leads* we have three that are principally used with this instrument for Cox duck; they are, of course, a large variety of sizes of different patterns, such as round-nose, bullet, or barrel fashion, and rounds. These are used for working up moulding and many other purposes.

(To be continued.)

THE DYNAMO: HOW MADE AND HOW USED.—VIII.*

By Selimo R. Bottone.

The Patterns.

§ 18. In the dynamo we are about to construct, three separate pieces for patterns are absolutely necessary—viz., one for the armature, one for the legs of the field magnets, and one for the standard which supports the flywheel. There is no necessity for the amateur to put himself to the trouble of cutting out a pattern for the flywheel, since such wheels with handles already fixed can be had for two or three shillings. In constructing the wooden patterns, from which the iron castings are afterwards to be procured, the amateur should remember to choose dry, well seasoned wood, free from knots. Red pine, for such small work as is required, will be found as good as any. Any joints that are absolutely necessary (and joints should be avoided as much as possible) should be attached together with dowels and Prout's elastic glue. It must be borne in mind that the pattern-moulder places the patterns in *green* (moist) sand, and that this moisture causes ordinary glued joints to come undone or expand. Any roughnesses left on the pattern also swell up, catch the sand, and thus destroy the sharpness and beauty of the mould, and therefore of the resulting casting. It is therefore advisable, after having got the wooden pattern to the highest possible degree of smoothness and trueness by means of emery paper, &c., to give it a coating of melted paraffin wax, and polish the surfaces carefully with a roll of flannel. This renders the surfaces not only extremely smooth but impervious to moisture, so that the pattern does not warp or swell when placed in the sand. In order that the pattern should come clean out of the sand and not break away any portion of the mould, care must be taken that the edges be slightly rounded, so as to give what is technically called *clearance*. The possessor of a *lathe* can turn up many portions of the fittings with much greater accuracy and rapidity than one provided with only ordinary tools; but in the ensuing directions the amateur is supposed to possess tools of the simplest kind only.

§ 19. The pattern for the *armature* first demands our attention. When completed, it presents the appearance shown at Fig. 14, *a* being the elevation and *b* the section, on a scale of about half the real size, and consists of a wooden cylinder 1¼in. in diameter by 3⅜in. in length, with a deep channel round the ends and sides. To construct this pattern, procure a piece of pine 8in. long by 1¼in. wide and ¾ of an inch thick. Lay this on a table on its widest side, and draw a line along its whole length, that shall divide it into two halves of ⅜ of an inch each. Now, draw a line on each side of this central line, rather better than ⅛in. from it. Holding a metal rule against one of these side lines, with a sharp penknife, cut into the wood along the line to a depth of about ⅝ of an inch—rather less than more. Now, perform the same operation on the other side line to the same depth. With a sharp ½in. chisel, shave away the wood on the outside of the cut lines to the depth of ⅜in. on the outsides, but *rising up slightly toward the centre*, as shown at Fig. This precaution will ensure the pattern lifting out clear from the mould.

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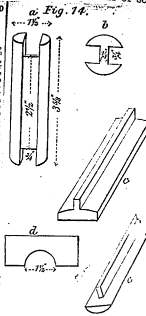


Fig. 14.

Now, take a piece of stout cardboard, and with a pair of compasses, strike out a circle 1¼in. diameter. Cut the circle out of the cardboard so as to leave a clean circular aperture of the diameter specified. This is to serve as the *templet*, or gauge, of the size and general truth of our armature. Strike out, also, in a similar manner a circle in a piece of stoutish zinc, or tinned iron, also 1¼in. diameter, and cut this in two halves (one of which is shown at *d*). These will serve to shave away the last irregularities from the wood, when it has been roughly trimmed up to the shape shown at *c*, by means of a small plane, or penknife. The piece may now be cut into two halves across its length, dowelled and fastened together with Prout's elastic glue, and cut down to the exact length required—namely, 3⅜in. All roughnesses should now be carefully sandpapered, and care should be taken that the finished pattern should pass exactly through the cardboard pattern, being appreciably neither thicker nor thinner at any part. When this has been effected satisfactorily, a small quantity of paraffin wax (a piece of paraffin candle will do) should be melted in an iron spoon, and well rubbed into the pattern at all points with a roll of flannel until it is thoroughly impregnated with the wax; rubbing the pattern until it acquires a polish completes the operation, and renders it ready for the founder. The thin central portion, which joins the semicircular portions, should be about 2¼in. in length, having rather more than ½ an inch cut away at each end, so that the channel is continuous round the armature, being ⅜in. wide and about ⅜in. deep all round.

THE DYNAMO: HOW MADE AND HOW USED.—IX.*

By Selimo R. Bottone.

§ 20. The pattern for the *legs* of the electro-magnet (*field magnets, exciting magnets*) will next require our care. Since the two legs are exact counterparts, the one of the other, so we need only make one pattern, from which, however, *two* castings must be obtained. Fig. 15 illustrates the form and dimensions of this pattern on a scale of about one-quarter the real size. The dimensions are marked in inches.

*All rights reserved.

A represents the outside view, *i.e.*, as seen from the side which is farthest from the armature: B gives the view from the inside (close to which the armature rotates).

To make this pattern, procure a piece of pine 6in. in length, 4in. in width, and ⅜in. thick, planed smooth, and free from knots and roughness. Glue and dowel along the bottom edge a strip 1¼in. wide, 4in. long, and ⅜in. thick, as shown at Fig. 16*a*. Now, with a sharp plane,

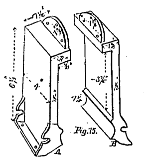


Fig. 15.

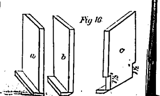
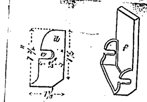


Fig. 16.



remove half the inner edge, as shown at Fig. 16, *b*, so that it makes an angle with the edge of the 6in. piece. With a fine saw cut a recess on each side of the jointed piece 1¼in. long by ⅜in. deep, as shown at *c*, and glue and dowel in each recess the two flanges, made of ⅜in. stuff, of the shape and dimensions given at *d*. To insure the slot *e* being exactly at the same point in each flange, the two flanges, after being roughly shaped with a fretsaw, or otherwise, should be clamped together, and the finishing touches given with a rat-tail file, for the slot *e*, and with sandpaper along the rounded edges. Care must be taken that these flanges should be a trifle thinner near the edge marked 1¾ than on the opposite edge, to insure the pattern coming out clean from the mould. For this reason the slot *e* must not be narrower at the outside than at the inside, but rather the contrary. The slot *e* must be ⅜in. wide, and must reach in depth to the 6in. piece, to which the flanges are attached. At this point our pattern will present somewhat the appearance shown at *f*. A piece of wood 4in. long by 1¼in. wide, and ⅜in. thick, perfectly smooth, square, and free from knots, must now be chosen, and the two sides planed away, on the upper side to such an extent as to make an angle of 60° with the base (see Fig. 17, *a*). With some good thin, hot glue (not Prout's), this piece is to be glued along the bottom edge of the 6in. piece, on the side opposite the flanges, and in such a manner that the slope of the base is continued by the slope of the piece, as shown at Fig. 17, *b*. When the glue is quite dry, by means of an inch gouge, cautiously hollow out along the entire length of this piece, in a semicircular form, nearly to the depth of the original 6in. piece, so as to fit accurately the pattern of the armature, which has already been made. (§ 19.) When this is as true and smooth as it can be made with the gouge, fold a piece of fine glasspaper over the pattern of the armature, rough side outwards, lay the armature in the channel, and work it backward and forward until perfect smoothness and a perfect fit are insured. The pattern should now present the appearance given at Fig. 17 *c*. When this end has been attained, four small dowels should be inserted into the thicker portions of this semicircular piece, to hold it firmly down to the 6in. piece. We now need only make the top flange, by which the bracket or standard that bears the wheel is clamped to the legs of the dynamo. This is made most easily in two pieces, one being squared up to 4in. long, ⅝in. thick by ⅞in. wide. The other piece is to be ⅜in. thick, and must be cut into a perfect semicircle, with a radius of 1¼in. By means of Prout's glue and a couple of dowels, this is neatly attached to one side of the other square piece, as illustrated at Fig. 17, *d*, and then the whole is carefully and squarely glued and dowelled, in like manner, to the top of the 6in. piece, so that it now presents the appearance shown at A and B., Fig. 15. The holes shown in the bottom and top flanges may be bored, and core prints inserted, *if the founder will take the trouble to put them in his mould*; but, as a rule, founders do not care to cast small castings with holes in them, as they seldom come true, so that it will be, perhaps, as well to have them bored afterwards, which can be done at a cost not exceeding 2d. a hole. This pattern must now be carefully smoothed, the sharp edges rounded, to insure parting from the mould, and finally paraffined and polished, as recommended for the armature, § 19, when it will be ready for the moulder.

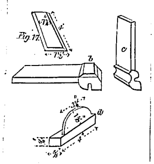
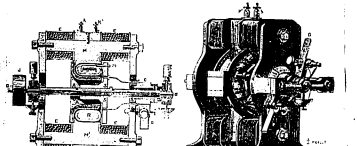


Fig. 17.

FEIN'S DYNAMO-ELECTRIC GENERATOR.



FEIN'S DYNAMO-ELECTRIC GENERATOR.

M. Fein, of Berlin, patented in May, 1880, a modification of the Gramme machine illustrated above by Figs. 1 and 2, and the details of which are described by the inventor substantially as follows: In dynamo-electric generators constructed on the Pacinotti-Gramme principle, the portions of the electro-magnets exert their inductive action only on the exterior part of the ring, whilst the other portions of the two electromotive wires are of special and only to increase the resistance of the circuit, which gives rise necessarily to a very disadvantageous heating. In order to avoid these inconveniences some generators have been constructed with a flattened ring instead of the more common cylindrical drum, in such a way that the coils can be subjected on both sides to the action of the electro-magnets. By this arrangement the wires, instead of being parallel to one another, are wound obliquely; from which it follows that in order to have on a flat ring, groups of coils of the same total length, and the same number of turns as with a cylindrical ring, it is necessary to give a much larger diameter to the ring. But this increase in diameter produces an increase of resistance, and in order to drive the flat ring, more power is required than for the circular armature. The way by which M. Fein proposed to obviate this inconvenience, and at the same time to secure the most efficient action of the electromagnets, is shown by the form of generator in the illustrations, of which one is a perspective view, and the other a longitudinal section. In the latter the ring is shown at C. It is formed by means of screws which in the drawing are shown in end view, and which is the first point to be noticed. The ends of the wire from each group of coils on the ring pass through insulated holes in the body of the ring, and are led to the commutator C which is placed outside the frame. The current is collected by the two brushes B B. The wound cross current of a number of thin plates insulated from each other, the core is formed of these plates, which are held in the connecting screws. The ends of the latter are connected to the pole-pieces M M, which are bent inwards, as shown in the details of the ring, and these are fixed to the auxiliary pole-pieces A A A bolted to the pole-pieces M, which vertically enclose the ring as shown in the longitudinal section. In this way almost the whole surface of the ring is exposed to the action of the electro-magnets, there being only the small part adjacent to the body S which does not exist in the production of the electromotive force. It is stated that a very simple experiment illustrates the efficiency of this machine; after measuring the intensity of the current it produces in its normal state, if the pole-pieces A A be removed it will be found that the intensity is hardly one-half that which it was before. The advantages claimed by the inventor for this arrangement are: 1. The reduction of the ring are sufficient to counterbalance the resistance of the coils. 2. The reduction of the ring are sufficient to counterbalance the resistance of the coils. 3. The employment of cross currents in practice to receive a variety of small charges for delivery to the screw at the end of the mandrel, which with the exception of the first, is also bored through, so as to allow a small wire to be passed through from behind without impinging on the charge. The system is also claimed to be capable of being used in connection with other machines for the production of electromotive force, as well as for the purpose to which it is more particularly applied by the inventor.

DYNAMO-ELECTRIC MACHINERY.—VIII.*

By Prof. S. P. Thompson, D.A., D.Sc.

(*Continued from page* 562.)

The Dynamo as a Motor.

IN my first lecture I laid down the definition that "by dynamo-electric machinery is meant machinery for converting the energy of mechanical motion into the energy of electric currents, or *vice versâ*."

An electric motor, or, as it was formerly called, an electro-magnetic engine, is one which does mechanical work at the expense of electric energy; and this is true, no matter whether the magnets which produce the field in such machines be permanent magnets capable of steady magnetism or not, even, in fact, of the four kinds of dynamo enumerated successively as a motor, though, as we shall see, some seem appropriately than others. But the machines which are designed to be permanently magnetised, and not of temporarily magnetised iron, all these machines are governed by the same principles; and it is easy, then a mere part of a bar or of moving which is an electro-magnet, and which is such attracts and is attracted magnetically.

Everyone knows that a magnet will attract the soft iron armature of another magnet, and will pull it over, and that the very magnet placed in a magnetic field of force tends to turn round one axis of suspension.

As a matter of fact, a mere coil of wire carrying a current is acted upon when placed in the magnetic field, and is pulled round as a magnet is.

On this very principle was constructed the earliest electro-motor of Ritchie, known as the "rotating spiral," or as a steel spiral of eight segments separated by little letter in readily than a toy.

A great step in advance was made by Jacobi, also in 1838, constructed his multipolar machine; and Froment, in 1844, improved for his electro-motor for driving machine wooden frames, in each of which a dozen electro-magnets were fixed, with their poles being set alternately. Between these, upon a wooden disc, were placed another set of electro-magnets, driven by the ordinary alternating arrangement of the fixed poles were kept in rotation, the moving magnets were kept in rotation, the moving magnets were at the moment of passing the poles of the fixed magnets, by means of a contrivance devised by Jacobi, consisting of two wheels, each of four brass toothed wheels, having pieces of ivory let into the teeth between the teeth for insulation. Froment's was, in fact, a very advanced type of dynamo, and did good work in driving the lathes and machines of one's wood-and-metal factory.

A still earlier rotating apparatus, and, like Froment's, a motor, a man was Dr. Barlow's wheel, described in 1823. This instrument, interesting on account of the theoretical remarks of Sir Charles Wheatstone, is important class of machines, namely, those which have a rotating conical magnet.

A fourth class of motors may be named, wherein the moving part, instead of rotating on axis, is caused to oscillate backwards and forwards. Such oscillations may be of very small amount, as in the case of the tuning-fingers, constructed in 1876 by Prof. Hughes, or may be of considerable amount, as in the instrument of Sir Charles Wheatstone, and in the action of an electro-magnet. Del Negro's motor of 1833 was of this class; it is a steel rod was caused to oscillate between the poles of an electro-magnet, and was connected by a crank and connecting-rod to drive machinery. A double oscillating motor of this type of machine was introduced by Page, who employed hollow coils or bobbins as electro-magnets, which, by their alternate action, sucked down from each end into the coils, and caused them to oscillate to and fro. Motors of this kind form an important class, which has been developed by Marcel Deprez, first formulated by Ohmer, but developed later by Maxwell, to the effect that a circuit acted on a magnetic pole in such a way as to manage the number of magnetic lines of force that pass through the circuit a maximum.

Page's suggestion was further developed by Bourbouze, who employed a number of bobbins, each connected like an arc of a circle, and all together like a horse, crank, fly-wheel, connecting-rod, and even an eccentric valve-gear and a slide-valve. But, for cylinders, we have four hollow electro-magnets for pistons we have iron cores that are alternately sucked in and repelled out; and the valve-gear consists of a commutator worked by dragging a pair of platinum-tipped springs over a flat surface made of three pieces of brass separated by two insulating strips of ivory, serves at every stroke the direction of the currents in the coils of the electro-magnets. It is easily a very ingenious machine, and, in point of efficiency, far behind the best of the modern machines. Unfortunately, it does not do to design dynamo-electric machinery on the same lines as steam-engines.

* Extracted from the Cantor Lectures, delivered before the Society of Arts.

ALTERNATING CURRENT MACHINES.

THEORY AND PRACTICAL FORMULÆ OF ALTERNATING CURRENT MAGNETO-ELECTRIC MACHINES.

NOTE BY M. FELIX LUCAS, PRESENTED BY M. CORNU.*

THE moveable armature of an alternating current magneto-electric machine comprises $N = \mu \times \rho$ equal bobbins, and we group in quantity ν groups of ρ bobbins joined up in series; there are as many possible modes of grouping as there are manners of decomposing N into two entire factors, ρ and ν. The inductor is composed of fixed magnets.

For one mode of grouping we may first impart to the armature a fixed speed of rotation of n revolutions per minute. The effects obtained vary, then, with the circuit. Let I be the intensity of the electric current and T the motive work received by the machine and transformed by it into electrical energy: I and T are two functions of R. Let us designate, on the other hand, by r the resistance (measured, for instance, by means of a Wheatstone bridge) of the system of bobbins included in the circuit. We might express it and r in ohms, I in amperes, and T in horse-power. The principle of the conservation of energy gives first

$$(1.) \qquad (R + r)\, I^2 = 75\, g\, T.$$

In order to obtain a second equation, we may have recourse to experiment. I close the circuit by a conductor of unknown resistance; an electro-dynamometer shows the intensity, I, of the current; the engine makes known the work which it produces and from which I subtract the work (measured beforehand) absorbed by the transmissions and by the movement of the machine when it runs with an open circuit; I thus obtain T. By varying the external resistance from zero to infinity, so as to obtain a great number of corresponding values, I and T, we obtain the elements of a graphic tracing in which we take I for the abscissæ and T for the ordinate. I have recognised thus that the law according to which T depends on I, is represented by a parabola of the second degree which passes by the origin of the co-ordinates and of which the axis is vertical. We have, consequently,

$$(2.) \qquad \kappa\,(I - h)^2 = 75\, g\, (k - T).$$

The numerical values of the three parameters, ρ (resistance), h (intensity), and k (mechanical work), are determined when required from the graphic; as the curve passes by the origin of the co-ordinates, we have—

$$(3.) \qquad \rho\, h^2 = 75\, g\, k.$$

If we eliminate T in the equations (1) and (2), taking into account the formula (3), and considering

$$(4.) \qquad \varphi = q\, \rho\, h,$$

we find that there exists between R and I the very simple relation

$$(5.) \qquad (R + r + \rho)\, I = \varphi.$$

The parameter, φ, is expressed in volts: as the electro-motive force ρ represents a fictitious resistance, to which no consumption of mechanical work corresponds. The two equations, (1) and (2), contain all the laws of the function of the machine for a constant speed of the armature and for a fixed method of grouping.

If we wish to determine directly φ and ρ, we may make two accurate experiments, giving to the resistance, R, two known values, R′ and R″, and measuring the corresponding intensities, I′ and I″. We shall thus have

$$(6.) \qquad \begin{cases} \rho = \dfrac{R'\, I' - R''\, I'}{I' - I''} - r, \\ \varphi = (R' - R'')\, \dfrac{I'\, I''}{I' - I''}. \end{cases}$$

For variable speeds of the armature, ρ and φ become functions of the number, n, of revolutions per minute. By determining experimentally the nature of these functions, n varying from 150 to 850 revolutions, I have ascertained that they are linear. In other terms: The parameters, ρ and φ, increase in direct ratio to n. We have therefore—

$$(7.) \qquad \begin{cases} \varphi = \alpha + \alpha\, n \\ \rho = b + \beta\, n \end{cases}$$

and the formula (5) becomes

$$(8.) \qquad I = \frac{\alpha + \alpha\, n}{R + r + b + \beta\, n};$$

I have verified this formula by a very great number of experiments.

We have now only to consider the mode of grouping of the machine, and experiment has led me to the following observations:—

The series grouping of μ identical systems multiplies by μ the parameters ρ, φ, and r: the grouping in quantity of ν identical systems divides by ν the parameters ρ and r, without modifying the parameter φ.

If, therefore, we designate by a_0, α_0, b_0, β_0, and r_0, the parameters corresponding to a single one of the bobbins, we shall have—

$$(9.) \qquad a = \frac{\mu}{\nu}\, a_0,\ \alpha = \frac{\mu}{\nu}\, \alpha_0,\ r = \frac{\mu}{\nu}\, r_0,\ b = \mu\, b_0,\ \beta = \mu\, \beta_0.$$

The electrical energy furnished by the machine on the external circuit is given by the formula

$$(10.) \qquad 75\, g\, T_e = \frac{N\,(\alpha_1 + \alpha_1\, n)^2\, R}{[\nu\, R + \mu\,(r_1 + b_1 + \beta_1\, n)]^2}.$$

It reaches the maximum when we conform to the relation

$$(11.) \qquad \nu\, R = \mu\,(r_1 + b_1 + \beta_1\, n),$$

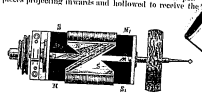
and its value is then

$$(12.) \qquad 75\, g\, T_e = \frac{N\,(\alpha_1 + \alpha_1\, n)^2}{4\,(r_1 + b_1 + \beta_1\, n)}.$$

My experiments, to obtain and verify these various formulæ, were made at the Dépôt Central des Phares, in December, January, and February last, with magneto-electric machines on the De Méritens system.

IRISH'S NEW ELECTRO-MOTOR.

THIS motor has been devised, we are informed, in consequence of the demand for small and effective portable motors. The illustration represents a convenient form for domestic and other uses, where small power only is required, and it is fitted with universal tool holder for brushes, emery wheels, drills, &c., also abscess and friction wheel. Although a hand machine, it may be easily clamped to the bench or table. The field-magnets are simply electro-magnets, with their pole-pieces projecting inwards and hollowed to receive the



armature. The ends of the magnets are coupled together by brass plates, which also form the bearings for the armature. The field-magnets are connected up so that their respective coils come together of different polarity. The armature is of simple Siemens form, but with a twist, which brings one pole opposite N, S, the other pole opposite S, S. The machine is said to act well as a dynamo.

THE E.M.F. OF DYNAMO MACHINES, EXCITED BY A CONSTANT CURRENT.

[A COMMUNICATION.]

IT has been frequently assumed that the E.M.F. is constant for a uniform speed in dynamos, the field-magnets of which are excited by a constant current, and that the fall of potential at the brushes, consequent on increased current through the armature, is only due to the latter having some resistance.* For example, let a dynamo, the field-magnets of which are separately excited, give a difference of potential, V, at the brushes, when a current, C, flows through the circuit. If the resistance in the circuit is diminished, so that a larger current, C_0, flows through the armature the potential at the brushes will be diminished to V_1 and on the assumption that the E.M.F. is constant

$$V + C\, r = V_1 + C_1\, r$$

where r is the resistance of the armature

$$V = V_1 - r\,(C_1 - C)$$

and

$$V_1 = V - r\,(C_1 - C)$$

This means that the potential at the brushes is diminished by a quantity equal to the product of the additional current and resistance of the armature, and from this it might be expected that in any machine

* In connection with this subject I would draw the attention of your readers to an extract from an American paper, which appeared in the ENGINEER for February 2nd, entitled "Regulation of Electromotive Force." In the article referred to Mr. F. B. Crocker ignores everything save the resistance of the armature.

* Comptes Rendus.

an example of machine in which the method of winding makes p and q a minimum for a given number of turns on the armature, the Siemens dynamo might be cited; while, on the other hand, the Bürgin machine might be cited as one in which q, p_1 and also r_1 are excessive for a given number of turns. The armature of the latter machine is wound so as to employ, it would seem, a maximum length of wire for the enclosure of the lines of force, instead of a minimum, and the dividing up of the armature, and separate coiling of each piece, renders p and q very large indeed. Occupying a position midway between these two extremes come the Gramme machine, and generally machines having ring armatures.

In shunt dynamos, it is of special importance that q, p and c, be kept as small as possible, since the potential at the brushes determines the strength of the field, and any diminution due to the foregoing causes, immediately augmentes the fall of potential by weakening the field-magnets. For this reason the curve connecting the difference of potential at the brushes with the current in the lamp circuit for a shunt machine, is never a straight line, but in a well constructed dynamo the curvature for a long range is small, and the slope very gradual. In fig. 3 is shown the curve for a shunt dynamo giving a current of 145 amperes and 50 volts; during the experiments the speed of the machine was maintained uniform at 1,500 revolutions per minute.

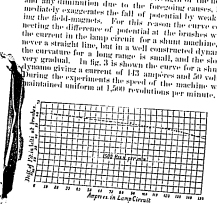


FIG. 3.

The fact of there being a certain E.M.F. expended in starting the current in the coils of the revolving armature does not affect any calculations respecting the commercial efficiency of dynamo machines, since, by commercial efficiency, we mean the ratio of the total energy expended in driving the machine; but it does affect the items of which the commercial efficiency is made up. For example, if in a series dynamo, armature, and r_2 the resistance of the field-magnets, it is generally assumed that the electrical efficiency is expressed by

$$\frac{R}{R + r_1 + r_2},$$

taking for granted, of course, that the E.M.F. of the machine is $c\,(R + r_1 + r_2)$, where c is the current flowing. But it has been shown that the E.M.F. is really $c\,(R + r_1 + r_2 + p)$, where p has the meaning before assigned to it, and the electrical efficiency therefore becomes

$$\frac{R}{R + r_1 + r_2 + p}$$

or somewhat lower than before. On the other hand, the conversion efficiency of the machine is raised somewhat. More of the energy expended in driving the machine is converted into electricity, and less of the energy so converted is utilised.

W. H. ESSON.

speed of the motor. The increased resistance causes a relative movement between the disc and its shaft, and this movement is by suitable mechanism made to impart the adjustment of the throttle valve, or equivalent part of the motor. When the action of one or more of the lights is removed, the strength of current through the shunt circuit, and the relative setting of the disc, become diminished, so as to lessen the resistance to the disc's rotation; and the subtle spring then causes a reversed relative movement of the disc, which brings about the adjustment of the throttle valve, or equivalent part of the motor.

CORRESPONDENCE.

The Electric Light in the Observatory.

As I presume Mr. M. G. Towne is an astronomer, I should have thought that he would have taken in "The Observatory," a publication issued from Greenwich. If he had done so he would have seen an account, in two separate numbers, issued *two years ago*, of an adaptation of the electric light to the Observatory, precisely similar to that described in your last number, only with many more details. That adaptation I have continued ever since, and it is at this moment in full working order. The battery (only four *leclanché* cells) the moveable light (a $\frac{20}{2}$ candle Swan lamp); the switch to change the light into the eye-piece in order to illuminate the wires of the micrometer &c., and the regulation of that light by the depth the elements are sunk in the solution; all is there described much more fully than by Mr. Towne. "Palmam qui meruit."

St. Vincent Beechey.

Hilgay Rectory, *April 5th*, 1884.

Domestic Electric Lighting.

Hilgay Rectory, *Norfolk*, is now completely lighted by the Electric light. A description and some account of the cost and working may not be uninteresting to your amateur readers. The engine is a one-horse nominal steam engine. The boiler, a vertical one, suited to it. The Gramme is a Gramme machine sufficient for sixty 20 C.P. lamps. Much larger, of course, than I require. But as I was fortunate enough to buy it second-hand, though as good as new, for one quarter of its original cost, and, as I can get out of it as much as my engine can drive, it is far more economical than a smaller dynamo. It needs only 600 revolutions for all the lamps that I require. It is most solid and substantial and cannot get out of order. It *never sparks*, and as neither brushes nor commutator ever burn, and it never needs looking after all after its four hours run. I have three lamps in the dining-room, three in the drawing-room, one in my study, two in the hall and staircase, one in each of three bedrooms, one in the pantry, one in the kitchen, one in the back kitchen, two in my parish room, and one in the engine-room or workshop, in all eighteen lamps. I *rare* use all these at once, but it requires the steam to be kept up to 60 lbs. in order to do so, and I never require them all. As a rule the drawing-room and dining-room are not both required at once, except with company, when I use both. The three bedroom lights are turned on and off like gas, to be used only when dressing &c., the two lights in the parish room are only required once or twice a week for an hour. Also all the single lamps have switch holders, so that they can be separately turned on or off as wanted. As a general rule I run twelve lamps, which number I can keep perfectly bright with the steam kept at 45 lbs on the inch. As I also got my engine secondhand and very cheap, the cost of the entire plant did not much exceed fifty pounds. I put up all the wires &c., myself. The lighting is a very complete success.

Now as to economy. It costs me in coals, and the lad who looks after engine and dynamo, 2*s.* 6*d.* a night. That is 2½*d.* for each lamp burning three or four hours. Say one penny per lamp per hour (an over estimate). In one sense this is *far* from economical. It is not dear if you are buying *light*, for each lamp is equal to twelve wax candles. But it is dear, because you are using and *wasting more*, more light than you want. You save nothing by running less than twelve lamps. It is not dear, if you, as I do, in a village where there is no gas, and you hate paraffin, and you take into account all the cleaning and filling of lamps, wicks, glasses, and smells. And it is decidedly cheap if you have company, and want a nice bright, cheerful house, with cool, fresh rooms, and well lighted offices. I may just add that in the bedrooms the lamps are on brackets just over the looking glass, so that the ladies have plenty of light to see they are all right before they go down to dinner.

What is really the greatest drawback to the use of the electric light in domestic lighting is the want of accumulators; for as we do not like to keep our fuel up after ten o'clock, we let him knock off about that time.

St. Vincent Beechey.

Hon. Canon of Manchester.

On the Action which takes place in Ring Armatures.

When the controversy, begun in the ELECTRICAL REVIEW a short time since concerning the action of the Gramme ring, and the action and direction of the magnetic lines of force, I waited anxiously the result, because I thought some useful and valuable knowledge would come of the controversy. I can only say that I was disappointed, and as were others, because it simply ended in personal abuse, and an endeavour to largely advertise a machine as being superior to all others. With the editor's kind permission, I will describe, as well as I can, the means that was always cleared the difficulty, to my mind, as to the real action of the so-called Gramme ring.

I am one of those who hold that the wire in the under part of the ring is not idle, but equally as active as the wire upon the upper part of the ring, minus the cutting of the lines of force of the field magnet poles. I hold this view all the more forcibly because it is the result of actual practice in the every day construction of dynamo-electric machines. But there are certain conditions necessary to bring about this result in the best possible manner, and these conditions have only been found after years of laborious work, careful study and repeated failures in the constructing of such machines.

I am glad to see that Prof. Silvanus Thompson has pretty well come to the conclusion that the Pacinotti form of ring is probably one of the best forms of ring armatures, because it is this form of ring that I have made for some considerable time, being led thereto from a consideration of theoretical principles.

These principles I will now endeavour to describe. *a*, in fig. 1, represents a bar magnet, *b* represents a bar of soft iron surrounded with a coil of insulated wire at its centre, the terminals of this wire coil, *x*, *y*, are attached to a galvanometer; when the bar magnet, *a*, approaches or touches the soft iron bar, *b*, the needle of the galvanometer becomes deflected, and when the bar-magnet, *a*, is withdrawn, the needle is again deflected, only this time in the opposite direction. The cause of this deflection of the galvanometer needle is due to a current of electricity being produced in the wire coil surrounding the iron bar, *b*. This current of electricity being itself produced by the inductive action of the iron bar, *b*, and this inductive action of the iron bar, *b*, is caused by the bar-magnet, *a*. We learn from this experiment three important points—first, that no parts of the wire are idle; second, that molecular change takes place in the bar, *b*; and thirdly, it is the principle of the so-called unipolar dynamo machine, in fig. 2 the bar, *b*, is bent like the letter U. If the wires, *x*, *y*, are attached to a galvanometer, and the bar-magnet, *a*, is made to touch or approach the end of one of the legs, exactly the same effect will take place as in fig. 1. But if we substitute the bar-magnet,

consequence of its automatic action; but those of the Rosum and southern companies considered that the simplicity of the Brady was so great an advantage that they would prefer to renounce the automatic action upon lines of every gradient.

BALL'S UNIPOLAR DYNAMO MACHINE.

Thanks has recently arrived from America a new dynamo machine of the type conventionally known as "unipolar," that is to which the armature is subject to the inductive influence of one pole-piece only. It is the invention of Mr. C. E. Ball, of Philadelphia, and is now being exhibited at No. 46, Kirby-street, Hatton Garden. The small perspective view and the plan on the present page illustrate the machine in this country, while the large perspective view shows a later form of generator, designed to burn fifteen lights, but the difference between the two is merely constructive, both acting in precisely the same way. Referring to the large view, it will be seen that the machine has a double two drums of the Pacinotti type placed end to end, each armature being partly surrounded by a two pole-piece only instead of two, as is usual. The armatures are rectangular bars carrying bobbins wound with insulated wire in such a way as to produce consequent poles, at a distance of about one-third their length from one end. Thus the pole-piece on the upper magnets is, say, of south polarity, and that on the lower magnets of south polarity, and each influences an armature only. In the machine makes the two parallel lines CC constitute the series of the field magnets, and for constructive reasons are left naked opposite the armatures, whether intended to receive a pole-piece or not. The direction of the current is shown on the drawing; leaving the commutator P it passes in succession through the left-hand coil and the middle coil of the bar c, through the coil c', through the external circuit, through the coils c'', c''', to the brush P' and armature P', and by the brush F through the armature P. This arrangement may be modified in various ways; for instance, both the pole-pieces may be of the same polarity, and the armatures may be wound in the same or opposite directions.

The installation at Kirby-street has been placed in the hands of Mr. Robert Sabine, who has made a numbered dynamometrical, photometrical, and electrical tests, of which the following are the more results:

Current in the circuit	15 amperes
Difference of potential between terminals	185 volts.
Resistance of dynamo ...	3·5 ohms.
Speed of dynamo	1650 to 1710 revs. per min.
dynamometer	332 revs. per min.
Indicated pull on dynamometer, less pull when the circuit was open	52 kilos.

From these values it follows that the useful work imparted to the dynamo, less that absorbed by the friction of the spindle, was 3·68 horse-power; and the work actually accumulated for in the outside circuit was 3·32 horse-power, and in the inner circuit 1·35 horse-power. The proportion accounted for electrically was, therefore,

$$\frac{3{\cdot}37}{3{\cdot}68} = 0{\cdot}92,$$

of which

$$\frac{2{\cdot}92}{3{\cdot}68} = 0{\cdot}79$$

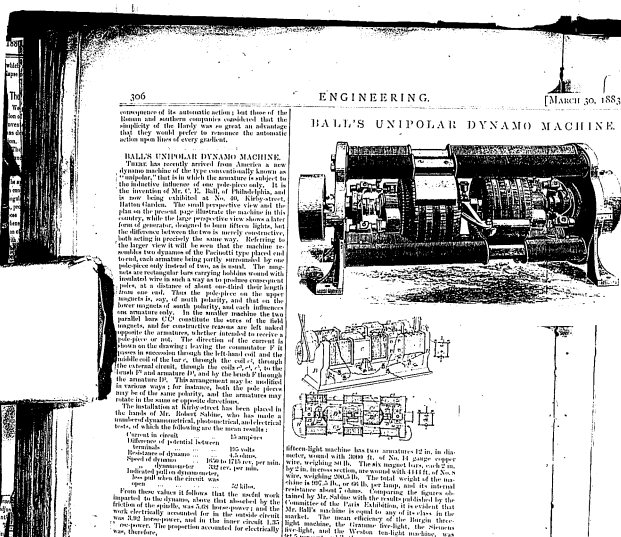
was found in the lamp circuit. Photometric measurements were made with those of the lamps placed upon from the others in a dark recess, the light of the five remaining lamps not being measured. The following mean results were obtained during the observations:

Current in lamps	13·9 amperes.
Potential difference ...	103 volts.
Horse-power accounted for in lamps	0·75 H.P.

The illuminating effects were as follows:

	Illuminating Power.	
Position of Arc with Regard to Photometer.	Standard Candles.	Candles per Horse-Power Accounted for in Lamps.
45° Arc below	1577	1052
22½ ,,	1572	962
Horizontal	1575	1050
22½° Arc above	1533	1047
45 ,,	1533	1047
67½ ,,	1952	2608
90 ,,	1930	2578

The dynamo machine upon which the test was made had two armatures, each 8 in. in diameter, rotating in opposite directions, and each wound with about 10 lb. of No. 14 (American gauge) copper wire. The field magnet coils consisted of 130 lb. of No. 20 wire, the total weight of copper in the machine being 168 lb., which, divided into the number of volts given, gives 17·4 volts per pound of copper. In later machines much better results have been obtained, but none recently done, designed for five lights, having but 88 lb. of copper in it, and weighing only 350 lb. The different light machine has two armatures 12 in. in diameter, wound with about 28 lb. of No. 14 gauge copper wire, weighing 80 lb. The six magnet bars, each 2 in. by 2 in., are also wound, as mentioned with 1111 lb. of No. 8 wire, weighing 1045 lb. The total weight of the machine is 1697 lb., or 56 lb. per lamp, and its internal resistance about 2 ohms. Comparing the figures obtained by Mr. Sabine with the results published by the Committee of the Paris Exhibition, it is evident that Mr. Ball's machine is equal to any of the class in the market. The mean efficiency of the Burgin three-light machine, the Gramme five-light, the Siemens five-light, and the Weston ten-light machine, was 92·5 per cent., while the mean was accounted for in the arcs fed by these machines was 79·5 per cent. of the total. It is difficult to see what advantage can be gained by the use of one pole-piece in place of two, as the magnetic field must necessarily be weakened, and the experiments show that it is not attended by any loss, and that when accompanied by a high speed of rotation it does not necessitate the use of specially large machines.



BALL'S UNIPOLAR DYNAMO MACHINE.

M. JABLOCHKOFF'S NEW ELECTRIC-MOTOR.

Some weeks since we drew attention to the fact that M. Paul Jablochkoff, during a visit to London, had submitted to the inspection of several scientific friends a new electro-motor of his own invention, at once simple and novel. We were enabled to view M. Jablochkoff's machine, but could not at the time publish any facts concerning the principles on which its construction was based. We are now, however, in a position to lay before our readers a few facts concerning the action of this apparatus.

It seems to be established, according to the experiments undertaken on various occasions upon the transmission of power to a distance, that the modern continuous current dynamo-electric machines—Gramme, Siemens, Bürgin, &c.—constitute very efficient electro-motors.

In fact, if they transform 50 per cent. of the power applied to them into electric energy, they are capable of furnishing also in effective work at least 50 per cent. of the electric energy which is supplied to them from terminal to terminal. This return, however, supposes a few secondary modifications in the dynamo-electric machines employed as motors—such, for example, as the arrangement of the brushes, which ought to be set behind the neutral line with respect to the direction of motion instead of in front.

The experiments made with the object of increasing the efficiency of the motor do not seem therefore justifiable, since this efficiency attains at present a figure which it would be difficult to surpass; but besides this question, there is another which it will suffice merely to state in order to make its importance appreciated. What is the actual price of a continuous current dynamo-electric machine capable of supplying $\frac{1}{2}$, $\frac{3}{4}$, $\frac{1}{4}$, 1, 2, 3, &c., horse-power? Practice shows that the actual machines, for equal efficiency, are more economical in cost price as they become more powerful, but that they are very expensive when constructed to furnish the work of only a few kilogrammetres.

We may therefore seek, with little chance of success, for a small electro-motor giving a satisfactory efficiency and low-priced compared to the quantity of work which it can supply, though the problem to be solved has to some extent been effected by the Siemens armature as applied by Marcel Deprez, Trouvé, and by Griscom.

The principal cause of the high efficiency of the Gramme machine, employed as a motor, results from the fact that the changes of direction of the current, and the reversals of polarity, are produced by successive fractions, in a single section at the time, the magnetic force, which must be overcome, is therefore only felt to an imperceptible extent, and one can counteract its detrimental action by a suitable arrangement of the collecting brushes.

In the double T bobbin-motors of Siemens, the magnetic force is less than in the first motors of Froment, Larmoyeur, Page, Lenoirx, &c., by reason of the relatively small dimensions of the magnetic masses submitted to the alterations of polarity; this explains why the return from these motors is intermediate between that of the Froment apparatus and the present continuous current machines. There was one more step to advance in this direction by dispensing completely with the magnetic masses submitted to the change of direction of the current.

At the International Exhibition of Electricity, in Paris held in 1881, M. Bürgin, of Bâle, exhibited an apparatus founded on this principle, and which we described and figured in the ELECTRICAL REVIEW of the 14th January, 1882 (Vol. X., p. 20), translated from *L'Electricien*. We propose to again in order that it may be studied side by side with that of M. Jablochkoff.

It consists of a core of iron, n (figs. 1, 2, and 3), wound round with wire, M, the convolutions of which are wound so as to complete a sphere. This core of iron turns on a horizontal axis, the wires, M, which are attached to the sections of a commutator, C, are traversed by a continuous current from the source of electricity (a battery or a dynamo-electric machine) and polarise the extremities of the core of iron, without reversing the polarities, notwithstanding the rotatory movement of the core.

The sphere formed by this core and the wire, M, M, M, inside a second sphere which is hollow and fixed, and which is wound horizontally a second contiguous wire attached to two brushes of the commutator, C.

In consequence of the reciprocal reaction which takes place between the fixed sphere, B, and the movable polarised core inside, and in consequence of the reversals of current produced in the outer sphere, a rapid rotatory movement is imparted to the core and its axis.

This motor is characterised by the following points:—

(1.) The movable part consists of an electro-magnet, the polarity of which is never reversed.

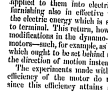


Fig. 1.

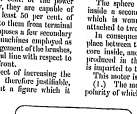


Fig. 2.

Bürgin's Electro-Motor.

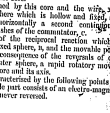


Fig. 3

(2.) The currents are reversed in the fixed part of the motor, and not in the movable part.

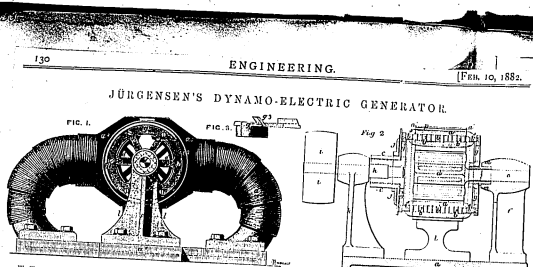
(3.) The movements are produced by the reciprocal action of a current and an electro-magnet, and not by the mutual attraction exercised by two electro-magnets.

There is, therefore, with this mode of construction, no magnetic inertia to overcome, since the system works without reversing the polarity of the core.

The motor of M. Paul Jablochkoff, of which we give an illustration (fig. 4) is due to the same class as the Bürgin machine. It is composed of two bobbins, one fixed upon a horizontal axis in an inclined position, and turning with it, this bobbin is coiled upon a framework of iron, the circles of which form two circular poles (north and south), which, by the arrangement of the commutator, change their polarity twice in a revolution; the second bobbin is fixed in a vertical plane more or less inclined in relation to the horizontal axis of the revolving bobbin; it is coiled upon a non-magnetic frame, and the current which traverses it is continuous in direction. It is the relatively inclined position of the two bobbins which has given the apparatus the name of ecliptic, by reason of the analogy which this inclination presents to that of the ecliptic upon the equator.

The apparatus has arrangements for varying the inclination of the two bobbins so as to determine the best conditions for working; but in the motors for commercial purposes the position of the bobbins, determined once for all, will be fixed and invariable. When studying the mutual action between the movable electro-magnet upon its horizontal axis, which is submitted to the alterations of direction of the current, and the fixed solenoid in which a continuous current circulates, we see that there must result from it a

JÜRGENSEN'S DYNAMO-ELECTRIC GENERATOR.



We illustrate above an interesting form of dynamo-electric machine which was shown at the recent Paris Electrical Exhibition, but which attracted little attention on account of the absence of any attendant to explain its construction. It is the joint design of Professor C. H. Jürgensen and Mr. F. L. V. Lorenz, both of Copenhagen, and embodies several special features in its construction, the principal one being the introduction within the ring armature of an electro-magnet intended to utilise the inner portion of the coils on the ring. The ring consists of a number of thin sections *b* placed side by side, and insulated from each other to prevent the creation of induction currents; by this arrangement very wide rings can be constructed. The sections are held together by bolts passing through them at intervals as shown. Around the ring thus formed the wire is coiled, as indicated in Fig. 2, to complete the armature, which is constructed as follows: To the outer surfaces of the insulating discs *d*, are secured insulated rings *g*, *g* provided with spokes, but each ring is of a somewhat different form. These *g*'s have a small boss, to which is screwed the sleeve *n*, which enters the bearing *a* of the main standard *f*. The other boss *g*' is formed with a long sleeve passing over and secured to the driving shaft *k*. The spokes connecting the ring *g* with the boss are provided with wings *g*', shown in Fig. 3 for the purpose of creating an entire current of air to and keeping the various parts of the machine cool. This is given to them by the pulley *i* mounted on the shaft *k*, which will be seen terminates flush with the inner face of the ring *g*'. The outer electro-magnet *m*, *m* are base-plate at *l*. Each magnet terminates in a wide pole-piece *o*, *o*', the faces of which embrace the armature for nearly the whole of its circumference. In addition to the coils in these magnets increase in volume up to the pole-pieces, the object of this being to obtain a more equal distribution, with less resistance. In order to increase the attraction and increase the steadiness of the machine, the tops of the pole-pieces are held together by an insulated plate *p*, and the latter by two insulated standards *l*, *l*. So far then the machine consists of a cylindrical armature, long at the end of a short shaft, and placed between the widespread polepieces of the two curved electro-magnets, which complete the machine. The space within the cylindrical armature is filled with a second electro-magnet, as shown in Fig. 2. The magnet is carried at the end of the shaft *s*, passing through the bearing *a*, and the sleeve *n* which carries the ring *g*. The magnet consists of two bar magnets at right angles to each other, as shown in Fig. 1, the method of coiling being indicated in the section Fig. 2. At the ends of these magnets are the pole-pieces *r* curved so as to present their surfaces to nearly the whole inner side of the ring. The north and south poles of this magnet are opposite the similar poles of the outer magnets.

The commutator of the machine is shown at *c*, and consists of a series of copper L-shaped bars, one face of which rests on the sleeve to which the driving shaft is screwed, the other face projecting against the ring *g*; the section shows two of these commutator bars. They are, as shown, insulated from the sleeve and ring, and also from the large washer *q*, by which they are fastened to the ring *g*'s. The collecting brushes are not shown, but they are of the usual kind, and may be placed on the bracket *t*. They are capable of adjustment. The current to the inner and outer electro-magnet may be either taken from the main current of the machine, or from a part of the armature reserved for that purpose, or a separate exciting machine may be employed.

The special features in the machine we have described, which was exhibited by Messrs. Jurgensen and Lorenz, are the application in dynamo-electric machines of an electromagnet within the revolving armature, with or without the use of external electro-magnets; the use of annular rings, insulated from each other; the special mode of mounting and coiling the machine by means of the fan or wings attached to the ring at the end of the armature; and the special form of outer electro-magnet. It is to be regretted that no figures are available as to the duty of this machine. Messrs. Jurgensen and Lorenz claim that for its size it is the most powerful dynamo-electric machine yet made, but we have no data on the subject.

Electrical Notes, 1882.

A series of public experiments were made with the Hjelmstrome and Vincent dynamo machine on the evening of Wednesday, February 21, at the offices of Mr. Edwin Brothers, Little Bridge-street, Ludgate hill. The machine was shown feeding 300 Swan lamps, but it is capable of maintaining as many as 600. In addition to this a number of experiments were performed by the Swan, such as boiling water, fusing long lengths of wire, and burning a file. The lamp, so used in the Swan, capable of giving an illumination equal to 100,000 candles.

THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XI.—NO. 255.

THE "FERRANTI" MACHINE.

ALTHOUGH so much interest has recently been excited in the public mind by the various reports which have been circulated as to the revolution to be effected in electric lighting by the new dynamo-electric machine devised by Mr. Ferranti, the effect on the shares of the other electric light companies has been comparatively nothing worth speaking of. Whether this state of things will continue remains to be seen; but it appears evident that the public is beginning to understand what may be expected from the very best machines that we can ever hope to produce. We may mention here that the system of electric lighting of which we are now speaking, and which is being brought forward under the auspices of the "Hammond" Electric Light Company, is known under the name of "Ferranti" only, Sir William Thomson's connection with the former gentleman being in the alternating current machine of which they are joint inventors. An interesting correspondence, touching the efficiency of the new machine, has recently taken place in the columns of the *Times*, and a Mr. Pertwee—evidently an enthusiastic advocate of the Ferranti system—makes use of what knowledge he possesses regarding the merits of the recent invention to place the Brush machines in a bad light. The secretary of the Anglo-American Brush Electric Light Corporation has replied to Mr. Pertwee's criticisms, very much to the point; however, we can only express a wish that the public will look at such correspondence with indifference, and that they can be actually supplied with genuine figures on which to base their judgment.

It is easy for those conversant with the details of electric lighting to see where comparisons fail, but the general public cannot yet be expected to understand that machines constructed for arc lights will not answer for incandescence lamps. We stated in our columns a short time since that it was difficult to credit the stated low efficiency of the Brush machine for incandescent lighting, more especially if constructed for the latter purpose, and we now find that the results given were obtained from a machine manufactured for arc lighting. Eleven incandescent lamps, of 20 candle-power each per horse-power, from a Ferranti dynamo is not such an exceedingly startling performance as many would imagine, unless we understand by this that the horse-power is that of the engine, and not electrical. We do not know where Mr. Pertwee gets his information from concerning the large Ferranti machine for 25,000 lamps, and upon which he bases some comparative estimates, but we presume that all the various types of these machines are calculated from the experimental one. There is, however, really in existence a dynamo-electric machine, devised by another inventor, which we believe was constructed either for 5,000 or 8,000 lamps. This we hear is, experimentally, highly successful, and as many as 2,000 incandescence lights have at present been connected up with the machine. We are not at liberty to publish further information we have regarding this dynamo, the largest by far yet actually constructed, but as its results will be eagerly looked for we shall endeavour to keep our readers informed as to its performances. To the best of our knowledge, only a small experimental Ferranti machine has yet been tested, and on the strength of this the Hammond Electric Light Company has issued a pamphlet giving estimates for complete installations of the Ferranti system, from 25 to 25,000 incandescence lamps, and from 1 to 65 arc lamps, each system of lighting being from one machine.

We recommend this circular to the notice of all interested in electric lighting, and it may not be out of place to give some particulars here as to the estimated prices of these new machines. One F' Ferranti dynamo, for 65 lamps of 1,500 (nominal) candle-power each, £650, and an E' machine, for 32 similar lamps, £350. For 65 arc lamps, of 2,000 (nominal) candle-power each, one E' machine costs £650, and a machine for 26 similar lamps, £200. Concerning these latter it is stated that three-quarter indicated horse-power is required for each light. It would be premature to express an opinion on this matter at present, but one thing is certain, that if machines to produce the above results can be sold at the prices named, then the ventors of the Hammond Electric Light Company will be well repaid; and the public also will not be slow to take advantage of the greater inducements offered to further the progress of electric lighting.

NEW DYNAMO-ELECTRIC MACHINES

THERE is no doubt but that the consumtaker of a continuous current dynamo-electric machine gives generally more trouble, and requires more attention, than any of the other sorts of such apparatus. The reasons why the commutator requires special care are too well known to electricians to render it necessary for us to dwell upon them; and to do away with this portion of the machine altogether has long been the aim of many inventors.

We do not know of any successful result in this direction as yet, and when an invention professing to accomplish this object is brought forward it deserves more than passing notice.

There has just been issued the specification of H. R. Newton (communicated by Alphonse Isidore Gravier, of Paris). Mr. Gravier's previous ideas are well known to electric light engineers, and the object of the present invention is the production of continuous or of alternating current from a dynamo-electric machine, either in intensity, quantity, or in series, without the use of rubbers, collectors, brushes, or commutators.

The inventor says that by studying the action of dynamo or magneto-electric machines, one general fact which dominates them all is apparent, viz., the necessity for the commutation of the current produced.

Thus if a permanent or electro-magnet be caused to turn in front of a system of bobbins however arranged, currents are induced in these bobbins which change in direction at each half revolution of the inducing magnet.

This is all very well when such alternating currents can be utilised; but should continuous currents be required, recourse must be had to various contrivances, such as commutators, rubbers, brushes, &c.

Besides this, the currents thus obtained and re-arranged are not continuous in the strict interpretation of the word. They are in the same direction, it is true, but they really consist of a series of short currents starting from zero, rising

THE SCHUCKERT DYNAMO-ELECTRIC GENERATOR.

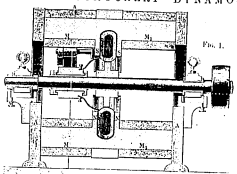


FIG. 1.

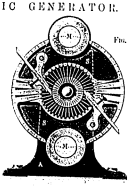


FIG. 2.

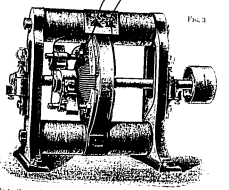


FIG. 3

FIG. 4.

ANNEXED are illustrations of a dynamo-electric generator used considerably on the Continent and in this country, manufactured by the Brush Electric Light Company. This machine, constructed by Mr. S. Schuckert, of Nuremberg, consists of two vertical frames A, between which are fixed the cores of the electro-magnets M M. These cores are cylindrical except at the middle of their length, where they are widened as shown, and formed with a channel groove to receive the revolving armature. The latter consists of a ring built up of a number of plate discs insulated from each other, and covered with coils as shown in the section. This ring is nearly enclosed by the semicircular cores before mentioned as being formed in the middle of the field magnets, and which approach each other within a short distance of the horizontal axis of the ring. The object of this special arrangement is of course to bring a large a number of the convolutions of the armature coils as possible within the influence of the magnetic field. The commutator of this machine consists of a number of metal segments insulated from each other, these segments being connected respectively to the sections of the armature coil. The number of these sections varies from four to one hundred, according to whether the machine is intended for low or high tension, and the end of each section is connected to the corresponding segment by a screw, so as to be easily removed for repair or renewal. In the generator illustrated the commutator is shown within the frame, but in the latest pattern it is placed outside the frame so as to be more readily accessible. The arrangement of coils on the armature, and their connexions with the commutator, are shown in Figs. 3 and 3, which also illustrate the way in which the brushes are attached to the pole-pieces. It will be seen that they are each pivoted on a pin, and are free to move the brush passing through a screw and fixed in position by set screws so as to be easily made of exact adjustment.

As already stated, this generator is in considerable use, and appears to give very good results. It is constructed after several different types, varying with the size, and the purpose for which they are specially intended, for the deposition of metals or the production of the electric light. In no modification these machines are made self-exciting, with commutators on both sides of the armature, about one-third of the current being taken off to excite the field magnets. In another type two rings are placed side by side on the shaft, the latter being adapted leading itself to this arrangement, which, of course, involves the use of two commutators. Although the machine is driven at a high speed in ordinary working there is little or no trouble from heating.

The generator has probably the highest electro-motive force in any in practical use, and for this reason it shows with the finish machine the advantage of being especially applicable to installations in which the driving station is at a considerable distance from the area to be illuminated, but it of course requires a proportionately increased care in handling, and in the manipulation and fixing of the conductors.

THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XI.—No. 252.

...TIVE-POWER FROM ELECTRICITY.

...ount the idea of obtaining motive-power by the ...ation of electricity is very old, and notwithstanding ...t that we possess at the present time such means of ...ing powerful currents as were quite unknown to the ...s men of electricians, yet the matter does not seem to ...so much attention concentrated upon its ultimate ...n now as is formerly did. This seeming want of interest ...bable, chiefly accounted for by the superior attractive... or the moment, of the electric light, so it is scarcely ...vondered at that the electric-motor is being worked ...y comparatively few. Had our predecessors possessed ...namo-electric machines of our day, the problem of ...ng to a practical and economical end the latent power ...waste forces of nature would have been solved. We ...not, however, lose sight of what has been done by ... Siemens and others of late years towards the practical development and use of electric railways; but the distribution of electric force for light work, such as actuating small lathes, &c., does not appear to have yet arrived at any definite solution. It has been stated over and over again what a boon such an application of electricity would be to the numberless workmen privately engaged in the mechanical trades, and who cannot afford to erect a steam-engine and boiler to supply their motive-power. Such a desirable method of securing an invisible but powerful ally cannot, however, fail to the lot of the British workman until, as in the case of electric lighting, central stations are established for electrical distribution on a large scale. Almost without exception electric lighting companies have the word "power" attached to their titles, yet we cannot call to mind a single instance of the application of electricity for such a purpose by any one company. It is somewhat surprising that an association has not yet been formed in England for supplying motive-power solely. With machines which will reproduce at a distance 60 per cent. of the horse-power developed by the driving engine, surely a profitable business might be insured to any company based on such a project, and we feel convinced that the venture would meet with the most favourable support.

The late Electrical Exhibition held in Paris gave sufficient evidence that such an idea is quite practicable, and it may be that the forthcoming exhibits at the Crystal Palace and the Royal Aquarium may produce something novel in this direction. Although private householders might not at first be induced to "rent" electricity for the purpose of driving the family sewing machine, yet there are innumerable instances of manufacturers employing dozens of these useful domestic articles who would certainly be well content to use electric power for the benefit of themselves and the operatives, who cannot but experience great fatigue in driving such machines throughout the long hours to which they are usually subjected. A company formed for this object would not be under the necessity of purchasing patents, as there are several good and simple motors which are free to every one, and the dynamo-electric machines can be obtained from numerous firms. Such extraordinary speculation has been indulged in during the present year, in connection with electrical matters, that we believe the public would strongly support a genuine movement for the general supply of electric power if kept free from electric lighting altogether. It is probable that the most successful start could be made in certain provincial towns rather than in the metropolis, but in either case the scheme appears perfectly feasible.

TESTING BATTERIES OF LOW RESISTANCE.

By H. R. KEMPE.

THE practical difficulties which are found to exist in carrying out the ordinary battery resistance tests, when these tests are applied to the measurement of batteries or accumulators of low resistance, are being continually experienced; some method, therefore, of overcoming these difficulties may prove useful. One fruitful source of error is no doubt imperfect connections from the terminals of the battery cells not being properly cleaned or screwed up, whilst the resistance of the connecting wires themselves may introduce an error which cannot be ignored when the resistance of the cells is excessively small; for instance, the resistance of a single cell of an accumulator may be as low as ·001 ohm, that is about the resistance, of 12 inches of copper wire of No. 13 B.W.G. or 1·10th in. diameter. Supposing, however, that the proper precautions have been taken so as to avoid such errors in the foregoing we are confronted with other difficulties. It is pretty generally known by those who have had to make practical measurements that in order to take battery tests with anything like accuracy, it is necessary that one measurement be made with the battery connected to a resistance approximately equivalent to the resistance of the battery itself; thus in the well-known "half deflection" method we first connect the battery to a galvanometer of very low (and consequently negligible) resistance, and then having noted the deflection, we introduce into the circuit a resistance sufficient to reduce the deflection to that point which indicates that the current flowing in the circuit has been halved in strength. When this is the case the resistance added in the circuit is the resistance of the battery. Instead of reducing the current to one-half strength, it is sufficient to introduce sufficient resistance in the circuit to produce a definite diminution in the deflection, and then from the true deflection observed, and the resistance added in the circuit, the resistance of the battery can be determined by a simple formula. Another well-known method is to charge a condenser from the battery, and then to note the discharge; a second discharge is then taken with the battery shunted, and then the resistance of the battery is determined by a simple formula. Now, in order that any of these methods may be accurate, it is very necessary that the reduced deflection be a decided one. For instance, if the first deflection on a Thomson's galvanometer, say) be 200 divisions, then the reduced deflection should not be less than 150 divisions, and preferably it should be as near to 100 divisions as possible. Assuming, however, that 150 divisions is sufficient, then this will mean that the battery is shunted by a resistance equal to three times the resistance of the battery. Now, supposing we tried to test a single cell of an accumulator having a resistance of ·001 ohm by this method, then when the shunt is inserted we should have a current flowing through the latter equal to

$$\frac{2 \text{ volts}}{\cdot 001 \times 666} = 500 \text{ ampères,}$$

a current sufficient to fuse, or at least, seriously heat (and

arrangements were made to ascertain the exact number of lamps in the circuit during the observations. They were scattered through the whole district, and could not, of course, be stopped at any given moment after they had been started for the night. We were not able to count the lamps at the time to measure the power generated, and also the difference of potentials between the two poles, but we got at these results by indirect way. We were enabled to measure not only the difference of potentials between the two mains, but the current flowing, and, therefore, we got by means of knowing the energy expended in the wires. Simultaneously with these observations we made others on the mean power of the lamps, so as to keep that constant in our calculations. Of the current which comes out of the dynamo, more or less, can be thrown into the magnets; and, by altering the current, the whole of the lamps can be raised or lowered so that they can be kept constantly at 16-candle power. Experiments with the series of indicated dynamos were taken to indicate the power consumed simply in turning the machine at a normal speed when no current was generated. For that purpose the switches which connect them with the magnets, and the lamps with the mains, were opened, and the engine was run at the speed of 270 to 300 revolutions. The results observed were plotted down as a curve, the ordinates of diagram, where the abscissæ were taken to represent the number of lamps and the ordinates the horsepower. Immediately after that the main switch was closed, the external remaining open. So that the dynamos were taken represented the difference between the two energies—that is, the power employed or consumed in maintaining the current in a full circuit, and also local currents in the coil and armature. That difference was found to be 19·77 horse-power. With these safeguards, then, we found that for 300 lamps we had an expenditure of 42·45 horse-power; for 600, 105 horse-power; for 900, 172 horse-power; for 1,200, 145 horse-power. Deducting the 19·77 horse-power consumed in charging the field and overcoming the friction, a total of 125 horsepower remained as occupied in maintaining 1,200 lamps. The result, therefore, is that, after overcoming the friction, the addition of eight 16-candle lamps makes a difference of one additional indicated horse-power. The efficiency so stated is a compound efficiency—partly of dynamo and partly of lamp. The 16-candle lamps were taken at a current of 0·66 (28) ohms when hot, and the 16 only 1·10 ohms—or one-fifth only half the current and horsepower the latter yield. Deducting 19·77 from 125, we get as the efficiency of the dynamo from the lamp, or, did one not want of time, make accurate experiments to measure the current directly, but we made arrangements for ascertaining what was the actual current going out. We could get this from our diagrams. The observations on the difference of potential between the poles of the machine showed that the machine was generating 105·5 volts as the mean. The resistance of the field-magnets taken as the constant is 6·72 ohms. The magnets are twelve in number, and the coils are coupled each in series and two in multiple arc. Therefore the energy

$$\frac{105{\cdot}5^2}{6{\cdot}72} = 1{,}654 \text{ Watts,}$$

represented by the current in the field is

or two horse-power. The total power was 19·7 horse-power. Deducting from this 2 for friction and 2·2 expended by the energy of the field current, we have 9·5 as waste in local current and in the armature bars. We have, then, on the whole, 17·56 horse-power as ineffective in producing current when the dynamo is running with 1,200 candles. The total horsepower ought to be 125. The efficiency of the dynamo is the difference, or 88 per cent., or nearly 90 per cent. This efficiency increases with the number of lamps, and as the machine will bear working up to 1,200 lamps the external resistance of the circuit, and the armature begins to heat, a slightly higher efficiency can be obtained. Special tests on the efficiency of the lamp, to determine the actual horse-power expended in the carbon, showed that with a current of 0·66 ohm the pressure was 46·2 volts, and with a current of 1·05 volts and the current per lamp 7·4 or 7·5 amperes. The result was 72·63 Watts or 1-10th horse-power in the energy expended in the carbon itself. From the horse-power indicated useful series of facts could be obtained. We were able to plot another curve, of which the abscissæ represented *time* and the ordinates horse-power equivalents, so as to express the work of the engine in horse-power hours. Other experiments in general interest were made at the same time on the efficiency of the boiler. The results, therefore, carried out with very considerable care, show that this dynamo has the power of converting into energy of electric current some 90 per cent. of the energy applied to turn the armature of the machine.

The President said that it was only upon such experiments as these that the public were enabled to form an opinion on the subject. Discussion being invited,

Mr. Hedges said that they did not yet know the exact laws upon which the efficiency of energy took place. He had never seen a satisfactory expression for the work of one of these machines, from which one could deduce the connection of the current with the speed, and the resistance which were the three variables in the problem which the engineer required to solve before he could be thoroughly answerable for the action of these machines. They heard a great deal about the characteristic curve of a machine; here it had been furnished by a series of experiments which only supplied what might be have been known without them. Problems in dealing with current velocity of resolution and resistance ought not to depend on experiment for their solution. He had himself endeavoured to analyse published figures on the subject. One of the chief things which he really wanted to know was, "Is the alteration which occurs in the magnetic field produced by the revolving armature considered as a metallic mass?" This was most important for the practical question of the electric magnetism is one of the factors in the determination of the magnetic force. The method of experiment which had been made by Mr. Siemens and described in a paper given before the Society of Arts in May, 1881. That paper assumed the reduction of the magnetism from what it would be when the armature did not receive

by the field, to be proportional to that augmentation and to the velocity of rotation. But it has since been found out that the velocity of the following machine is greater than the velocity of the driver, a very odd thing indeed, and one which entirely did away with the hypothesis of that paper. Siemens that the magnetism in the armature machine would be increased by the revolution of the armature.

Mr. Mackenzie, Edinburgh, followed with a few remarks on the practical results of these machines as exhibited in actual lighting, contending that frequently the cost of the system was a bar in its adoption.

RECENT PROGRESS IN ELECTRIC RAILWAYS.

[Paper read before Section G, Monday, August 28th, 1882.
By Dr. Fleeming.]

Mr. Ritchie has for some time been struck by the economy involved in an electric system of transport, and has set himself to design an electric locomotive, taking as his type the ordinary steam locomotive. He has taken out all the interior mechanism and replaced it by mechanism appropriated to drive the machine by means of an electric current. The machine which he has designed has been done is as follows:—At a certain station they were driven a set of dynamo machines of the well-known patent of Elihu Thomson, consisting of eight of the ordinary 16-candle incandescent lights. A battery is set up at the central station with mains proceeding out at different points on the railway. The current, when it has entered the circumference of the wheel, passes up into the central hub, and so is taken off by brushes into the dynamo placed in the interior of the engine. Hence it is necessary to have the centre of the wheel insulated from the tyre. The dynamo in the interior are of the same type as made by Mr. Ritchie for lighting purposes. The armatures are wound on the Siemens principle, and the same possibility is preserved in the dynamo of making what Edison calls a large intervening mass of iron. The armature is driven by a pinion which takes teeth of cast in the usual way, can be started or stopped by shifting the current into the dynamo, and by varying the external resistance in the circuit of the field of the dynamo, the engineer or locomotive driver has the power of varying the speed of the engine. Mr. Edison has so far succeeded in his experiments that they can run a train of rolling stock at 30 miles an hour in Menlo Park. The most important question of course is whether this engine is to be at any rate economical than the ordinary steam locomotive, and Mr. Edison's statements as to this are based on the design of the ordinary locomotive of the usual type. In such a locomotive it is not possible to get one indicated horse-power with a less consumption than 9 lbs. of coal per hour, unless special attention is given to the living and running. With careless living it is possible to get it to run at a great deal more in the consumption of the coal, using as low as 6 lbs. of coke through the funnel. But under this arrangement you have to add to the consumption of consumption of the coal from the fire-box of the engine to the central station, at which the stationary engines will be of a far more economical type, and using engineering engines of the best type and taking very careful means to economise the consumption of coal, it can be got down to something like 2½ lbs. per horse-power per hour. Therefore there is in the first place a large saving in coal—though it remains to be seen whether what is thus gained is not lost in the transformation of the energy of the coal into electric current. Careful experiments have yet to be made to ascertain the efficiency of the dynamos used: what proportion of the coal-power is transformed into electric current. Some recent experiments at Messrs. Siemens' Mr. Edison's electric light efficiency. The result, so far as the experiments have hitherto gone, is that 84 per cent. of the power supplied to the electric energy more than 90 per cent. of the power appears in turn there. Then as to the resistance of the circuit, which is the other factor in the question, there is another question. Of course there is a loss of energy in the circuit of the mains, and also a loss due to leakage on the railway by imperfect insulation; but even allowing these losses as 50 per cent. for this, assuming that the Porter-Allen engines give an indicated horsepower of 2½ lbs. of coal per hour, Mr. Edison thinks 1 horse-power required for his electric railway, as against six in driving a locomotive. Hence Mr. Edison thinks we may regard these figures as a reliable indication that an electric railway is a more economical means of realising the energy of coal for obtaining motive from place to place. Another controversy which Mr. Edison sees is for the purpose of enabling locomotives to climb the hills in certain cases where the locomotive has to ascend an incline, as for example greater than 1 in 30 or 1 in 40. Mr. Edison proposes to overcome this difficulty by the use of a rack and pinion.

In the first dynamo, Mr. Edison contemplates the use of a belt, but in the later forms he has adopted an endless screw gearing, which is safer than the belt. In the dynamos which he is using to supply a current from the central station he has adopted the plan instead of doing away with belt and gearing, and making the engine connect to the armature of the machine, so that I think there will be still greater advances in the economy and efficiency of the machine which he has devised.

Dr. Forbes said that the assumption on which the calculations seemed to be based on the locomotive consuming 6 lbs. of coal per horse-power per hour was nearly twice the actual fact.

Prof. Forbes said that much in this paper required very great consideration before an opinion could be formed upon it. They were told that 90 per cent. of the power put into the dynamo was converted into the current, but they were not told how much of current was used up in overcoming the dynamo effective, i.e., in overcoming the internal resistances. That statement was quite distinct from stating that 90 per cent. was being used efficiently. Perhaps about one-half might be used in overcoming internal resistance, so that if they allowed 10 per cent. for leakage and so forth, and a large loss of current in the interior of the machine, it would seem almost impossible to imagine that the cost could be so small as had just been stated.

Menlo Park Scrapbook, Cat. 1027

No. 17B. "Magneto Electric Generators"

This scrapbook covers the years 1881-1885 and contains clippings about generators. There is also one item for 1879. The book is unnumbered. Approximately 60 pages have been used.

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1027

EFFICIENCY OF THE FERRANTI GENERATORS.

On Wednesday last, in the presence of several scientific gentlemen at Messrs. Fernald, Thompson, and Waters, Limited, a series of tests of one of their generators, designed to feed one thousand Swan lamps, their object being to show the number of lamps which could be maintained at full efficiency per indicated horse-power of the engine. The plant consisted, in addition to the generator, of a 25-hp four semi-portable compound engine, with cylinders 12in. and 23in. in diameter, and 24in. stroke, driving a countershaft from which the dynamo, running at 1,000 revolutions per minute, was actuated. The Swan lamps were arranged in two groups; of these the smaller group contained only sixty, and upon these the photometric and other tests were made, as the total current for all the lamps was so large to be conveniently measured. The larger group contained 960 lamps, but as there was a difficulty in transmitting the necessary power through so many miles of them were thrown out of circuit, and consequently the total number actually in use during the experiments was 840.

The resistance of one lamp as tested cold was 292 ohms, and when hot 106.8 ohms. The standard of efficiency adopted for each lamp was .61 watts per candle, and at this intensity the average illuminating power equalled 1,836 candle power. The conductors leading to the smaller group of lamps offered a much less resistance, proportionately to the filaments, than those leading to the larger group, and therefore the intensity of the light of these lamps would be greater than that actually measured. The total resistance of the 840 lamps, plus that of the 1,120 ohms, and of the leads and collecting brushes, when cold, .065 ohm. This, it is observed, is not quite constant, for as the metallic resistance increases with the increase of temperature, that due to the friction on the surface of the collectors would fall, as they get a better bearing on the rings during the rotation of the armatures. Thus the ratio of internal to external resistance was as .065 to .179 or as 1 to 35.3. This includes the resistance of the leads, which for the greater part of the current was less than 1 per cent. but of the lamps. The resistance of the exciting coil was 2.75 ohms, and that of the field magnets 7.37 ohms, while the exciting current was 22.7 amperes.

Several sets of diagrams were taken from the engines and the mean power developed proved to be 123 horse-power. When the straps were thrown off the dynamo, and the engine and countershaft were running light, the power absorbed was 34.7 horse-power, and if to this be added six horse-power, the estimated amount absorbed by the two heavy leather link belts employed to drive the dynamo, the net amount transmitted to the generator is 82.4 horse-power. Dividing the number of lamps by the power we find that each horse-power maintained 10.19 lamps, a most satisfactory number. Calculating the electrical horse-power by the figures obtained from the test group we find it to be 67.8, or within 15 of the indicated mechanical power.

If, as we understood, the resistance of the leads to the small group of lamps was 11 per cent. of the resistance of the filaments, and the resistance of the leads to the large group was less than 1 per cent., then the difference of potential at the terminals of the lamps of the larger group would be greater than that exerted, and the current would likewise be greater, and hence a higher efficiency would be obtained than appears from the figures, and the electrical horse-power, instead of being 81.8 per cent. of the absorbed horse-power, would be much higher. It would be interesting to see the experiments repeated under still more exact conditions.

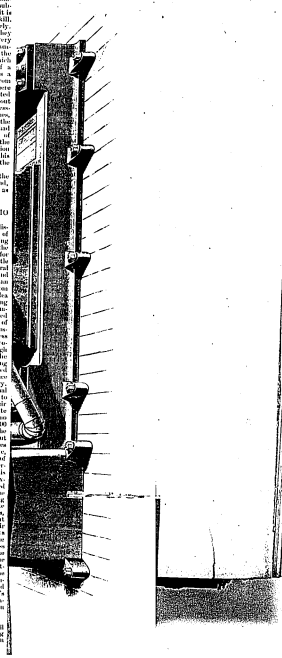
The Ferranti Company, unlike many of their competitors, have chosen to work out each successive improvement which has presented itself before electrifying the criticisms of the public, and hence the plant has sometimes been held that they feared to face inquiry. The figures obtained by these experiments, and the open manner in which they were conducted, should prove that the Ferranti machine, in addition to being exceedingly compact and small for its power, is also economical and efficient. At the same time it need be remembered a consumer is not so much interested in measuring the power absorbed by the generator as the power indicated in the engine required to drive it, as that determines his coal bill, and hence for his purposes it must be said that the number of lamps per horse-power was 6.84, a striking difference, and one which is not always borne in mind in calculations of this kind.

sioners of Montreal as one of a Commission of Engineers to report upon a general scheme of improvements for that harbour, his colleagues being Major-General Newton, of the Corps of Engineers of the United States Army, and Mr. (now Sir) Sanford Fleming, C.M.G., &c., Ottawa, engineer-in-chief of the Intercolonial and Canadian Pacific Railways, Mr. Bell was elected to serve as the chairman of the Commission. The report which they prepared on the subject is now on Blue paper, and the plans by which it is accompanied display a vast amount of engineering skill, which Messrs. Bell and Miller chiefly, though not entirely, devoted themselves to dock and harbour work. They designed and superintended the construction of a very fine bridge over the Clyde at Glasgow, which was completed about a dozen years ago. It is known as the Albert Bridge, an illustrated description of which appears in our tenth volume. Another work of a similar sort was finished a few years ago; it is a bridge over the Kelvin on the road leading from Glasgow to Dumbarton. It may be mentioned here that Messrs. Bell and Miller practically reconstructed the Portland-street Suspension Bridge, Glasgow, about fifteen years ago. They also designed and successfully carried out at least three water supply schemes, one for the town of Grangemouth, another for the cities of Rio Grande and Pelotas in Brazil. We had almost omitted to mention that his London firm of Bell, Miller, and Bell, have in hand the works of the Albert Exhibition Palace, now in course of erection at Battersea. The third member of the firm in this case is Mr. Imrie Bell, Mem. Inst. C.E., who was the engineer for the Jersey Dock Works.

Mr. Bruce Bell was long a leading member of the Institution of Engineers and Shipbuilders in Scotland, serving on the Council as a Vice-President, and as President during the years 1876-78.

THE CENTRAL STATION EDISON DYNAMO MACHINE.

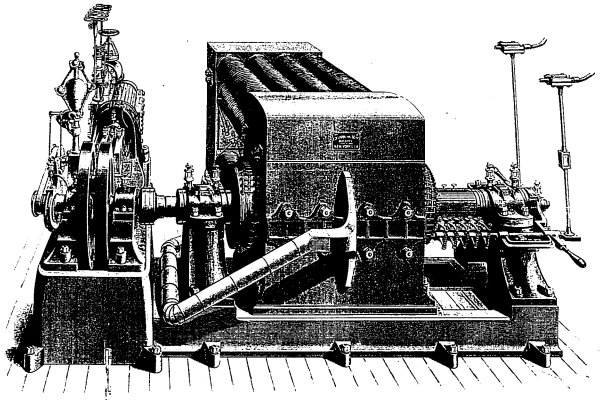
Now that central stations for the lighting of districts are about to be erected in several parts of London, the subject of generators capable of giving powerful currents acquires a new interest, and at the same time the problem of driving them, presents a solution. Hitherto a large installation has been little more than an assemblage within one building of several small ones driven from one or two countershafts, and thus it has come that such plants have presented an appearance of complication, and have further, from the creaking and rustling of the belts, given the idea that an immense amount of wear and tear was going on. It is quite certain that before large areas, employing many thousands of lights, can be supplied from one source, great alterations both in the sizes of the generators themselves, and in the means of transmission, will have to be made before practical success is attained. The earliest and most enthusiastic advocate of district lighting was Mr. Edison, and although his anticipations have not been realised with the rapidity he predicted, yet his system is spreading rapidly in the States, where the company engaged in carrying it out has obtained greater experience of town lighting than any firm in this country, consequently their operations acquire additional interest to English electricians who are about to engage in enterprises of a magnitude far beyond their previous experience, and in view of this we illustrate on the next page the latest type of the Edison dynamo machine, as it appears when designed for feeding 1200 incandescence lamps from a central station. The generator is driven directly from the engine without the use of belts or gearing, and consequently revolves at a moderate speed, about 350 revolutions per minute, while there is no fear of a stoppage from the failure of the intermediate parts. The engine is of the Porter-Allen type, and indicates about 250 horse-power; it is fitted with a Porter governor and an automatic expansion gear, and drives on to a crank-pin fitted between two balance discs. The dynamo follows the ordinary horizontal Edison type, the armature being formed of copper bars upon a core built upof alternate discs of sheet iron and paper, and the field magnets, of which there are twelve, being placed in a shunt circuit. A small fan delivers a constant stream of air to the centre of the armature, where it divides and flows to each end, carrying away the heat generated by the current. Five brushes, each in a separate holder, press upon each side of the commutator, and deliver the current into the two mains shown at the right of the figure, from whence it is distributed through the network of conductors laid all over the district. The point of contact between the brushes and the commutators can be varied, as the whole system is carried on a pivot co-axial with the armature. Mr. Edison's system provides for the connexion of several such machines with one set of mains, and for their regulation according to the demands made upon them.



ELECTRIC LIGHTING IN PARIS.—The Municipal Council of Paris has voted a credit of 200*l*. for the electric lighting of the principal rooms of the Hotel de Ville. The Edison system will be the one adopted.

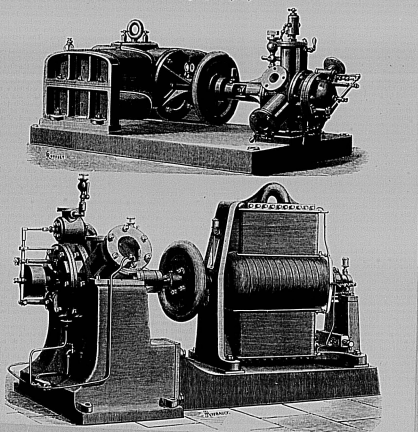
EDISON TWELVE-HUNDRED LIGHT DYNAMO MACHINE, WITH PORTER-ALLEN ENGINE.

(*For Description, see preceding Page*).



DYNAMO-ELECTRIC MACHINE DRIVEN BY BROTHERHOOD ENGINES

(*For Description, see Page* 63).



Engineering, July 20th 1883

MR. PETER BROTHERHOOD'S WORKS.

In our issue of April 27 last, we gave a series of plan and elevations illustrating the new works which Mr. Peter Brotherhood recently erected on the south bank of the Thames immediately below Westminster Bridge, and now we supplement those by a phototype which we publish with the present number, and which gives a perspective view of the interior of the erecting shop. This shows more particularly the central portion, conveying a clear idea of its spacious accommodation. The parts under the galleries of each side, where the machine tools are erected, do not appear in the view. The roof is in four spans, 80 ft. in all, two being over the central erecting shop, and one over each gallery; the length of the part shown in the view being 76 ft.

In addition we give two engravings of the three-cylinder Brotherhood engine arranged to drive dynamo-electric machines. Fig. 1 shows an engine with cylinders 3 in. by 2¾ in., coupled direct to a 6½ Hopkinson dynamo machine, intended to run at a speed of 1500 revolutions a minute and feed forty 5-ohm lamps. Many of our readers are acquainted with the construction of these engines, but we may briefly call attention to the leading features of their design. The chief point which renders the attainment of such high speeds possible is that the connecting rods are always in compression, the steam pressure acting on the back of the pistons to force them forward, and the crank forcing them back. This uniformity of direction of pressure not only does away with all backlash, but greatly simplifies the big ends of the connecting rods, which, instead of having eyes which completely surround the crank-pin end, are segmental bearings of rather less than 120 deg. each. The three connecting rods articulate in the same vertical plane, and abut upon a bush loose upon the crank-pin, where they are held together, for security's sake, by two encircling steel hoops. There are no piston rods, but the pistons are made very long, so as to form guides for themselves. The distribution and exhaustion of the steam is effected for all three cylinders by one valve, situated on a shaft coaxial with the crankshaft. This valve is in the form of a short hollow cylinder, divided into two parts by an internal partition, and provided with ports around its periphery and on its two end faces. It rotates within a steam chamber, and between two faces furnished with three sets of ports in communication with the cylinders; the steam enters one compartment of the valve, and passes through the side ports to one cylinder, while exhaustion is taking place from another cylinder into the other compartment of the valve, which communicates by an opening, near the centre, with the exhaust pipe. By varying the sizes of the ports, the cut-off and compression can be varied to any extent. The governor, which consists of two weights sliding in slots against the pressure of a spring, is fixed on the same spindle as the valve, and operates the throttle valve through a lever shown to the right of the figure. By adjusting the pressure of the spring the speed of the engine can be set to any required velocity.

Fig. 2 illustrates a Brotherhood engine applied to drive a Siemens D dynamo machine, for the production of a naval search light of 50,000 candle power. It would be easy to multiply examples of this kind, as nearly every electric light company has tried these engines, while for many other purposes, particularly for Whitehead torpedoes, they have found an extended application.

THE FERRANTI DYNAMO-ELECTRIC GE

(For Description, see opposite Page).

FIG. 1.

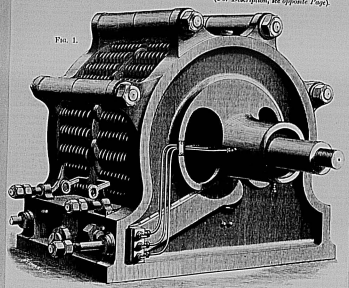
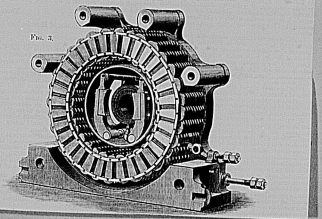


FIG. 2.



Engineering Oct. 21, 1883.

THE FERRANTI DYNAMO MACHINE.

In view of the great extension of electric lighting which is anticipated upon the passing of the numerous provisional orders now before Parliament, and more particularly in readiness for the needs of their own district of Hampstead, Messrs. Ferranti, Thompson, and Ince have been making more powerful types of their machines, and at the same time have introduced many changes which have resulted partly from their extended experience, and partly from the altered conditions of large machines as compared with small ones.

The dynamo which we illustrate on the opposite page is one of three, and is designed to supply 5000 lamps, each requiring a current having an electromotive force of 200 volts, and an intensity of .33 ampères. It comprises three principal parts, each of which is self-contained. These are the armature (Fig. 2) and the two sets of field magnets (Fig. 3). The former consists of two discs of bosses insulated from each other and from the shaft, and carrying between them an insulated brass ring. To the periphery of this ring there are fastened at equal intervals eight copper strips 1 in. wide and .175 inch thick, and these strips are then bent into the undulating form shown in Fig. 2, each strip making the circuit of the sinuous periphery of the armature twice, and being secured at its outer end to a rivet in electrical contact with one of the discs. Thus as the strips are divided from each other by insulating material, there are eight parallel circuits around the armature, each starting from the internal brass ring and ending, after two complete revolutions, at one of the bosses. At either side of the armature is a collector ring, one of them being joined by a heavy copper connexion (Fig. 2) to the internal brass ring, and the other to the opposite disc, so that the two rings form the terminals of the armature circuit. The current is not taken off by brushes in the usual way, but by solid rubbing pieces (Fig. 3) which embrace both sides of the collector rings, and are held up to their places by springs. The current is led from these collectors down heavy copper bars enclosed in a coating on the outside of the framing (Fig. 1), to two terminal studs, by which it is transmitted to the main leads. The outside diameter of the armature is 26 in., and its speed rather less than 1000 revolutions per minute, at which rate it will furnish about 2000 ampères of current with an electromotive force of 200 volts. As the machine is separately excited from an independent generator, and as its internal resistance is exceedingly small in comparison with that of the outside circuit, to which it will be applied, it follows that the difference of potential at the terminals will be sensibly constant for a given speed, whether there be few or many lamps in action, and that those will burn with the same brilliancy whether a part or the whole of them be lighted. Further as the amount of current in circulation varies exactly with the number of lamps in action, the power absorbed by the machine rises and falls with the amount of light produced, and there is no waste of fuel at the time when the demands for current are but slight.

Although the armature shows considerable improvement in detail from the form in which it originally appeared, yet it is in the field magnet that the most striking alterations are to be seen. There are thirty-two magnets on each side alternately north and south, each north pole being confronted by a south pole, and likewise having a south pole on either side of it. The cores of the magnets are cast with the framing, which, as shown in Fig. 3, is made in halves, and thus by the removal of six bolts the machine may be divided in the centre, and the whole of the internal parts laid open for inspection, while at the same time there is no

ELECTRIC LIGHTING NOTES.

On more than one occasion we have called attention to the improvements effected by Dr. Hopkinson in the Edison dynamo machines. When these first came to this country they were constructed in three sizes, marked Z, L, and K, and designed respectively to feed 60, 120, and 250 lamps. The weight and cost per lamp are given by the following Table:

—	Floor Space per Lamp.	Weight per Lamp.	Price per Lamp.
Z	sqr. ft. 15	lb. 50	£ s. d. 3 10 0
L	11	40	3 0 0
K	.072	33	1 16 0

The L machine was the first to be modified; the diameter of each of its four field magnets was increased 1 in., and two additional layers of wire were put on it. It was then found that 100 volts, or thereabouts, could be obtained at a speed of about 500 revolutions per minute instead of 800 as formerly, without at the same time increasing the consumption of energy in the field-magnet circuit. The total weight was increased by 6 cwt., of which 4 cwt. is cast iron, and 1 cwt. 1 qr. copper wire. A number of these altered machines were placed on various steamships and driven by Brotherhood engines. The improved machine has now gone much further than this; the multiple field-magnets have been replaced by a single one, of round, oval, or rectangular cross section, placed either vertically or horizontally, according to convenience. These magnets are thicker and shorter than in the old machines, and thus the dynamo has been made more compact. The following Table gives the weight and cost per lamp of the new machine:

Lights.	Floor Space per Lamp.	Weight per Lamp.	Cost per Lamp.
	sq. ft.	lb.	£ s. d.
125	.561	21	2 0 0
250	.072	20	1 14 0
500	.037	23	1 3 7

If this be compared with the former Table it will be seen that the new slow-speed Edison-Hopkinson dynamos are cheaper and in every way more efficient than the old high-speed Edison machines.

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For description of Jablochkoff's Alternating Current Generator see "Transmission of Power" Page 7/8.

THE MAGNETO-ELECTRIC GENERATOR OF M. DE ROMILLY.

THE magneto-electric machine of M. Wenns de Romilly was patented in France in March, 1880, and the specification under which the invention was secured is a very remarkable one, as it contains the first indication of much that has been done by subsequent inventors. The patent claims three classes of armatures, which are described and illustrated beneath in much detail—the ring armature, the drum armature, and a second form of ring armature, in which the wire is coiled upon a deep and narrow ring, so as to present a laced surface of coils to the fixed magnets, at right angles to the

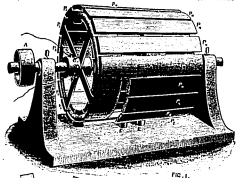


FIG. 1.

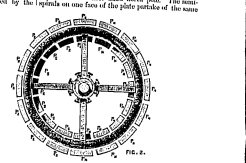


FIG. 2.

FIG. 4.

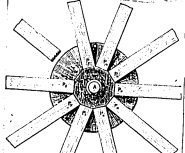


FIG. 3.

axis of rotation. Further, in the principal arrangement described, the field magnets—permanent, not electro-magnets, however—are arranged in a parallel series, and running longitudinally around the armature, and two such series of magnets are employed, one placed without and the other within the ring, so as to utilise both sides of the coils. The armatures described, suggest at once those, long after wards patented, of Gramme, of Allocchi, and of Schuckert, while the arrangement of the field magnets resembles not a little that of Da Meritens and of Jablochkoff; again, the mode of utilising the inner as well as the outer sides of the ring, recalls the recent proposals of Jürgensen and others.

The text of M. de Romilly's specification is as follows: When we cause a metallic plate to pass before the pole of a magnet, perpendicularly to the axis of this magnet, whether the movement is rectilinear, or whether, having the form of a disc, it revolves without interruption before the pole, there are set up in this plate, induced currents perpendicular to the direction of movement, and of the same sign, before and after the passage in front of the pole. This phenomenon, discovered by Arago, explained afterwards by Faraday, and studied in their details by Poisson, by Nobili, Antinori, and Matteucci, have received the name of "magnetism of rotation," "or magnetism of movement." It is the collection and utilisation of induced currents, which are produced when a metal plate passes before the pole of a magnet, perpendicular to its axis—currents which are set up perpendicular to the direction of the passage of the current—that is to say, the collection and utilisation of these currents due to what is named "magnetism by movement," or "magnetism of rotation," which I propose to reserve by the present patent. Induced currents which, up to the present time, have been utilised by employing artificial or natural magnets, have always been produced by the successive reciprocations of a bar of soft iron carrying one or several wires coiled in a direction perpendicular to its axis, and passed in front of the inducto-magnet in such a way as to be magnetised or demagnetised rapidly (as in the Clarke and Alliance machines), or have been produced by the passage, and the successive and rapid interruptions of a current from a voltaic battery in an inductor wire coiled round a bar of soft iron, and itself covered with a coil, in which is set up the induced current (as in induction coils or Ruhmkorff machines). Here it is necessary to pass before the pole of a magnet, or between the two poles of a magnet, a piece of metal of high conductivity—a plate or a copper wire, for example—and to collect the current thus obtained. Experiments made up to the present have been conducted with revolving discs, or with plates passing and repassing before the poles. The current thus produced is very weak, which has rendered it impossible to collect them so as to employ them as ordinary induced currents. What renders the current de feeble is, in the first place, the continuity of the plate or disc, which allows it to be dispersed with extreme facility, so that only a small part can be taken off to demonstrate its existence.

To obviate this inconvenience, it would suffice to pass before the pole a succession of wires, separated from each other, and each extremity of which would communicate with a fixed conductor that would come in contact successively at the moment of their passage before the pole. The current would thus be produced successively on the passage of each separate wire before the inductor pole, without any part being lost, as is the case with a continuous plate. This current, very feeble, when the wire passes before a single pole, is greatly increased when it passes between two opposite poles.

I now assume that it is possible to connect each of these separate wires to the adjacent wire in such a way that the current obtained in one may be in the same direction, and, as it were, a continuation of that which is obtained in the other; in this manner a kind of battery would be obtained, each wire of which would represent an element. To arrive at this, we cause to revolve between two poles of the same name—both north or both south—a plate of soft iron covered with well insulated wire, and coiled in such a manner that the flattened spirals in this iron core are presented perpendicularly to an imaginary line joining the two poles, and perpendicular also to the line indicating the direction of movement of the plate. The soft iron will thus assume a polarity contrary to that of two similar poles. The passage of the plate covered with wire will give rise, on the one side, to a current procured by the wire travelling before a north pole, for example, and a south pole is produced in the plate itself by the influence of the fixed pole, while on the opposite side of the plate there is set up in the coil of wire a contrary current produced by the passage in the same direction before a south pole, resulting from the influence on the soft iron plate, and the other fixed north pole. The semi-spirals on one face of the plate partake of the same movement as the semi-spirals of the other face in a contrary position, referred to a fixed pole, and the pole produced by induction.

This is precisely what is required in order that the currents which have to flow around the core may form at each semi-coil, at each coil, and throughout the series of coils, a continuation of each other. If, then, we suppose a long plate of soft iron thus surrounded, and passing between the similar poles on the two extremities of the coil, being connected by a conductor to a galvanometer, this latter will indicate the presence of a continuous current as long as the plate moves in the same direction, but which will be interrupted when the movement is reversed, and which will take the contrary sign when the plate travels in the opposite direction. The sign of the current can also be changed, by the introversion of the poles, by the direction of the movement, and also by the direction of winding the coils to the right or left. Further, this wire coiled singly can be covered by a second wire wound parallel to it, and brought back over itself, so as to surround the soft iron core several times. Each thickness of the coil superposed will add its current to that of the preceding coil. In this manner, instead of a feeble current, we shall have one, the energy of which will depend on the power of the magnets, on their proximity, on the purity of the soft iron core, on the number of superposed coils, and upon the velocity of movement.

Next to consider an arrangement which will make this process practical, and for which one can collect the induction currents of which we have been speaking. Instead of a soft iron plate, we will take a plate curved in such a way as to form a cylinder, of which the diameter is much greater than the height. We will connect this cylinder by radial arms converging from one side to a rigid shaft passing through the centre of the cylinder; this shaft will rest on bearings in which it may revolve easily. The cylinder, entirely open within, has this only one of its sides partially occupied by the radial arms, that serve to fix it to the central shaft. This arrangement allows of winding longitudinally on the cylinder, a copper wire covered with an insulating material. We will first assume only half the circumference of the cylinder to be thus covered, then we will place in close proximity to one side of the cylinder two magnets, each formed of a bar of steel magnetised; the similar poles of these two magnets—the north for example—are opposite to one another, and allow the iron cylinder, one half of which is surrounded with insulated wire, to pass between them; in this way the wire receives an opposite polarity. We will now do the same thing with the side of the cylinder diametrically opposite, in such a way that

THE CROMPTON SYSTEM OF ELECTRIC LIGHTING.

By reason of its combined power and beauty the electric light was early recognised to be peculiarly adapted for the illumination of railway termini; and the first application of it for that purpose was at the Northern Station in Paris, in 1875. There the superiority of the light over gas was found to expedite the business of the station, and numerous then being soon spread over other stations not only in France but other countries. In Great Britain one of the most important installations was that at St. Enoch's Station, Glasgow,* where the success there attained by Mr. Crompton has now been followed by the lighting of the King's Cross terminus of the Great Northern Railway in Euston-road by a similar arrangement.

The usually large area and high roof of a railway station is favourable to electric lighting by means of powerful arc lamps, for these can be suspended at such a height that the strong shadows they would otherwise throw upon the platform are dissipated, and the blending of the several lights produces a very constant general effect. At King's Cross the power which is lighted within the station consists of two covered bays each 980 ft. long by 105 ft. wide, together with a cab-rank, 40 ft. wide, adjoining the arrival platform. The total area is, therefore, 210,000 square feet, and as it is illuminated by twelve Crompton lamps, the area lighted by each arc is 18,333 square feet, or nearly half an acre. Six of the lamps are placed above the arrival platforms, and six above the departure platform, while two others of greater power are mounted on the east side of the building at the extreme corners of its front to illuminate the side approaches. These fourteen splendid lights are fed by the currents from five Brotherhood steam engines machines driven by a steam engine of 12 horse power nominal.

At St. Enoch's, Glasgow, an area 225 ft. long by 203 ft. wide is lighted by six Crompton lamps fed by six Gramme machines of the A type; but the Brotherhood machine employed at King's Cross confers several advantages on the later installation. When the Gramme or the Siemens generator is used, only one lamp can be placed in the circuit of each machine, and though this arrangement insures that the failure of a single lamp will not affect the others in the series, it involves considerable expense for plant and leading wires. With the Brush generator from five to forty lamps can be supplied by one machine, and the percentage of useful lighting effect is much higher than with the single-light Gramme system; but as all the lamps are connected in one circuit, a fault in any part of it, through defective insulation, or derangement of the apparatus, is necessarily followed by the extinction of all the lights. The arrangement at King's Cross occupies an intermediate position between the Gramme and Brush systems, and unites some of the merits of both. Each Brotherhood machine feeds three arc Crompton lamps connected in series; and the total illumination is produced by combining two or more circuits together so that alternate lamps are fed from different machines. By following this plan the failure of any one circuit only reduces the intensity of the general light one-half, since the lamps in the other circuit are still unaffected.

The Burgin machine is the invention of M. Emile Burgin, of Bâle, in Switzerland, and it was at first designed as a single-light machine. Mr. Crompton, however, saw that it was capable of being modified so as to yield an electromotive force sufficient to supply several lights, while at the same time its small size and simplicity of construction would lend themselves to portability and cheapness. The machine is illustrated on the two following pages, where Fig. 1 is a general view of the side on which the commutator is placed, Fig. 2 is a similar view of the other side showing the driving pulley, Fig. 3 is a view of the armature, Fig. 4 is a part longitudinal section and part elevation, and Fig. 5 a corresponding transverse section.

To get a high electromotive force a high surface velocity of the coils of the armature is necessary, and the ordinary Gramme ring does not admit of this, because the wire of the coils is closely confined and wound so thickly that it is apt to heat with the current. The coils of the Burgin ring, on the other hand, are wound as shown in Fig. 3, which represents the armature of a three-light machine, instead of a single ring as in the Gramme machine, it is composed, as will be seen, of several individual rings B, mounted on the same spindle S, so as to form a kind of barrel. The coils of these rings are, however, all connected in series to the sections of the commutator C, so that the current is collected in the ordinary manner by a pair of copper "brushes." Instead of being a solid circular ring as in the Gramme, each iron core is a hexagonal frame of soft charcoal wire built up into a square bar. Each of the six sides of the core after being covered with varnished tape is wound with a coil of wire in such a manner as to leave the iron cores as bare and bring the general outline of the coil circular. This arrangement will be more understood by reference to Fig. 4, where it is the ring, i the bare cores of the core, and w the coil of wire. It offers several practical advantages. For example, the bare surface of the iron cores next to the poles of the inducing magnets give rise to an intense magnetisation of the ring. Moreover, the simplicity of the winding renders the ring easy to make, and the small number of layers in each coil, together with the free access of air to the exposed surfaces of the wire prevent the coils from being unduly heated by the current. In the Gramme machine there are usually fourteen layers of wire in a coil, whereas in the Burgin there are only five; and the result is that a current which would destroy the Gramme coils has no effect whatever on those of the Burgin machine.

As the six coils on one ring are not sufficient to provide the current required for three lights, eight rings are arranged side by side on the same spindle, and each ring is displaced one-twenty-fourth of a revolution in advance of the last. Fig. 3 illustrates this ingenious construction, which favours the production of a continuous current, for the coils of the barrel which follow one another at this fraction of a revolution are connected in series one after another and their ends joined to the successive strips of the commutator. Thus in Fig. 6, the successive coils of the same ring are not connected in series as in the Gramme armature, but the coil of one particular ring is connected in series to the coil on the next ring which follows it at a distance of one-twenty-fourth of a revolution. This arrangement will be better apprehended by consulting Fig. 6, where a, b, c, d, e, f, are the coils

Fig. 6.

which properly succeed each other in the length of the barrel. They are connected in series, and wires proceed from each to the slips of the commutator. The last coil on the left, a, is properly followed by the first coil of the next set on the right, and it is connected to f, δc., as before. This method of joining the coils obtains throughout the whole ring.

The contact slips of the commutator are made of phosphor-bronze, a metal which wears better than the copper which is usually employed. The two "brushes" B, Fig. 4, which draw off the positive and negative current from the slips C, consist of six short copper combs laid one above another. Each is carried by a bar b which is fixed by means of an adjusting screw a, and a packing piece k; the whole being supported by a bracket c which turns loosely on the spindle f, and presses the brush against the slips of the commutator by means of the spiral spring g. One merit of this arrangement is that the brushes and other parts of the commutator can be readily replaced when worn out.

In the Gramme machine the copper ring required to be mounted on an insulating hub; and as iron cores are all more or less subject to atmospheric influences, the efficiency of the machine is not entirely independent of the climate or country in which it may be placed. But the hexagonal rings of the Burgin armature enable it to be mounted on the spindle S by a hub and spokes of metal as seen at f, in Figs. 4 and 5. The whole armature is light and accurately balanced, and is capable of a high velocity. It comprises 48 coils, each containing 18 ft. of cotton-covered copper wire 0.065 in. in diameter, and the total weight of the wire is only 25 lb. The electric resistance of the whole armature between the two brushes is 1.6 ohms, and the electromotive force or difference of potentials between them for a speed of 1500 revolutions per minute is 155 volts. At 1600 revolutions per minute, the electromotive force is about 206 volts. The speed of the mean diameter of the coils through the magnetic field corresponding to an angular velocity of 1500 revolutions per minute is 2250 ft. per minute. The driving pulley is shown at A in Figs. 1 and 2.

In the Siemens generator the cores of the electromagnets are built up of separate bars of wrought iron, but in the Burgin they form one solid iron casting, which is bored to admit the armature and fitted with a cylinder cover to carry the bobbins. This mode of construction, besides being inexpensive, gives great steadiness of working. Moreover, the mass of iron serves to intensify the magnetic field and the tuned for the armature being truly bored, the bobbins run concentric with the magnetic poles. The cores of the magnets are of oval section, and the heavy pole-pieces f in Fig. 4 are concave at M M, with 10⅛ in. of cotton-covered copper wire 0.141 in. in diameter, and the total weight of wire on the four cores is 140 lb. They are, as will be seen from the figure, coupled in opposite pairs, so as to form two poles of opposite name, between which the bobbins of the armature revolve with great velocity. The electric resistance of these magnet coils is only 1.2 ohms.

The electro-magnets of the Burgin machine can either be separately excited by the current from an auxiliary continuous current machine, or they can be self-excited by the current from the armature. In this case the magnet coils are connected in circuit with the armature coils by suitable terminals, and the total internal resistance of the machine is then 2.8 ohms, or 1.2 ohms less than when excited by 1.6 ohms for the armature. By separately exciting the machine the internal resistance of the circuit is simply the 1.6 ohms due to the armature, and hence a higher electromotive force may be obtained. The machines employed at King's Cross terminus are, therefore, separately excited by Gramme machines of the A type. There are five Burgin generators, and two Gramme machines suffice to excite them, besides feeding several Swan incandescence lamps of the pattern tried in the Pleasley mines, which serve to light the engine-room. The circling current is about 12 webers.

The whole of these seven dynamo-electric machines are driven from a short length of counter-shafting by a semi-portable engine constructed according to Mr. Crompton's designs by Messrs. Marshall, Sons, and Co., of Gainsborough, and similar to that supplied by them to Messrs. Crompton and Co. for the Electrical Exhibition. The engine has a 12 in. cylinder and a 1 ft. stroke. Its nominal horse power is 12, but it is capable of working up to 35 horse power, and at King's Cross when all the lamps are burning it is found to indicate 29 horse power, of which 3½ horse power is absorbed by the engine and gearing. Each of the twelve lights within the station absorbs about 1½ horse power, and each of the six external lights in the station front, some 3 horse power. The five 5 horse power lamps in the engine shed are estimated to absorb about 1½ horse power.

At present only one engine is used, but to guard against the inconvenience of a breakdown, a second of the same type will shortly be placed in the shed, and connected to the countershafting in a similar manner to the present engine. By the aid of a friction clutch, either engine will be put into gear with the shafting instantaneously, so that should an accident happen to one engine the work can be transferred to the other at a moment's notice.

The shed where the generators are placed is situated at a distance of about 252 yards from the nearest point of the station, so that the leading wires are of considerable length. The longest circuit of the internal lamps is about 600 yards, and that for the furthest external lamps 720 yards, including the return wire. The twelve lights within the station are arranged on four separate circuits, three to each circuit, and the two external lights are connected to a separate circuit; but a single return wire answers for all.

Bare copper wire, of No. 8 gauge, is employed, and it is carried on posts from the engine-house on the west over the roof of the Suburban Station. The rest of the terminus is then entered by means of flexible insulated leads, and bare wire supported from the wall by wood insulators is then used to convey the current to the lamps. The six lamps above each platform are fed by two separate circuits, and

But the light from six of the Crompton lights is quite as good as that which was formerly obtained from these gas burners. The twelve lights, therefore, give a much superior illumination, and by the terms of contract with Mr. Crompton the cost is no greater than for gas. The working expense at King's Cross is about 4d. per hour per lamp, including coal, cartage, oil, waste, petty repairs, and attendance. To this must be added the interest on the prime cost of the machines and installation; but as the Burgin machine is comparatively inexpensive the Crompton-Burgin light has an advantage in this respect. A Burgin machine giving eight lights costs about £60.

With regard to the efficiency of the system we may observe that it is higher when the resistance in the external circuit is about double the internal resistance of the machine, a law which appears to quite as good for electric machines in general. Careful experiments made at King's Cross and the Arc Works, Chelmsford, have proved that

* See ENGINEERING, vol. xxix., page 329.

MPTON SYSTEM OF ELECTRIC LIGHTING.

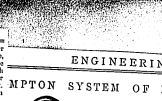


Fig. 4.

Fig. 5.

Fig. 2.

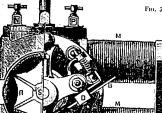


Fig. 1.

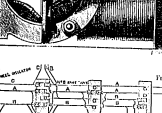


Fig. 7.

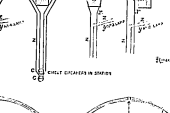
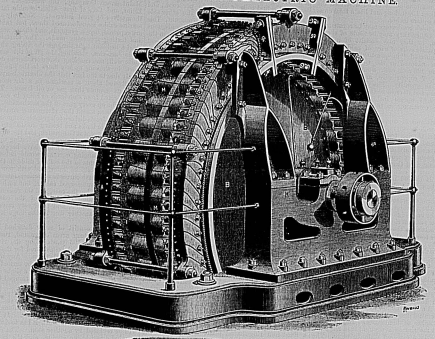
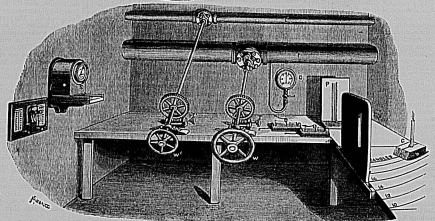


Fig. 3.

Fig. 8.

THE GORDON DYNAMO-ELECTRIC MACHINE.





Mr. Gordon's dynamo-electric machine recently completed at the works of the Telegraph Construction and Maintenance Company, Greenwich, is without doubt the largest which has yet been constructed. The object of the inventor was to produce a plant which would take as it were the place of large gas works for supplying light from a central station, and all who have seen the machine and its achievements must admit that he has been experimentally successful.

Mr. Gordon has designed the machine we illustrate to supply from 6000 to 7000 Swan incandescent lights of 20-candle power each; and he has constructed it after a model which may admit of yet much larger sizes being made. This last consideration involves difficulties of its own, for it is a fact too often lost sight of by inventors, that a small machine may work very well, whereas a large machine made on precisely the same plan, will not prove economical. There are several reasons for this; for example, in a small machine, the metal parts of the armature other than the conducting wire upon it, can without weakening the armature be so disposed as not to do any mischief, either electrically or magnetically. But any machine, whether electric or not, which has to absorb say from 600 to 1000 horse power, must have great strength and rigidity in its revolving parts. In the case of a dynamo there would be great difficulty in obtaining the necessary strength of armature, if no metal except the conductor was allowed to move through the magnetic field.

In the new machine the inducing magnets are revolved and the induced coils are fixed, a principle which has been followed before by other inventors. Such a plan allows the revolving wheel in the Gordon machine to be built up of massive wrought-iron plates. A disadvantage of machines in which the armature itself moves, is the difficulty of constructing a suitable rubbing contact for currents of from 1000 to 10,000 amperes or more in strength; but when the magnets themselves are caused to revolve what the magnets themselves are caused to revolve this difficulty does not appear. A further difference in the pattern for large and small dynamos is to be found in the fact that about the same electromotive force is required whether the dynamo be large or small. The armature of a small dynamo large or small. The armature of a small dynamo is wound with a great length of fine wire; but the

meter. The steam gauge indicates the pressure of steam in the boiler of which feeds both engines. The steelyometer indicates the speed in turns per minute of the large dynamos, and the ammeter shows the strength of current in the exciting magnets. One valve wheel, W, works the stop valve of the engine driving the generator, and the other, W, works that of the engine driving the exciting dynamos. The control is effected in the following manner: Two Swan lamps are fitted up on the photometer table, one in the red circuit and one in the blue. By means of suitable switches the current is turned on one of these lamps, and the intensity of the shadow cast by it on the screen of the photometer which is compared with that thrown by a standard candle C. If it is too dim, showing that the lamp is too feeble, the operator turns the valve wheel W of the engine driving the exciter, and admits more steam, thus quickening the engine and the exciting machines. The result is that the exciting currents in the magnets are increased in strength as the ammeter in circuit shows. The intensification of the magnetic field of the generator which ensues, of course causes the generator to go slower, but this slackening of speed is corrected by admitting more steam to its driving engine by working the other valve wheel W. The steelyometer indicates when the old speed has been regained, and the photometer shows that the lamp has recovered its normal brightness. If a lamp should become too bright the same process in the contrary direction is followed out, and one circuit after the other is tested thus by means of the switches. The speed of the generator is kept practically constant, the regulation being effected by increasing or diminishing the strength of current in the exciting magnets. This mode of regulation allows of a great number of lights being put out at a time, and enables the machine to feel few or many. To avoid any sudden change of light in regulating, a slow motion is given to the valve wheels by means of tangent screws T T turned by hand.

THE SCHUCKERT DYNAMO-ELECTRIC GENERATOR.

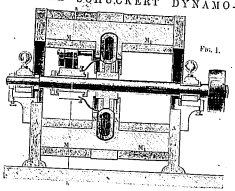


FIG. 1.

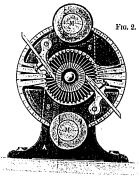


FIG. 2.

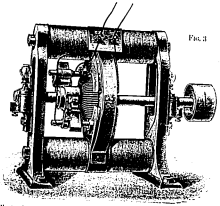


FIG. 3.

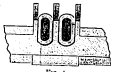


FIG. 4.

ABOVE are illustrations of a dynamo-electric generator used considerably on the Continent and in this country, amongst others by the Brush Electric Light Company. This machine, constructed by Mr. S. Schuckert, of Nürnberg, consists of two vertical iron bars A, between which are fixed the cores of the electro-magnets M M. These cores are cylindrical except at the middle of their length, where they are widened as shown, and formed with a central groove to receive the revolving armature. The latter consists of a ring built up of a number of thin discs insulated from each other, and covered with coil as shown in the section. This ring is nearly enclosed by the semi-circular pole-pieces before mentioned as being formed in the middle of the field magnets, and which approach each other within a short distance of the horizontal axis of the ring. The object of this special arrangement is, of course to bring as large a number of the convolutions of the armature coils as possible within the influence of the magnetic field. The commutator of the machine consists of a number of metal segments insulated from each other, these segments being connected respectively to the sections of the armature coil. The number of three sections varies from ten to one hundred, according to whether the machine is intended for low or high tension, and the end of each section is connected to its corresponding segment by a screw, so as to be easily removed for repair or renewal. In the generator illustrated the commutator is shown within the frame, but in the latest pattern it is placed outside the frame so as to be more readily accessible. The arrangement of coils on the armature, and their connection with the commutator, are shown in Figs. 1 and 2, which also illustrate the way in which the brushes are attached to the pole-pieces. It will be seen that they are each pivoted on a pin, and are free to move the brush passing through a screw and fixed in position by set screws so as to be capable of exact adjustment.

As already stated, this generator is in considerable use, and appears to give very good results. It is constructed after several different types, varying with the size, and the purpose for which they are specially intended, for the deposition of metals or the production of the electric light. In some differences these machines are made self-exciting, with commutators on both sides of the armature, about one-third of the current being taken off to excite the field magnets. In another form two rings are placed side by side on the shaft, the flat form adopted leading itself to this arrangement, which, of course, involves the use of two commutators. Although the machine is driven at a high speed in ordinary working there is little or no trouble from heating.

This generator has probably the highest electromotive force of any in practical use, and for this reason it shares with the Brush machine the advantage of being especially applicable to installations in which the driving station is at a considerable distance from the area to be illuminated, but it of course requires a proportionately increased care in handling, and in the manipulation and fixing of the conductors.

Engineering, Nov. 17, 1882. p. 474

ELECTRIC LIGHTING.

By Dr. C. W. Siemens.*

Having received the honour of being elected Chairman of the Council of the Society of Arts for the ensuing year, the duty devolves upon me of opening the coming session with some introductory remarks.

Only a few months have elapsed since I was called upon to deliver a presidential address to the British Association at Southampton, and it may be reasonably supposed that I then exhausted my stock of accumulated thought and observation regarding the present development of science, both abstract and applied; that, in fact, I come before you, to use a popular phrase, pretty well pumped dry. And yet so large is the field of modern science and industry, that, notwithstanding the good opportunity given me at Southampton, I could there do only scanty justice to comparatively few of the branches of modern progress, and had to curtail, or entirely omit, reference to others, upon which I should otherwise have wished to dwell.

There is this essential difference between the British Association and the Society of Arts, that the former can only take an annual survey of the progress of science, and must then confide to individuals, or to committees, specific inquiries, to be reported upon to the different sections at subsequent meetings; whereas the Society of Arts, with its 3150 permanent members, its ninety-five associated societies, spread throughout the length and breadth of the country, its permanent building, its well-conducted Journal, its almost daily meetings and lectures, extending over six months of the year, possesses exceptionally favourable opportunities of following up questions of industrial progress to the point of their practical accomplishment.

In glancing back upon its history during the 128 years of its existence, we discover that the Society of Arts was the first institution to introduce science into the industrial arts; it was through the Society of Arts and its illustrious Past President, the late Prince Consort, that the first Universal Exhibition was proposed, and brought to a successful issue in 1851; and it is due to the same Society, supported on all important occasions by its actual President, the Prince of Wales, that so many important changes in our educational and industrial institutions have been inaugurated, too numerous to be referred to specifically on the present occasion.

Amongst the practical questions that now chiefly occupy public attention are those of electric lighting and of the transmission of force by electricity. These together form a subject which has occupied my attention and that of my brothers for a great number of years, and upon which I may consequently be expected to dwell on the present occasion, considering that at Southampton I could deal only with some purely scientific considerations involved in this important subject.

I need hardly remind you that electric lighting, viewed as a physical experiment, has been known to us since the early part of the present century, and that many attempts have, from time to time, been made to promote its application. Two principal difficulties have stood in the way of its practical introduction, viz., the great cost of producing an electric current so long as chemical means had to be resorted to, and the mechanical difficulty of constructing electric lamps capable of sustaining, with steadiness, prolonged effects.

The dynamo-machine, which enables us to convert mechanical into electrical force, purely and simply, has very effectually disposed of the former difficulty, inasmuch as a properly conceived and well-constructed machine of this character converts more than 90 per cent. of the mechanical force imparted to it into electricity, 90 per cent. again of which may be reconverted into force at a moderate distance. The margin of loss, therefore, does not exceed 20 per cent., excluding purely mechanical losses, and this is quite capable of being reduced to some extent by improved modes of construction; but it results from these figures that no great step in advance can be looked for in this direction. The dynamo machine presents the great advantage of simplicity over steam or other power-transmitting engines; it has but one working part, namely, a shaft which, revolving in a pair of bearings, carries a coil or coils of wire admitting of perfect balancing. Frictional resistance is thus reduced to an absolute minimum, and no allowance has to be made for loss by condensation, or badly fitting pistons, stuffing boxes, or valves, or for the jerking action due to oscillating weights. The materials composing the machine, namely, soft iron and copper wire, undergo no deterioration or change by continuous working, and the depreciation of value is therefore a minimum, except where currents of exceptionally high potential are used, which appear to render the copper wire brittle.

The essential points to be attended to in the conception of the dynamo machine, are the prevention of induced currents in the iron, and place the wire in such position as to make the whole of it effective for the production of outward current. These principles, which have been clearly established by the labours of comparatively few workers in applied science, admit of being carried out in an almost infinite variety of constructive forms, for each of which may be claimed some real or imaginary merits regarding questions of convenience or cost of production.

For many years after the principles involved in the construction of dynamo machines had been made known, little general interest was manifested in their favour, and few were the forms of construction offered for public use. The essential features involved in the dynamo machine, the Siemens armature (1856), the Pacinotti ring (1861), and the self-exciting principle (1867), were published by their authors for the pure scientific interest attached to them, without being made subject matter of letters patent, which circumstance appears to have had the contrary effect of what might have been expected, in that it has retarded the introduction of this class of electrical machine, because no person or firm had a sufficient commercial interest to undertake the large expenditure which must necessarily be incurred in reducing a first conception into a practical shape. Great credit is due to Monsieur Gramme for taking the initiative in the practical introduction of dynamo machines embodying those principles, but when five years ago I ventured to predict for the dynamo-electric current a great practical future, as a means of transmitting power to a distance, those views were still looked upon as more or less chimerical. A few striking examples of what could be practically effected by the dynamo-electric current, such as the illumination of the Place de l'Opera, Paris, the occasional exhibition of powerful arc lights, and their adoption for military and lighthouse purposes, but especially the gradual accomplishment of the much desired lamp by incandescence in vacuum, gave rise to a somewhat sudden reversion of public feeling; and you may remember the scare at the Stock Exchange, affecting the value of gas shares, which ensued in 1878, when the accomplishment of the subdivision of the electric light by incandescent wire was first announced, somewhat prematurely, through the Atlantic cable.

From this time forward electric lighting has been attracting more and more public attention, until the brilliant displays at the exhibition of Paris, and at the Crystal Palace last year, served to excite public interest, to an extraordinary degree. New companies for the purpose of introducing electric light and power have been announced almost daily, whose claim to public attention as investments was based in some cases upon only very slight modifications of well-known forms of dynamo machines, of arc regulators, or of incandescent carbon lights, the merits of which rested rather upon anticipations than upon any scientific or practical proof. These arrangements were supposed to be of such superlative merit that gas and other illuminants must soon be matters simply of history, and hence arose the depression in gas shares already alluded to. It should be borne in mind, however, that any great technical advance is necessarily the work of time and of serious labour, and that when accomplished, it is generally found that so far from injuring existing industries, it calls additional ones into existence, to supply new demands, and thus give rise to an increase in the sum total of our resources. It is, therefore, reasonable to expect that side by side with the introduction of the new illuminant, gas lighting will go on improving and extending, although the advantage of electric light for many applications, such as the lighting of public halls and warehouses, of our drawing-rooms and dining-rooms, our passenger steamers, our docks and harbours, are so evident, that its advent may be looked upon as a matter of certainty.

Our Legislature has not been slow in recognising the importance of the new illuminant. In 1879 a Select Committee of the House of Commons instituted a careful inquiry into its nature and probable cost, with a view to legislation, and the conclusions at which they arrived were, I consider, the best that could have been laid down. They advised that applications should be encouraged tentatively by the granting of permissive Bills, and this policy has given rise to the Electric Lighting Bill, 1882, promoted by Mr. Chamberlain, the President of the Board of Trade, regarding which much controversy has arisen. It could, indeed, hardly be expected that any Act of legislation upon this subject could give universal satisfaction, because while there are many believers in gas who would gladly oppose any measure likely to favour the progress of the rival illuminant, and others who wish to see it monopolised, either by local authorities or by large financial corporations, there are others again who would throw the doors open so wide as to enable almost all comers to interfere with the public thoroughfares, for the establishment of conducting wires, without let or hindrance, and without any safeguards to public security or convenience.

The law as now established takes, I consider, a medium course between these diverging opinions, and, if properly interpreted, will protect, I believe, all legitimate interests, without impeding the healthy growth of establishments for the distribution of electric energy for lighting and for the transmission of power. Any firm or lighting company may, by application to the local authorities, obtain leave to place electric conductors below public thoroughfares, subject to such conditions as may be mutually agreed upon, the term of such license being limited to seven years; or an application may be made to the Board of Trade for a provisional order to the same effect, which, when sanctioned by Parliament, secures a right of occupation for twenty-one years. The license offers the advantage of cheapness, and may be regarded as a purely tentative measure, to enable the firm or company to prove the value of their plant. If this is fairly established, the license would in all probability be affirmed, either by an engagement for its prolongation from time to time, or by a provisional order which would, in that case, be obtained by joint application of the contractor and the local authority. At the time of expiration of the provisional order, pre-emption of purchase is accorded to the local authority, against which it has been objected with much force by so competent an authority as Sir Frederick Bramwell, that the conditions of purchase laid down are not such as fairly remunerate the contracting companies for their expenditure and risk, and that the power of purchase would inevitably induce the parochial bodies to become mere trading associations. But while admitting the undesirability of such a consummation, I cannot help thinking that it was necessary to put some term to contracts entered into with speculative bodies at a time when the true value of electric energy, and the best conditions under which it should be applied, are still very imperfectly understood. The supply of electric energy, particularly in its application to transmission of power, is a matter simply of commercial demand and supply, which need not partake of the character of a large monopoly similar to gas and water supply, and which may therefore be safely left in the hands of individuals, or of local associations, subject to a certain control for the protection of public interests. At the termination of the period of the provisional order, the contract may be renewed upon such terms and conditions as may at that time appear just and reasonable to Parliament, under whose authority the Board of Trade will be empowered to effect such renewal.

Complaints appear almost daily in the public papers, to the effect that townships refuse their assent to applications by electric light companies for provisional orders; but it may be surmised that many of these applications are of a more or less speculative character, the object being to secure monopolies for eventual use or sale, under which circumstances the authorities are clearly justified, I consider, in withholding their assent; and no licenses or provisional orders should be granted, I consider, unless the applicants can give assurance of being able and willing to carry out the work within a reasonable time. But there are technical questions involved which are not yet sufficiently well understood to admit of immediate operations upon a large scale.

Attention has been very properly called to the great divergence in the opinions expressed by scientific men regarding the area that each lighting district should comprise, the capital required to light such an area, and the amount of electric tension that should be allowed in the conductors. In the case of gas supply, the works are necessarily situated in the outskirts of the town, on account of the nuisance this manufacture occasions to the immediate neighbourhood; and, therefore, gas supply must range over a large area. It would be possible, no doubt, to deal with electricity on a similar basis, to establish electrical mains in the shape of copper rods of great thickness, with branches diverging from it in all directions; but the question to be considered is, whether such an imitative course is desirable on account either of relative expense or of facility of working. My own opinion, based upon some practical experience and thought devoted to the subject, is decidedly adverse to such a plan. In my evidence before the Parliamentary Committee, I limited the desirable area of an electric district in densely populated towns to a quarter of a square mile, and estimated the cost of the necessary establishment of engines, dynamo-machines, and conductors, at 100,000*l*., while other witnesses held that areas from one to four square miles could be worked advantageously from one centre, and at a cost not exceeding materially the figure I had given. These discrepancies do not necessarily imply wide differences in the estimated cost of each machine or electric light, inasmuch as such estimates are necessarily based upon various assumptions regarding the number of houses and of public buildings comprised in such a district, and the amount of light to be apportioned to each, but I still maintain my preference for small districts.

By way of illustration, let us take the parish of St. James's, near at hand, a district not more densely populated than other equal areas within the metropolis, although comprising, perhaps, a greater number of public buildings. Its population, according to the preliminary report of the census taken on the 4th April, 1881, was 29,865, it contains 3018 inhabited houses, and its area is 781,000 square yards, or slightly above a quarter of a square mile, and it has six and a half miles length of large streets.

To light a comfortable house of moderate dimensions in all its parts, to the exclusion of gas, oil, or candles, would require about 100 incandescence lights of from 15 to 18-candle power each, that being, for instance, the number of Swan lights employed by Sir William Thomson in lighting his house at Glasgow University. Eleven-horse power would be required to excite this number of incandescence lights, and at this rate the parish of St. James's would require $3018 \times 11 = 33,200$ horse power to work it. It may be fairly objected, however, that there are many houses in the parish much below the standard here referred to, but on the other hand, there are 600 of them with shops on the ground floor, involving larger requirements. Nor does this estimate provide for the large consumption of electric energy that would take place in lighting the eleven churches, eighteen club-houses, nine concert halls, three theatres, besides numerous hotels, restaurants, and lecture halls. A theatre of moderate dimensions, such as the Savoy Theatre, has been proved by experience to require 1200 incandescence lights, representing an expenditure of 133 horse power; and about one-half that power would have to be set aside for each of the other public buildings here mentioned, constituting an aggregate of nearly 2926 horse power; nor does this general estimate comprise street lighting, and to light the six and a half miles of principal streets of the parish with electric light, would require, per mile, thirty-five arc lights of 350-candle power each. This, taken at the rate of 0.8 horse power per light, represents a further requirement of 182 horse power, making a total of 3108 horse power, for purposes independent of house lighting, being equivalent to one horse power per inhabited house, and bringing the total requirements up to 109 lights=12 horse power per house.

I do not, however, agree with those who expect that gaslighting will be entirely superseded, but have, on the contrary, always maintained that the electric light, while possessing great and peculiar advantages for lighting our principal rooms, halls, warehouses, &c., owing to its brilliancy, and more particularly to its non-interference with the healthful condition of the atmosphere, will leave ample room for the development of the former, which is susceptible of great improvement, and is likely to hold its own for the ordinary lighting up of our streets and dwellings.

Assuming, therefore, that the bulk of domestic lighting remains to the gas companies, and that the electric light is introduced into private houses only, at the rate of say twelve incandescence lights per house, the parish of St. James's would have to be provided with electric energy sufficient to work $(9+12)\,3018 = 63,378$ lights=7042 horse power effective. This is equal to about one-fourth the total lighting power required, taking into account that the total number of lights that have to be provided for a house are not all used at one and the same time. No allowance is made in this estimate for the transmission of power, which, in course of time, will form a very large application of electric energy; but considering that power will be required mostly in the daytime, when light is not needed, a material increase in the plant will not be necessary for that purpose.

In order to minimise the length and thickness of the electric conductor, it would be important to establish the source of power, as nearly as may be, in the centre of the parish, and the position that suggests itself to my mind is that of Golden-square. If the unoccupied area of this square, representing 2500 square yards, was excavated to a depth of 25 ft., and then arched over so as to re-establish the present level, a suitable covered space would be provided for the boilers, engines, and dynamo-machines, without causing obstruction or public annoyance; the only erection above the surface would be the chimney, which, if made monumental in form, might be placed in the centre of the square, and be combined with shafts for ventilating the subterranean chamber, care being taken of course to avoid smoke by insuring perfect combustion of the fuel used. The cost of such a chamber, of engine power, and of dynamo machines, capable of converting that power into electric energy, I estimate at 140,000*l*. To this expense would have to be added that of providing and laying the conductors, together with the switches, current regulators, and arrangements for testing the insulation of the wire.

The cost and dimensions of the conductors would depend upon their length, and the electromotive force to be allowed. The latter would no doubt be limited, by the authorities, to the point at which contact of the two conductors with the human frame would not produce injurious effects, or say to 200 volts., except for street lighting, for which purpose a higher tension is admissible. In considering the proper size of conductor to be used in any given installation, two principal factors have to be taken into account; first, the charge for interest and depreciation on the original cost of a unit length of the conductor; and, secondly, the cost of the electrical energy lost through the resistance of a unit of length. The sum of these two, which may be regarded as the cost of conveyance of electricity, is clearly least, as Sir William Thomson pointed out some time ago, when the two components are equal. This, then, is the principle on which the size of a conductor should be determined.

From the experience of large installations, I consider that electricity can, roughly speaking, be produced in London at a cost of about one shilling per 10,000 watts for an hour. Hence, assuming that each set of four incandescence lamps in series (such as Swan's, but for which may be substituted a smaller number of higher resistance and higher luminosity) requires 200 volts

* Address delivered before the Society of Arts.

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electromotive force, and 60 watts for their efficient working, the total current required for 64,000 arch lights is 107,200 amperes, and the cost of the electric energy lost by this current in passing through $\frac{1}{10}$th of an ohm resistance, is 25l. per hour.

The resistance of a copper bar one quarter of a mile in length, and one square inch in section, is very nearly $\frac{1}{10}$th of an ohm, and the weight is about 2½ tons. Assuming, then, the price of insulated copper conductor at 80l. per ton, and the rate of interest and depreciation at 7½ per cent., the charge per hour of 1l. would suffice for, when used eight hours per day, 8.15l. Hence, following the principle I have stated above, the proper size of conductor to use for an installation of the magnitude I have supposed, would be one of 46.29 in. section, or a round rod 8 in. in diameter.

(*To be continued.*)

MATTHEWS' DYNAMO ELECTRIC MACHINE.

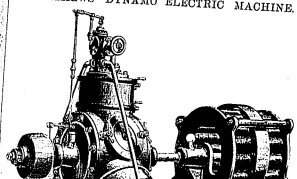

Fig. 1. Fig. 2 Fig. 3. Fig. 4. Fig. 5. Fig. 6.

Fig. 10. Fig. 11. Fig. 12. Fig. 13. Fig. 14.

Fig. 15. Fig. 16. Fig. 17.

MATTHEWS' THREE-CYLINDER ENGINE AND DYNAMO MACHINE.

A novel form of three-cylinder engine, in which increased economy is sought by the application of the Compound principle, is being manufactured by Mr. Herbert Matthews, of Hyde, Cheshire. The cylinders (under fashion radially around the crankshaft, the high-pressure cylinder being the rear one in each instance). In it there works a plunger, which is packed with three rings, while its forward end is joined to a larger plunger working in the low-pressure cylinder, the one cylinder opening directly into the other. A connecting rod couples the lower plunger to the crank. The rods abut upon a segmental bearing, so all are always in compression, some crank-pins. The rods being the shortest necessarily alternating, and lying in a diagonal direction.

For continuous current machines with armatures of the ring described with reference to Fig. 1, where the number of part coils is equal to the number of alternate bars, or equal to twice the number of the same polar faces, the discs are placed in advance of each other as in Fig. 10, so that the pairs of part coils or elements are not at their maximum induction at the same time. For continuous currents with armatures having but one set of bars, the number of spaces are arranged to be less or greater by any even number than twice the number of like polar fields, as in Fig. 17, where the fine radii represented by the dotted circles are nine in number, and the spaces and part coils are sixteen. The inner parts of the coils D' D' are coupled up and connected to a commutator J which is made up of 144 bars, each of the terminals 13 being coupled to nine bars of the commutator spaced at equal intervals, two such connections being shown by the rings M M, which have nine brushes K leading to the bars on the commutator, so that when all the connections are made there will be 144 bars. By this arrangement only one pair of brushes are required, instead of one pair to each pair of magnets as is usual in multi-polar direct current machines.

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his electric hoist and new dynamo-electric machines; but we must leave a fuller description of these and some to another occasion. The keys of Messrs. Muirhead Clark, Muirhead, and Co. are very instructive, and we furnish one or two useful hints to makers, for example, in the signalling key of Mr. Saunders, chief electrician to the Eastern Telegraph Company, the contacts are not made by the direct thrust of the clerk's fingers, but by a pair of springs in the rear of the key, and thus no microphonic variation near of the current due to the varying energy of the operator can take place, the rubbing sprung contact is always the same, whatever the force of the taut is always. The testing keys have large easily clerk's fingers. The testing keys have large easily grasped milled terminals for depressing the wires, and the lever resting for clearing. New should be substantially formed of electric. New should be forget the useful practice initiated by this firm of delineating the course of concealed connecting wires in keys and other apparatus by thin white lines inlaid in the ebonite frames and bases, thus initiating at a glance the course and direction of the current.

THE HEINRICHS SYSTEM OF ELECTRIC ILLUMINATION.

In February of last year* we illustrated and described the electric lamps or regulators, and automatic electric candles devised by Mr. Charles Frederick Heinrichs, the characteristic feature of which consists in the employment of electrically curved carbon rods, in the place of the straight, in dynamo-electric machines of both Siemens and Gramme, while at the same time in its most essential features it differs from either and from every other electric generator. Its point of resemblance to the Siemens machine consists (as will be seen on reference to Fig. 1) in the method by which the magnetic field is excited, and in the general disposition of the field magnets; while its point of resemblance to the Gramme machine lies in the fact that its armature is of annular form, and is wound, Gramme fashion, with insulated wire forming a closed circuit. The armature differs, however, from the Gramme ring in its totally different cross section, which instead of being rectangular as in the Gramme machine, is U-shaped, as seen in Fig. 2 and 3, which latter represents a portion of the ring partly wound and having the U-shaped coreing R cut in coils of insulated copper wire C C. The construction of the armature ring will be best understood by referring to Fig. 3, while the general construction and arrangement of the machine is very clearly shown in Figs. 1 and 2. Referring to the latter figure it will be seen that a is a shaft driven on a horizontal axis by the belt pulley p. On this shaft is keyed the boss r r carrying the armature ring r r, which is of very peculiar construction, being of U-shaped section and having wound upon it U-shaped bobbins while during the working of the machine are revolved within an intense magnetic field produced by the electro-magnet excitation coils a^1 a^2 a^3, &c., a^1 a^2 a^3, &c., which are excited by the powerful rectangular magnet-ring bobbins w w w w which form part of the main circuit of the machine. The various armature coils constructed so as in most machines of the Gramme type, with a set of copper segments r^1 r^2 r^3, &c., forming a cylindrical commutator, containing as many segments as there are wire bobbins on the ring; on to which commutators are pressed a pair of collecting brushes by which the currents generated in the armature are transmitted into the magnet coils and external circuit.

It will be observed that a special feature of this machine is the lateral disposition of the polar extensions of the field magnets which are so placed with respect to the sides of the armature as to embrace and be very close to every portion of its external convex surface, and it is this feature which, while considerably increasing the efficiency of the machine,

* See ENGINEERING, vol. xxix., page 161.

HEINRICHS'S DYNAMO-ELECTRIC MACHINE.

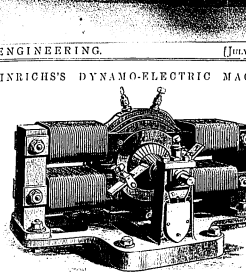


FIG. 1.

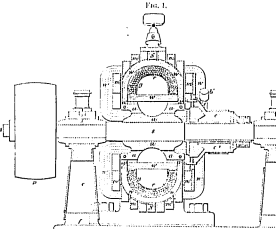


FIG. 2.

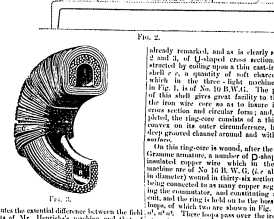


FIG. 3.

constitutes the essential difference between the field magnets of Mr. Heinrichs' machine and that of Messrs. Siemens Brothers and Co.

We will now refer to the construction of the armature ring, which more than anything else is the characteristic feature of Mr. Heinrichs' machine. The iron core of this ring is, as we have already remarked, and as is clearly shown in Figs. 2 and 3, of U-shaped cross section. It is constructed by rolling upon a thin cast-iron mouth or shell $r r_1$ a quantity of soft charcoal iron wire, which in the three-light machine, illustrated in Fig. 1, is of No. 16 B.W.G. (.6 of an inch diameter) wound in thirty-six sections, their ends being connected to as many copper segments forming the commutator, and constituting a closed circuit, and the ring is held on to the boss by six brass cones, of which two are shown in Fig. 2, marked a^1 a^2 a^3. These keep pace over the iron wire core, one at every sixth section, and their ends are attached by screws to the boss $r r_1$. Besides holding the ring-core in its place these brass strips form so many springs from the inside of the ring into the channel, and thus, by ventilating the armature,

"The high efficiency of Mr. Heinrichs's form of armature as an apparatus for inducing currents of electricity from a magnetic field will be understood from the following considerations, and by a comparison of the typical forms of armatures illustrated in the diagrams Figs. 4, 5, and 7. Fig. 4 is a

Fig. 4. Fig. 5.

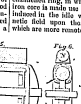


diagram of a Gramme ring within its magnetic field, while Figs. 5, 6, and 7 represent respectively the armatures and magnetic fields of the Siemens, Pacinotti, and Heinrichs machines. In all machines of this general type there must necessarily be a certain proportion of the wire upon the armature which is idle, that is to say, which does not contribute, under the influence of the magnetic field in which it moves, as much current to the main circuit as is taken from it by its own resistance, and it is clear that the greater the proportion of active wire on the armature to dead or idle wire, the greater, other things being equal, will be the efficiency of the machine. M. Antoine Breguet has shown* that one section of the iron ring in a Gramme machine is to screen off, almost entirely, lines of magnetic force from entering the interior of the ring, and from this it follows that all the convolutions of the armature coils which pass across the ring over its inside surface contribute no current, but on the contrary impede those in work, at the same time they add to the total resistance. Referring to Fig. 4 it will be seen that the quantity of wire traversing the ring on its inside is equal to that on the outside. Thus, if the ring be 6 in. wide, in every convolution of the wire there will be 6 in. of wire outside the ring under the influence of the magnetic field, and 6 in. inside the ring protected from the influence of magnetic force, and therefore having no useful effect. In a Siemens armature (see Fig. 5) 10 in. long and 6 in. in diameter, there are about 10 in. of useful line to about 7 in. of wire which, by passing across the ends of the armature, do not in its revolution cut through any lines of magnetic force, and therefore do not contribute to the current generated by the machine. In the Pacinotti machine (treating it as a geometry) the amount of wire under the immediate influence of the magnets N and S, Fig. 6 is very small compared to the rest of the convex of the armature. By adopting the U-shaped section of the armature core (see Fig. 2) and winding the U-shaped bobbins, and these enlarged all over their external surfaces by U-shaped magnet bobbins N N, S S S, Mr. Heinrichs has hit upon a form of dynamo-electric machine which is the most sensitive to think the maximum quantity of the armature circuit in proximity to the inducing influence of the magnetic field with the minimum of idle wire, and therefore the minimum of useless resistance to be included in the circuit; thus if the ring shown in

Fig. 7 be 6 in. wide there will be but 1 in. of idle wire in each convolution to 10 in. of conductor fully exposed to the induction action of the magnets which so nearly surround it. Figs. 5 and 7 are two other forms, suggested by Mr. Heinrichs, of his channelled ring, in which the screening action of the iron core is made use of to stimulate back-currents induced in the idle wire by the action of the magnetic field upon those portions of the armature which are more remote from the inducing magnets.

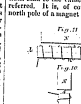


Fig. 6. Fig. 7.

It is a curious fact that Mr. Heinrichs was not led to the adoption of the U-shaped ring for the reasons to which we have just referred, valuable as they undoubtedly are, but from theoretical considerations which are highly ingenious and decidedly interesting, and Mr. Heinrichs attributes the efficiency of his machine more to these theoretical considerations than to the causes to which we have already referred. It is, of course, well known that if the north pole of a magnet N, see Fig. 10, be approached

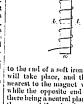


Fig. 11. Fig. 12.

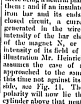


Fig. 10. Fig. 13.

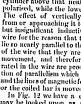
to the rod of a soft iron bar $r r_1$, magnetic induction will take place and the end of the bar which is nearest to the magnet will assume south polarity, while the opposite end will become a north pole, there being a neutral plane $l l$ about half-way between them; and if an insulated wire be wound round the iron bar and its ends joined so as to form a closed circuit, a current of electricity will be generated in the wire every time the magnetic intensity of the bar changes through a movement of the magnet N, or a change in the magnetic intensity of its field of force. Assuming from this illustration Mr. Heinrichs goes a step further, and supposes that the bar $r r_1$ instead of being approached to the same iron bar and coil, but without moving, is extensively but towards its pole, see Fig. 11. The neutral plane $l l$ of no polarity will now lie through its axis, and the left cylinder above that neutral plane will be southerly polarised, while the lower half will become north. The effect of vertically subdividing the magnet from or approaching it to such separate would have the same influence upon the bobbin of wire for the reason that the lines of magnetic force are nearly parallel to the plane of the convolutions of the wire that they are not cut by them in their movement, and therefore the only currents generated in the wire are produced by the slight aberration of parallelism which may exist between the coils and the lines of magnetic force when either the magnet or the coiled bar is moved in a vertical direction.

In Fig. 12 we have a condition of things which may be looked upon as a special case of Fig. 11. In this case the bar is bent round into a continuous ring, and the magnet poles N N S S are curved concentrically with respect to the ring, face again, for the reason given in reference to Fig. 11, but small inductive effect will be produced upon the wire before by the vertical movement of the two pole-pieces N S and N S, although rather more than in the case illustrated in Fig. 11, for the reason that as in the position shown in Fig. 12 the lines of magnetic force are, like the convolutions of

* See ENGINEERING, vol. xxix., page 154.

the coils, more or less radial to the ring, a vertical motion of the pole-pieces will cause certain lines of magnetic force near their outer extremities to be cut by a few of the convolutions near them, and electric currents will, therefore, be generated. But such a movement is in no way analogous to the action of a Gramme machine or apparatus of that type, each of this armature ring within the magnetic field, whereby a lateral or sectorial displacement of the convolutions of the armature takes place, thereby cutting through the nearly radial lines of magnetic force in every portion of their revolution.

Mr. Heinrichs's theory of the action of the Gramme machine is illustrated by the diagram, Fig. 13, which represents a Gramme armature with its commutator and brushes revolving in a direction indicated by the arrows within a magnetic field produced by the magnetic pole-pieces N N and S S. Assuming that in a solid iron ring of the Gramme form, the influence of each of the magnets N and S is to induce polarity opposite to itself on the parts of the ring nearest to it, and polarity of the same sign on the parts more remote, it would follow that if the ring were not in motion, its polarity would be distributed as is shown in Fig. 12, that is to say, the outer circumference of the upper half of the ring would be inner magnetic strength of its lower half would have south polarity, while the inner circumference of the upper half and the outer circumference of the lower half would assume north polarity



and the neutral region of the ring would be cylindrical surfaces passing through the circular axis of the iron ring. The moment, however, that the ring is rotated upon its principal axis (according to Mr. Heinrichs) a sectorial deflection of polarisation is set up. We may, for the purpose of this explanation, call the magnetic influence of N upon a in Fig. 10 *longitudinal* polarisation, and that in Fig. 11 *transverse* polarisation, the motion of the magnet in both cases being in a vertical direction. If however the magnet N in Fig. 11 be similarly displaced, that is to say, if it be moved in a direction parallel to $l l$, it will be found that all less taken an appreciable time to become established, and transverse polarisation, and may be termed for the purpose of this argument *sluggish* polarisation, the polarity of the more remote parts sluggishness, so to speak, behind that of the others in that existing in a plane the bottom more or less diagonal. Now, just as Fig. 12 represented a special instance of what was described generally under Fig. 11, on the assumption of a *vertical* displacement of either magnet or bar, so Fig. 13 may be regarded as a special instance of Fig. 11, on the assumption of a *lateral* displacement of either of the principal parts. In this case the neutral surface will become a spiral (dividing the ring into two parts), whose obliquity with respect to the circumference of the ring will be dependent upon several causes, the principal of which are the speed of rotation, the strength of the magnetic field and the magnetic capacity, or rather the rapidity of magnetic induction of the iron ring.

According to this theory that portion of the ring opposite p', which has been for a considerable portion of its revolution under the influence of the pole S S, will be almost entirely of north polarity; but immediately after passing under the influence of the south pole-piece N N, opposite l'

THE HEINRICHS SYSTEM OF ELECTRIC LIGHTING.

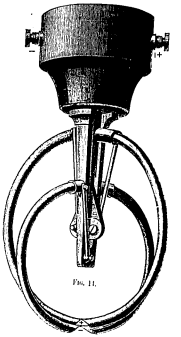


FIG. 11.

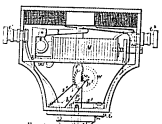


FIG. 15.

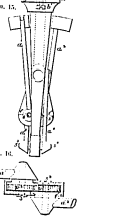


FIG. 16.

pencils, which is in its turn determined by form of construction and method of attachments of the carbon holders. Of this class the lamp known as the Hopfel-Regulator, which we figured and described some three years ago,* may be regarded as the general type; but Mr. Heinrichs's lamp possesses this advantage over that of M. Hopfel, that as the carbon rods, although carried, about against one another so as to be in contact at their point of contact there is no tendency to jam and become fixed, as must sometimes be the case with the V form of axial intersection adopted in the Hopfel regulator.

The general principle of Mr. Heinrichs's new lamp is identical with that we described in our issue of the 20th ultimo, that is to say, the arc is formed between the point of abutment or contact of one pair of circularly curved carbons, and the corresponding point of another similar pair below it, the lower of the two circles having perpendicular to one another, as shown in Fig. 11; the upper pair are positive, being connected to the positive pole of the dynamo-electric generator, and the lower pair are negative, being in electrical connection with the other terminal of the machine. The feed of the carbons requires no mechanical appparatus such as clockwork or gearing, but is maintained solely by the mechanical wasting away through the consumption of the carbon rods at their point of contact; the rods falling together by their own weight, as the carbon at their point of contact is dissipated under the action of the current.

While the feed of the carbons is determined by the consumption, the regulation of the length of the arc is effected by electrical means, the strength of current flowing at any one time determining, by the simple contrivances to which we shall next refer, the degree of approach or of separation of the carbon rings.

By reference to Figs. 15 and 16 it will be seen that the upper or positive pair of carbon holders *a*' and *a*'' are pivoted at the points *c*' and *c*'' to two small equal-sized pinions *p*' and *p*'', shown in the detached plan Fig. 16, which by gearing into one another cause the swing of the arms *a*' and *a*'' equal and symmetrical on each side of the vertical axis of the lamp. A similar method of pivoting is adopted for the arms *a*⁴ and *a*⁵, which are the holders for the pair of lower or negative carbons. The geared pinion of the upper pair are attached to the rod *f*, which is in its turn suspended from the long arm of the bell-crank lever *l*, of which the short arm is the armature of an electro-magnet M, which when the current passes through the lamp by attracting the armature *i* lifts the rod *f*, and with it the upper pair of carbons separating them from the lower pair, and thus establishing the arc. To prevent the lifting taking place with a sudden jerk, which might set the lamp jumping, the rod *f* is at the same time the adjustment of other lamps in the circuit, Mr. Heinrichs has adopted the very simple and ingenious checking apparatus shown at *d*'. This consists of a small rack forming part of the rod *f*, which gears into the small pinion *p*', on which is the large notched tooth-wheel *w*, against the teeth of which presses the light click spring *c*, and prevents any sudden vertical movement of the rod *f*, to which the upper carbons are attached. The lower or negative pair of carbon rods are fixed to and in electrical connection with the frame *D*, which while being insulated from the case of the lamp and positive terminal *p*, by the ebonite washer *i*, is connected by a wire to the negative attachment screw of the lamp *l*' seen to the left of the figure.

It is a coil of insulated German silver wire, whose resistance is about equal to that of the arc, and its use is to prevent the other lamps in the same circuit being affected by the vertical movement of the rod *f*, as the arc of the lamp of which it forms part; for the moment that the current ceases to flow from one pair of carbons to the other it is shunted through it by a very simple contrivance, and as the resistance offered by the coil is practically equal to that of the arc which it supplants the strength of the current throughout the rest of the circuit is not affected by the interruption, and it enables one of the lamps to be extinguished without affecting the others of the same series. The arrangement by which the circuit of R R is substituted for that of the arc when the latter is interrupted, is shown in Fig. 15. On the rod *f* is fixed a projecting pin *p*' which, when the rod drops, brings the contact spring *s*' against the contact screw *s*', which is connected to *D*, and by the wire *h* to the negative terminal. The same action brings the two pairs of carbons together, and in this position a current battery at *C* has two courses through the lamp open to it, one through the resistance R H, and the other through the carbons and through the magnet coils M; the latter portion of the circuit across the carbon to be separated by the lifting of the rod *f*, the arc is thereby established, and the pin *p*' rising with the rod *f* releases the spring *s*' from the screw *s*', thereby cutting the resistance R H out of the circuit and allowing the whole current to pass through the carbons and the arc.

Fig. 16 is a diagram showing the very simple and ingenious method of construction of the pair of pivoted points of the radial carbon holders *a*' and *a*''. In this figure it will be seen that the two pinions *p*' and *p*'' which are geared together are rigidly attached respectively to the radial arms *a*' and *a*'' turning on the pins *c*' and *c*'', which are fixed to opposite sides of the little framing, and the pinions being so proportioned that when pivoted against their respective stops the pinions are in gear and the rods are in their proper position, the axes of their carbon holders lying in the same vertical plane.

Mr. Heinrichs constructs his carbon rings by horizontal compression between dies, the diameter of the circles before they are cut in half varying from 10 in. to 14 in. With carbons of circular cross-section Mr. Heinrichs makes the positive carbon rod 13 millimetres diameter and the negative 11 millimetres, and the length of time which such carbons will burn varies from 20 to 30 hours, according to the diameter of the rings, or rather, the length of curved carbon rod employed—a continuance longer by many hours than can be required in actual practice except in the most exceptional applications.

The carbons, as we have noticed above, are consequently horizontally in dies, this system being more suitable than the longitudinal compression or "squirting" through a circular orifice in a compression cylinder, which can, however, by giving to the rods a curved form, be applied with equal facility to the production of curved carbons as to that of straight pencils.

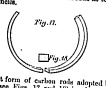


Fig. H.

Fig. N.

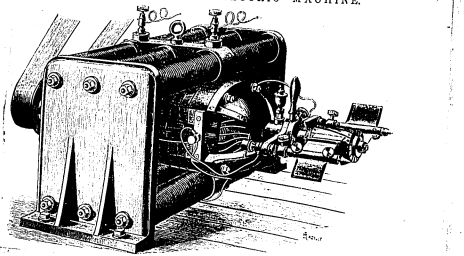
The latest form of carbon rods adopted by Mr. Heinrichs (see Figs. 17 and 18) is of rectangular cross section, measuring 14 millimetres by 12 millimetres, the sectional area being about equal to the ribbon form of circular section. Fig. 17 will show rather than any description the mutual positions of the longer and the shorter side of the cross section.

Mr. Heinrichs's rectangular carbon, and Fig. 19 shows a cross section of one of the carbons. This form of carbon presents several facilities in manufacture which has been admirably worked out by Mr. Heinrichs, one of the most important of which is the facility with which the rings can be compressed to any required density—a result not so easily attained with the circular cross section.

Mr. Heinrichs's new lamps work with admirable steadiness, and when enclosed in opal or ground glass globes produce a brilliant, well-distributed light, being remarkably steady notwithstanding the irregularities of the engine and the countermotion in the speed of the generator. From our own experience of the working of Mr. Heinrichs's system we are inclined to think that it must in time occupy a prominent position among systems of electric illumination, and it is much to be regretted that so interesting and characteristic a system, and one which is so successful in working, is not one of the competing electric lights of which there will be many in the coming Electrical Exhibition at Paris.

* See COMMUNICATIONS, vol xxvii., page 51.

THE WESTON DYNAMO-ELECTRIC MACHINE.



The Engineer
London, July 13, 1881.

The Mather Dynamo-Electric Machine.

An illustrated and descriptive circular and price list of the Mather dynamo-electric machine, which was recently seen us, contains considerable information of a valuable nature to those interested in this class of machines. The pamphlet comprises something over 30 pages, and is handsomely illustrated, containing, besides a number of woodcuts, two perspective views of different machines by the albertype process, which is a modification of the photolype process. The Mather dynamos are intended for electric lighting, electro-plating, electrotyping and similar uses. A rather full description is given of the Mather "F" machine, "besides a brief one of the "ring machine." The pamphlet closes with a price list of the machines, which are made in a number of different sizes, including the prices of their different parts. Among a list of references we notice the names of many well-known electric establishments and other manufacturers. The Mather dynamo-electric machines are manufactured by Mr. A. H. Eddy, Hartford, Conn.

THE WESTON SYSTEM OF ELECTRIC LIGHTING.

The name of Mr. Weston has long been before the public as the inventor of one of the most successful dynamo-electric machines that has been introduced for electro-plating, and we believe at the present time the greater bulk of the largely increasing industry of nickel-plating is performed by Mr. Weston's machines, which in general principle are very similar to the dynamo-electric machine of M. Lontin which has been described in these columns.* The lighting machine of Mr. Weston with which we have to do in the present notice has however nothing in common with the plating machine of the same inventor, for while it has points of resemblance in certain of its details with the machines of Siemens,† Gramme,‡ De Meritens,§ Hiorth, and Manby,‖ it is distinctly original and cannot be confounded with any one of them.

The general external appearance of the machine, which is shown in Fig. 1, on account of the distribution of its field magnets, bears a slight resemblance to one form of the Gramme machine. These magnets consist of six horizontal cylindrical electromagnets, six above the axis of rotation of the armature, and uniting in a single upper pole piece, and six below the armature uniting in two lower pole pieces, the two polar extensions having opposite polarity. The coils of these magnets are connected together in series, and the whole current generated by the machine is transmitted through them, thus producing an intense magnetic field, within which the armature is rotated at a speed of about 1200 revolutions per minute. Those parts of the pole pieces which embrace the armature, instead of being solid and continuous as in those of the Gramme machine, are cut into a series of tongues. These are shown marked T T T, T' T' T', &c., in Fig. 2, which is a diagram of the disposition of the pole pieces, as would be seen from one end of the machine if the magnets M M M and back plate were removed. It will be noticed also that the space between the two pole pieces is wider in the middle than at the two ends of the armature A A, the length of the tongues measured from the magnets decreasing from the centre towards the ends by a sort of elliptic curve. Mr. Weston states that by this arrangement greater regularity of current is secured, the inductive effect of the magnets upon the coils of the armature during its rotation taking place from the centre towards the ends and *reversed*, instead of simultaneously throughout the whole of any one section of the armature wire. The object of the slits in the pole pieces, whereby the latter are divided into a series of tongues, is twofold. In the first place, it effectually prevents cross currents being induced in the pole pieces by induction from the armature; and in the second place, the arrangement materially assists the ventilation of the armature and magnetic field, and thus prevents the machine from becoming overheated.

The armature of the Weston machine is of very peculiar construction, and although it bears some what of a resemblance, when wound and in its place, to the Siemens armature, the construction of its iron core and method of winding is very different. The core of the armature, like that of the Maxim machine, is compound, being built up of a number of iron discs all in form peculiar to itself. One of these discs is shown in Fig. 3 and consists of a disc of iron, shaped like a spur pinion, and having around its circumference sixteen projecting teeth and as many notches. The core of the armature is constructed by threading thirty-six of these discs upon the driving shaft of the machine with small separating washers between, so that there is an air-space between each washer and his neighbour equal in thickness to the thickness of the washer. When the core is completed by the addition of solid end-pieces of a diameter equal to that of the discs, measured across the bottoms of the notches, the whole presents generally the form of a cylinder with hemispherical ends and having a series of sixteen longitudinal grooves cut in its circumference parallel with its axis and a number of smaller transverse grooves between the discs and perpendicular to the longitudinal furrows. Into the sixteen longitudinal grooves are wound as many coils of insulated copper wire, the method of winding being similar to that in the Siemens armature, that is to say, it is laid along one groove across one end and back by the corresponding and diametrically opposite groove on the other side. By this peculiar method of construction it is obvious that the ventilation of the armature is exceptionally well secured, for not only is it hollow, but it is provided with sixteen openings from the inside to the circumference by every disc of which it is composed, or 576 openings in the whole armature; and, as the ends are also provided with openings, a continuous stream of air is, during the working of the machine, constantly being driven through the orifices of the armature and between the spaces of the poles into the outer air.

The commutator which is shown in Fig. 4 is similar in principle to the commutators used in the Siemens and Gramme machines, but its construction differs from them in the fact that the various segments of which it is composed are arranged helically on the shaft, and are separated by air spaces instead of by solid insulating material. The object of this helical disposition of the copper strips of which it is composed is that the rubbing edges of the collectors or "brushes" B (Fig. 5) are, in all positions of rotation of the commutator, in contact with two of its segments, thus insuring greater uniformity to the strength of the current.

Fig. 4.

The collectors or brushes B, of which there are two (diametrically opposed to one another), are made up of ten or a dozen thin curved plates of elastic copper cut by slits into three tongues, and are held against the commutator that the edges of the whole bundle press against the copper segments rotating beneath them, and the brush holders are like those of the Maxim generator, mounted upon a swing frame by which the strength of the current and of the magnetic field can be adjusted by setting the collectors by hand to positions of greater or less efficiency. This arrangement is very clearly shown in the general view of the machine, Fig. 1.

The Weston system is a complete one in itself, that is to say it has both machine and lamp peculiar to itself, and in the succeeding diagrams we give the form and construction of Mr. Weston's lamp, which gives the most highly satisfactory results, regulating itself with extreme accuracy to the strength of the current, and producing a perfectly steady white light. Fig. 5 is a general outside view of the lamp, and Fig. 6 is a diagram illustrative of its very

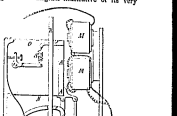


Fig. 6.

interesting and ingenious regulating mechanism, which is contained within the small dome-covered box shown in the upper part of Fig. 5. Referring to Fig. 6, it represents the rod carrying the upper carbon, which when in current is passing, slides freely through the clutch lever C, and therefore allows the upper carbon to rest on the lower. M M is an electro-magnet of peculiar construction, and A A is an armature capable of motion to and fro in a vertical direction only, being supported by the two parallel flat steel springs S and S1, which are firmly attached at their further extremities to the framing of the lamp. It will be observed that in its position of rest the upper end of the armature is just a little below the lower edge of the upper pole of the magnet, so that the action of a current being sent through the magnet coils would be to cause the armature A to be attracted vertically thereby lifting the end of the clutch lever C, to which it is attached by a link, and this lever is so constructed that when it lifts beyond a certain point it seizes and lifts the rod R, much in the same way as the lifting washer in the Brush lamp* lifts the rod of the carbon holder. S is a tension spring attached at its upper end to the top of the armature, and hooked at its lower end to the arm of the bell-crank lever L fixed in such a position that the tension of the spring S can be regulated by an adjustment screw shown in the figure. The movement of the armature therefore is controlled by the varying attractive force of the magnet M M drawing it upwards, and the adjustable tensile force of the spring S pulling it in the opposite direction; and in order to prevent a sudden and violent variation in the attractive influence of the magnet from setting the lamp "jumping," the lower end of the armature is attached by a small piston rod and piston, which moves in a little cylinder or "dash-pot" C containing glycerine, in which the piston is immersed, and the controlling action of this little contrivance can be adjusted within certain limits by allowing more or less glycerine to pass from one side of the piston to the other.

This adjustment is effected by a very simple contrivance shown in the figure. The piston of the glycerine cylinder is composed of two discs, the one fitted to the piston-rod and the other capable of being rotated through a small angle on its centre, which is coincident with that of the other disc as well as with the axis of the piston-rod. Around the edges of both discs are cut three notches at equal angular distances apart of 120 degs., and by the angular position of the movable disc with respect

* See ENGINEERING, vol. xxxii., page 66.

* See ENGINEERING, vol. xxxii., page 71.
† *Ibid.*, vol. xxxii., page 501.
‡ *Ibid.*, vol. xxxii., page 64.
§ *Ibid.*, vol. xxxii., page 222.
‖ *Ibid.*, vol. xxxii., page 56.
¶ *Ibid.*, vol. xxxii., page 61.

ROGER'S METHOD OF SUBDIVIDING THE ELECTRIC CURRENT.

THE following description, with accompanying illustrations will sufficiently explain the system by which Mr. Rogers of St. Clement's House, Lombard-street, E.C., proposes to subdivide and subdivide the electric current for lighting purposes. We gave a brief account of an exhibition of the apparatus on p. 125, ante, and the patents now being complete, we are enabled to illustrate the devices adopted

The object of the invention is improved means and apparatus for dividing and subdividing the electric current for lighting or other purposes, by means of pairs of spherical, conical, semi-spherical, ball, or flat, waves, or other suitable-shaped metallic bodies, having clips or other appliances for the attachment of the primary wires from a dynamo machine or other electric force producer, and with a series of other clips or other bands, loops, or edges of the metallic bodies, to which other wires can be connected for conducting the fluid to any desired number of lamps or carbons, or to other shaped vessels or metallic bodies arranged in pairs, from which again wires can be conducted to other lamps or carbons. The sizes of the ball or other shaped vessels or cups, if of ball shape, is generally of greater thickness than the body for accumulating and governing the fluid. The bands are also of greater thickness than the body for a similar purpose. Should the vessel have a spherical or globular form, the clips above referred to may be fixed upon a central band or ring, and instead of the single clips being on the apex, it may be fixed to the collar or stem on which the globe stands. For intensifying light, the series of clips on the bands for the vessels may have the primary wires of several electric force-producers attached to them, so that the united current may be transmitted through the apex wire of the ball-shaped vessel, or through the collar wire of the spherical vessel to one or more lamps or carbons. Any number of these metallic bodies may be used, between the force-producer and the light or lights if desired, for intensifying on the one hand, or dividing on the other.

Fig. 1 is a section of a bell-shaped apparatus, A, with lining vessels in the interior for current intensifying and distributing purposes; B is the apex, with a conducting wire, C, attached by the screw clip D, and E is the band or base around which a series of other conducting wires, F, are looped, leading to and connected with electric lamps for producing light from one main dynamo or other force-producer, as before mentioned, or for distribution of current for other purposes.

Figs. 2 and 3 are section and plan of a branched disc, with a wire arranged at the centre and branches for other wires. Many different forms can be used, but it is unnecessary to illustrate them.

The several branch conducting wires attached to the base or rim of any of the intermediate accumulators of current force or fluid may be led and attached to other gathering or accumulating apparatus, the subdividing being effected by pairs of intermediate apparatus of smaller sizes than those of the main pair, A further subdivision of the current may be effected by the attachment of the subsidiary wires to the second pair of apparatus which may be like the other or of different forms, and the distribution and redistribution may be carried out until the current is, so to speak, absorbed, or almost absorbed, by the several apparatus into which it passes.

Fig. 4 represents one of a pair of current accumulating apparatus, A, within a box, H. To the sides of this apparatus A one of the subdividing wires of the dynamo or battery is attached. The branch or subsidiary wires leading from the rim of the apparatus, nine in number, pass through a partition, J, of the box to the sides of nine other, but smaller, apparatus attached, and the box in which it is arranged is provided with nine smaller apparatus with branch or subsidiary wires from the rim of the primary one to their centres, in a similar manner and for the same purpose as that described for the completion of the circuit.

THE WESTON SYSTEM OE ELECTRIC LIGHTING.

(For Description, see next Page).

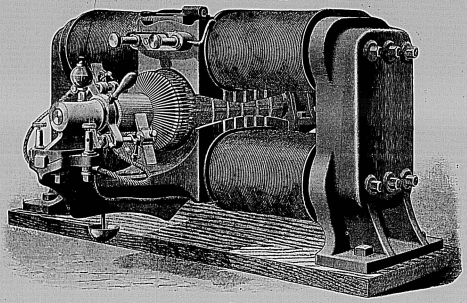


FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

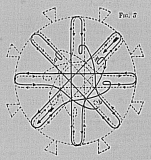


FIG. 5.

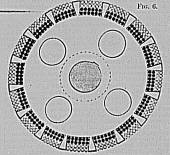


FIG. 6.

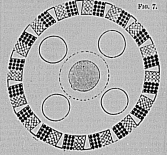


FIG. 7.

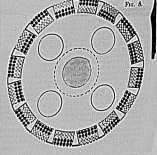
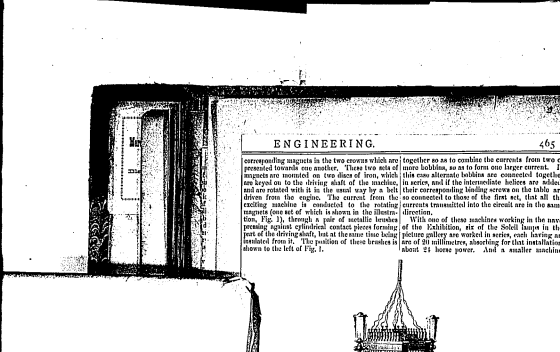


FIG. 8.



THE LACHAUSSÉE ELECTRIC MACHINE AT THE PARIS EXHIBITION.

In our preliminary general notices of the electric lighting apparatus at the Exposition d'Electricité, we gave a general outline of the characteristic features of the very interesting electric generator of M. Lachaussée, of Liège, which, together with the Soleil installation, forms the picture gallery and in the Belgian Section, constitute the highly important exhibit of the Compagnie Générale Belge de Lumière Electrique of Brussels. In the present notice we give illustrations of the Lachaussée apparatus, and as some of the peculiarities of our present issue we describe the Soleil system of electric lighting to which we also referred in the same preliminary notice.

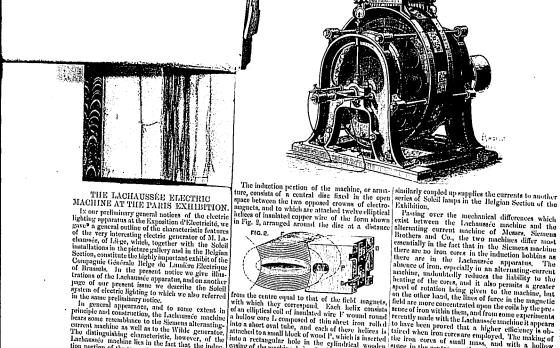
The general appearance, and to some extent the principle and construction, the Lachaussée machine bears some resemblance to the Siemens alternating-current machine as well as to the Wilde generator. The distinguishing characteristic, however, of the Lachaussée machine lies in the fact that the inductive portion of the apparatus or "armature" is fixed while the field magnets are rotated, a form of construction possessing several features of convenience to which we shall refer further on, and which it shares with the Jablochkoff, alternating Gramme, and Gerard machines, the latter of which it somewhat resembles from any other.

The rotating magnetic field is produced by two sets of electro-magnets, each set consisting of a crown of twelve electro-magnets, and attached to the shaft in such a position that the free ends of the one set are directed towards the free ends of the other set, but separated by a space within which is fixed the armature. The coils of these field magnets are connected together in series, in such a way that the direct current from a small Gramme machine in exciting the series given to the magnets, polarities alternating in direction around each crown, and of the same time produces opposite polarities in the

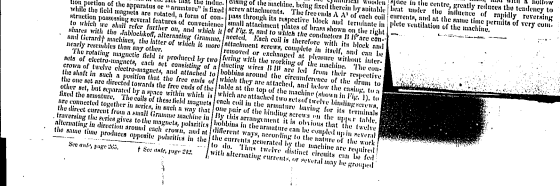
See end, page 505.

† See end, page 482.

corresponding magnets in the two crowns which are presented towards one another. These two sets of magnets are mounted on two discs of iron, which are keyed on to the driving shaft of the machine, and are rotated with it in the usual way by a belt driven from the engine. The current from the exciting machine is conducted to the rotating magnets (one set of which is shown in the illustration, Fig. 1), through a pair of metallic brushes pressing against cylindrical contact pieces forming part of the driving shaft, but at the same time being insulated from it. The position of these brushes is shown to the left of Fig. 1.



The induction portion of the machine, or armature, consists of a central disc fixed in the open space between the two opposed crowns of electro-magnets, and to which are attached twelve elliptical bobbins of insulated copper wire of the form shown in Fig. 2, arranged around the disc at a distance



from the centre equal to that of the field magnets, with which they correspond. Each bobbin consists of an elliptical coil of insulated wire F wound round a hollow core composed of thin sheet iron rolled into a short oval tube, and each of these bobbins is attached to a small block of wood F, which is inserted into a rectangular hole in the elliptical wooden ring of the machine, being fixed thereto by suitable screw attachments. The free ends A A' of each coil pass through its respective block and terminate in small attachment plates of brass shown on the right of Fig. 2, and to which the conductors H H' are connected. Each coil is therefore wire wound, but the core is of iron, and can be removed or exchanged as circumstances may require, without interfering with the working of the machine. The conducting wires H H' are led from their respective bobbins around the circumference of the drum to which they are attached, and below the casing, to a table at the top of the machine (shown in Fig. 1), to which are attached two mixed twelve binding-screws, each coil in the armature having for its terminals one pair of the binding screws on the upper table. By this arrangement it is obvious that the twelve bobbins in the armature can be coupled up in several different ways, according to the nature of the work to be done. The twelve distinct circuits can be fed with alternating currents, or several may be grouped similarly coupled up supplies the currents to another series of Soleil lamps in the Belgian Section of the Exhibition.

Passing over the mechanical differences which exist between the Lachaussée machine and the alternating current machine of Messrs. Siemens Brothers and Co., the two machines differ most essentially in the fact that in the Siemens machine there are no iron cores in the induction bobbins as there are in the Lachaussée apparatus. The absence of iron, especially in an alternating-current machine, undoubtedly reduces the liability to the heating of the coils, and it also permits a greater speed of rotation being given to the machine, but on the other hand, the loss of force in the magnetic field are more concentrated on the coils by the presence of iron within them, and from some experiments recently made with the Lachaussée machine it appears to have been proved that a higher efficiency is obtained when iron cores are employed. The making of the iron cores of small mass, and with a hollow core in the centre, greatly reduces the tendency to heat under the influence of rapidly reversing currents, and at the same time permits of very complete ventilation of the machine.

together so as to combine the currents from two or more bobbins, so as to form one larger current. In this case alternate bobbins are connected together in series, and if the intermediate bobbins are added, their corresponding binding-screws on the table are so connected to those of the first set, that all the currents transmitted into the circuit are in the same direction.

With one of these machines working in the nave of the Exhibition, six of the Soleil lamps in the picture gallery are worked in series, each having an arc of 20 millimetres, absorbing for that installation about 24 horse power. And a smaller machine

The Weston machine for running incandescent lamps is of the same general construction as the other Weston machines already described, but differs in many of its details, and is, in one respect at least, entirely new.

Incandescent lamps being used in multiple arc instead of in series, it is necessary that the electromotive force of the machine should be kept constant, and that the quantity should vary directly as the number of lights in circuit.

It is obvious that with a generator of constant electromotive force the current is absolutely proportional to

$$\text{for since } Q = \frac{E}{R} \text{ if } E \text{ be constant, } Q \text{ will vary inversely}$$

as R; but in the multiple-arc system of distribution, the resistance of the conductors is practically zero, and R is directly and accurately, with E constant, Q varies directly as the number of lamps, assuming of course that the lamps are uniform.

In all machines any variation in the external resistance acts upon the quantity of the current generated, but in all other machines with which we are familiar, the electromotive force of the current appears to be largely affected by variations in the quantity, so that any considerable change in the number of lights in circuit materially changes the current passing through the remaining lamps, and makes a readjustment of the latter necessary. Regulators of various kinds have been used to overcome this difficulty by varying the strength of the field to compensate for changes in the number of lamps in circuit. Such devices, whether manual or automatic, are open to the objection that they require attention of some kind, and cannot be relied upon in all cases to act quickly enough to save the lamps.

Mr. Weston has succeeded in constructing a machine of which the electromotive force is constant, and practically independent of the quantity of the current, and the most violent fluctuations in quantity seem to exert no appreciable influence upon the electromotive force. As for instance, with the hundred-light machine, ninety-nine lights may be turned off suddenly, and instantly without endangering the remaining lamps by heavy-duty affecting the brilliancy. This is no mere theoretical result, but is of importance for the incandescent system now being over-estimated. We are obliged, however, from lack of space, to defer a description of the particular construction of this machine for the present.

The Weston machine very desirable to have some device for varying the electromotive force of the machine within certain limits. For example, in the case of incandescent lamps it is seldom that the speed of the armature remains exactly that required to give the precise electromotive force to bring the lamps up to the standard illuminating power. It is also nearly impossible to make the incandescent lamps of perfectly uniform resistance, and the necessitates a change in the electromotive force to suit the lamps in circuit. Sometimes, also, it is desirable to have in which the illuminating power of the lamps must be varied as a whole. This is done by the use of a resistance-coil of German silver wire, which the light is put in circuit by all times.

In the arc system it is absolutely necessary that the electromotive force of the machine shall admit of wide variations, since this is the only available means of adjusting the machine to a varying number of lights, the resistance of the conductors remaining the same. This is constant, as is supposed, and if variations of the lamps are to be kept within practicable limits. The Weston machine is designed to meet these requirements.

It consists of the chestnut, which is shown in Fig. 36 interposed in the field circuit. The coils of the machine in four are connected with the terminals of resistance coils of German silver wire contained in the box. The resistance of the field circuit, and consequently the strength of the current, may be varied at will by turning the handle of the chestnut, so as to adjust the machine for running any number of lights from one to its full complement. This action of the chestnut does not at all disturb the proper operation of the machine, as is the case where the resistance is varied in the carbon arc, a field partially shunted out of the circuit. The twenty-four brass buttons on the chestnut with one long contact with the full complement. The same form of chestnut is used for the adjustment of the incandescent lamps, and for this purpose we have added the rheostat, which is divided to vary the illuminating power of all the lights, it is not used after the first adjustment is made.

A striking peculiarity of the Weston arc system is the shortness of the arc used. The arc is usually about one-tenth less than .02 of an inch in length. The arc in the Brush and most other systems, is .08 of an inch. In the Weston system a current of about 10 volts is used, while in the Brush machine a current of 50 volts is used, the Weston arc requiring only one-fifth of the energy. The short arc system is the incensed size of the fine coal-dust necessary for conveying the increased quantity of current without too great loss; but this disadvantage is more than counterbalanced by the steadiness of the light. More light is obtained for a given expenditure of current with a short arc than with a long one, other conditions being equal. Where a long arc is used there is a marked phosphorescence of the rays at the violet end of the spectrum, giving the light a bluish tinge. The intensity of the light is greater. With a short arc the light approaches more nearly a pure white, and is much more actinic and agreeable to the eye. It is also more diffusive—that is, it produces more perfect illumination at a distance from the lamp. The arc is also much steadier, and the impurities in the carbon, which usually produce disturbance with a long arc, do not appear to affect the short arc.

But by far the greatest advantage of the short arc system is the largely decreased liability of injury to persons coming in contact with the conductors. We have no doubt that the danger to be apprehended from electric lighting apparatus, as at present constructed, having been largely over-estimated; and such dangers as really exist can be overcome by proper care in the use of the apparatus. Experience has demonstrated, it is secure, that fatal accidents are possible with many of the arc lighting systems. Where currents of very high electromotive force are used, the most extreme care is necessary for avoiding accidents, and it is desirable, on this account, that the electromotive force should be kept as low as possible. It seems, on the whole, that the low electromotive force of the Weston system is a very important feature in the same circuit. The resistance of the lamps is such with a current of practically low-force potential, and the only resistance of any importance is that of the conductors. Among the many advantages of the Weston system, we have not referred to the fact that the apparatus, upon which have been attentions and the Weston machine, and we are informed that no accidents whatever have in fact occurred with this system. Probably this is to be largely attributable to the low electromotive force of the current used, but it is also due, in some degree also to the continuous character of the current. Alternating currents are known to be especially dangerous, and the substitution of a continuous current for an alternating current or an intermittent current, has been used in all cases where accidents have occurred. To whatever cause the immunity of the Weston system from accident is due, it is a matter of considerable importance to the public and is worthy of careful consideration.

Different forms of Weston arc lamps are used. Fig. 31 is a simple form of double-carbon lamp.

The feeding mechanism of the duplex lamp is shown in Figs. 32, 33, and 34. In this there is but one clutch employed. It is for controlling the feeding of both sets of carbons. The upper carbon is supported with two sets of nuts, one of coarse pitch, belonging to the feed of the arc circuit, and the other of fine wire for carrying the shunt. The negative fact that an alternating current or an intermittent current, has been used in all cases where accidents have occurred. To whatever cause the immunity of the Weston system from accident is due, it is a matter of considerable importance to the public and is worthy of careful consideration.

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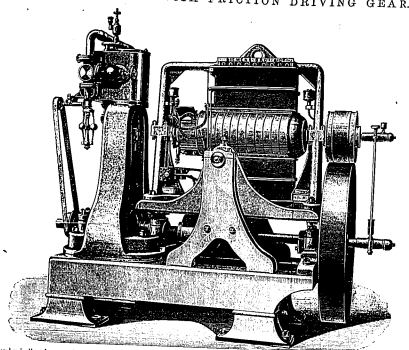
The lower terminal of the coarse wire helix is electrically connected with the upper carbon carrier, and the current and the feeding mechanism are slotted sliding-contact

SIEMENS' DYNAMO WITH FRICTION DRIVING GEAR.



Considered mechanically a dynamo-electric machine is an exceedingly simple appliance, and one which at first sight would appear to present no difficulties in driving. It is true that as usually run at a high speed, but quick-running machines are so rarity, and the best means of transmission to draw upon in days when each generator fed but one lamp, and consisted from two to four horse-power only, the matter was simple enough, but as the number of lamps supplied from one source increased, the subject developed a new difficulty and less familiar shape. Belts had now to be made wider and driving pulleys larger, while countershafts had to be driven at higher speed, and furnished with pulleys of unusual diameter. As the incandescence lamp gained ground another stage was reached, for whereas with arc lamps the maximum power absorbed by one generator seldom exceeded 20 horse-power, now it often reaches as much as 40 or 50 exceptionally double that, and at an electric light exhibition the bewildered visitor has a difficulty in finding the dynamos among the concourse of belts, engines, pulleys, and belts which entirely overshadow them. So long as there is ample space at disposal there is no great objection to be made to this; machines running at 600 or 700 revolutions per minute cannot well be driven directly, and belts are probably the best, certainly the best understood, means of transmitting the power to them. But unfortunately the requisite space is not always to be had; electric lighting is usually regarded as an adjunct which might be stowed away in a corner, generally in a vault or a most unsuitable, where it is impossible to employ a belt of sufficient length to run well, and then follow the mistakes which have so often brought discredit upon the new illuminant.

But however arrangements may be as the space allotted to the electrician on hand, it is always much larger than that within which he is confined when he undertakes the lighting of an ocean steamship. In a corner partitioned off from a coal bunker, he is expected to erect duplicate engines and plant for 500 incandescence lamps, and he often finds the problem very difficult of solution. He has to provide accommodation for two engines each capable of indicating 60 or 70 horse-power, and for two dynamos, while each engine must be so arranged that it will drive either generator, so that the chances of a breakdown may be reduced to the smallest amount. Arguing from the advantages offered by the electric light engineers to shipowners it would be reasonable to expect that they should have a fairer chance of doing themselves justice, but the question of space can be settled on theoretical grounds; the exigencies of trade demand that the machinery shall be contained within the smallest possible compass, and it is expected that the ingenuity of engineers will find a means of fulfilling this condition.

In our issue of May 4 we illustrated and described a method of rope transmission for driving dynamos machines on board ship, devised by Mr. J. S. Haworth, of Manchester. At the date of our article he had already applied it, on behalf of Messrs. Siemens Brothers, in twenty-three instances, of which the first was on board the City of Rome; since that time the number has been further increased, and in every case the ropes have given perfect satisfaction, showing no tendency to slip, and requiring but little supervision. The growing use of marine installations is now, however, surrounding upon the small area required even for the rope transmission, and Mr. Haworth has introduced a new method of driving, which we illustrate above, by which will, we think, from its novelty and simplicity, interest many of our readers besides those professionally connected with electric lighting. The system is that of friction or rolling contact, is of course perfectly well known, but hitherto it has never been applied to driving electric generators, nor, as we think, for transmitting so much as 40 horse-power. The difficulty in the application lay in the necessity of avoiding a great strain upon the bearings of the dynamo. The armature runs so closely to the field magnets that any considerable wear in the bearings brings about the destruction of the former, and since the contact between the rolling surfaces is theoretically only a line, it was feared that there must be a heavy pressure brought to bear upon them to gain the required adhesion, and that it would be dangerous to transmit it through the bearings. To avoid this the generator is mounted on a cradle carried in trunnions, so that it is perfectly free to swing in a vertical plane fore and aft, and so accommodate itself to any position of the driving pulley, the stress in the bearings being only that due to the weight of the armature, and the turning moment required to drive it, far less than that to which it is subjected when driven by a belt or by a rope.

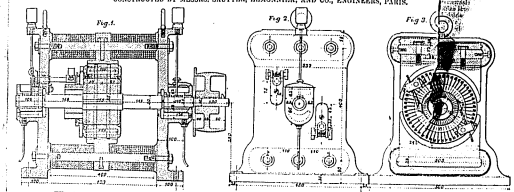
The pulley on the armature spindle is composed of discs of paper powerfully compressed between two gun-metal face-plates, and turned to a smooth cylindrical surface. It runs in contact with a large cast-iron pulley, which is also the flywheel of the engine, and the two are maintained in intimate connexion by a pair of tightening screws. The armature spindle and the flywheel shaft are each turned down at the end and run as gun-metal journals provided with steps or bags for the passage of these bars. At the lower end, each bar has a head, and at the upper end it is screwed to receive a nulled head nut, with a head 2 in. in diameter. Under each nut is a short helical spring about 1 in. in length, so that as the nuts are screwed down the strain is gradually increased, and a matter of fact the pressure required to keep the two rolling surfaces in working contact is exceedingly slight, two or three turns of the nuts, made only by the thumb and finger without any lever or screw-key, being amply sufficient for the purpose. The engraving represents a Siemens S D, dynamo, designed to feed 200 8-candle lamps and a 6 horse-power Tangye engine, controlled by a Pickering governor.

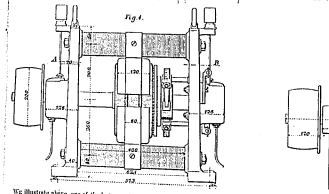
The first machines driven in this manner fed 60 lamps, and were placed on board the s.s. Jurmala, in which they have answered admirably. There is now a similar one upon the City of Chicago and two upon the Manitoba, of the Allan and Oriental service, and gradually increasing sizes, up to the largest constructed by Messrs. Siemens Brothers, are now being adopted to this method of driving with very successful results. When duplicate dynamos are installed, a pair of engines are placed in the centre of the hull with a generator at each side. The engines are not usually coupled together, but should one engine and the opposite dynamo both fail, then the two crankshafts can be coupled together to transmit the power from the remaining engine to the other generator. Our engraving represents one of five apparatus exhibited before the British Association at Southport.

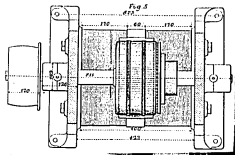
Canalisation of the Isthmus of Corinth.—The works here are advancing rapidly, and will be completed in four years. The quarrying of the rock has not proved as difficult as was anticipated. The total quantity of soil to be removed is estimated at about 1,500,000 cubic yards.

THE GRAMME DYNAMO-ELECTRIC GENERATOR FOR FIVE LIGHTS.

CONSTRUCTED BY MESSRS. SAUTTER, LEMONNIER, AND CO., ENGINEERS, PARIS.







We illustrate above one of the last new types of the Gramme dynamo-electric generator adopted for feeding five arc lights. Several examples of this machine were shown at the late Paris Electrical Exhibition, her two, five, six, and twenty lights, and which were employed for lighting in the main and third avenues on the first floor. These generators were exhibited by the Gramme Company, by M.M. Sautter, Lemonnier, and Co., and by the Spanish Electrical Company. The machine consists of a ring-core electro-magnets, in the centre of each of which a bearing is formed for the driving shaft on which the ring is mounted, near the top and bottom of each frame a face is formed with a transverse groove formed in it (Fig. 1) for the reception of the cores of the electro-magnets. The shape of the cores is shown in Figs. 1 and 2; they are flat rectangular bars 11.20 in. long by 1.26 in. thick. These cores, besides resting on the grooves formed in the frame, are secured by bolts passing through, three at each end of the core (Fig. 2). The cores are coiled around indicated on the drawings. In the middle of each magnet is this projection, 4.72 in. thick and held by screws to the core (Fig. 3); they are rather wider than the ring (7.122 in.) and the inner faces are semicircular, so as to embrace almost its complete circumference, a small space only carrying the revolving armature. A projection at one end beyond the frame is formed for driving pulley, 7.87 in. in diameter; the size of the steel shaft is 2.17 in. in diameter; the size of the ring, which is wound on a wooden core, 5.91 in. wide and of such a diameter as to fit tightly within the The outside diameter of the finished ring is 20.24 in.; the pole-pieces, and it will also be seen that the ring is strengthened by the addition of two bands or hoops, mounted on the wooden core by means of a copper ring, through which screws are passed at intervals into the core. Between the metal bands of the collector, on which the brushes bear, and the central shaft, a metal sleeve is interposed, as shown in the section. The detailed arrangement of the collector is indicated in Fig. 3. The brushes are controlled by an endless screw operated from the outside of the frame, so that their position may be regulated to secure the best effect. The great simplicity and excellent design of this machine give it quite a special character, and amongst the novel details may be indicated that of forming the bearings in the frames and the mode of lubricating, which is clearly shown in Fig. 1. It will be noticed that the bearings are of unusual length, 4.32 in., to enable the machine to run at a high speed with perfect steadiness. The following are some of the leading features of this generator:

Total length including pulley	...	...	52.09 in.
Width	...	...	21.26 "
Height	...	...	21.26 "
" of shaft above base	...	...	11.02 "
Diameter of pulley	...	...	7.87 "
Face of pulley	...	...	3.94 "
Total weight	...	...	792 lb.
Resistance of ring	...	...	0.0213 ohm.
Weight of wire on ring	...	...	1.5 ohms.
Resistance of electro-magnets	...	...	24.2 lb.
Weight of wire of electro-magnets	...	...	1.6 ohms.
Outside diameter of ring	...	...	1.6 lb.
Width of ring	...	...	20.24 in.
			5.91 "

This machine can be used for feeding from one to five lights by varying the speed at which it is driven and the resistance of the conductors. The annexed Table shows the most suitable speeds and resistances, as well as the space between the carbons during work and the length of arc at the point of extinction.

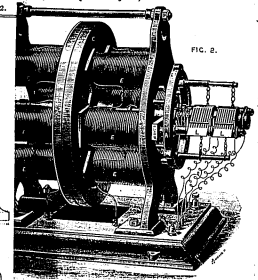
Number of lights.	Resistance per lamp.	Resistance in ohms of Conductors.	Normal lights.	Length of Arc at Point of Extinction.
1	500	1.00	1100	1.00
2	500	2.00	25	1.00
3	667	2.00	25	.87
4	1125	4.50	25	.75
5	1200	4.50	25	.63

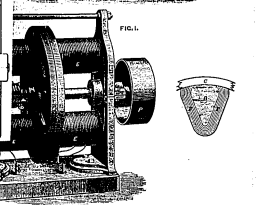
We may add that we have reproduced the illustration of this machine from our contemporary, *La Revue Industrielle*.

THE ARAGO DYNAMO-ELECTRIC GENERATOR.

(For Description see Page 62.)

JAN. 20, 1882.



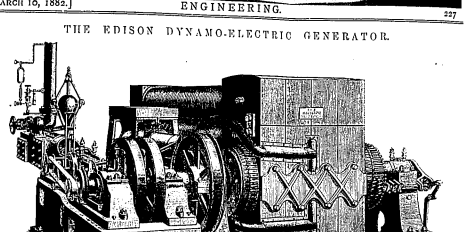


THE ARAGO DYNAMO-ELECTRIC GENERATOR.

Among the numerous dynamo-electric generators shown at the recent Paris Electrical Exhibition, were two machines of American origin, which, under the name of the "Arago disc dynamo," were exhibited by the Van House Mills Company, of Hoosac, New York. On the preceding page we publish drawings of both these machines, which we have already referred to (see ENGINEERING, vol. xxxii., p. 217). Fig. 1 shows the simpler of the two generators. It comprises, as will be seen, two pairs of electro-magnets E S, each having one end attached to the frame of the machine, and the other ends opposite each other; these magnets are so wound that they present alternate polarities, and the polarity of each pair of magnets facing one another is of an opposite nature. The magnets are provided, as shown, with sectional shaped pole-pieces, which collectively form the greater part of a disc. Each pair of magnets having such pole-pieces opposite to one another, it will be seen that at their nearest approach the edges of the pole-pieces are distant from one another by a narrow parallel space. Within the magnetic field thus formed revolves a wheel or disc, in which are mounted a series of six sector-shaped bobbins. These are clearly shown in Fig. 3, where B is a wooden core, F the coil, and C the zinc of the disc. All six of these coils are wound in one direction, but are coupled up in such a way that a current passing through them in series, would circulate round the disc in alternate directions. The coils are held in position by two plates on the driving shaft, and by the double copper ring G, that forms the periphery of the wheel.

The second and larger machine is shown in Fig. 2. It is constructed on the same principle, but involves more complication. In this generator there are six pairs of electro-magnets, arranged as in the smaller machine, and furnishing six alternating magnetic fields. The reversing disc is also as already described, only it has eight coils with wooden cores. The commutator consists of 24 plates. The means employed for rendering the current continuous is the same in principle as that used in the Heffner Altaneck machine. The space contained

THE EDISON DYNAMO-ELECTRIC GENERATOR.



pled between two coils of the shaft connected to three plates of the commutator in such a way that the latter form three groups of eight plates each. The two brushes are always in contact with two plates corresponding to the line that divides the induction coils in two equal parts traversed by opposite currents. The commutator is mounted on the same axis as the armature and similar to the smaller commutator each of the coils of the armature is in two parts. The induced current set up in the main important of these parts produces a current that it throws into the circuit of exterior work. The induction produced in the other portion creates a current that excites the electro-magnets. On account of this arrangement the collector is divided into two distinct parts, each corresponding to one of the circuits just mentioned. The brushes L L are mounted in a special way; they supports are fixed on a ring A (upon the frame of the machine, and the brushes themselves are also carried by springs fixed to the ring. From the foregoing description it will be seen that the lamps dim dynamo is a self-exciting generator, the arrangement adopted involving the use of two sets of brushes and two commutators, one connecting the magnets with the exciting coils, and the other connecting the induction coils and the outer circuit. The frame on which the brushes are mounted can be turned round through a considerable angle, so as to adjust the brushes to the position of highest efficiency. It is stated that the large of these machines, driven at a speed of 1000 revolutions, can feed eight arc lights of average intensity, consuming about six horse power, but accurate data as to its capacity are wanting. We are indebted to our contemporary *La Lumière Electrique* for the illustrations of these generators, and partially for the description of them.

THE EDISON SYSTEM OF ELECTRIC ILLUMINATION.

We have from time to time, in the pages of this Journal, referred to the many interesting and ingenious devices introduced by Mr. Edison in connection with electric illumination, and which have gone to develop what is probably the most complete and well-elaborated system of incandescent electric lighting which hears his name, and which formed one of the most attractive exhibits at the Exhibition of Electricity at Paris, as it does at the present electrical display at the Crystal Palace. At a future time, however, the public will have an opportunity of seeing in practical and extensive operation, as ordinary purposes by the lighting of the street lamps, and most of the shops and warehouses, throughout the whole length of the Holborn Viaduct in London, including part of the General Post Office, and the whole of the City Branch, for this installation is in a very forward state, and is rapidly approaching completion.

In our issue of the 21st of October of last year* we illustrated and described the great Edison dynamo-electric generator which was used during the progress of the Paris Exhibition, but which after the close of the work, illuminating as it did nearly a thousand Edison-Swan lamps formed an attractive a feature of that successful exhibition. In the present notice we propose to describe another enormous machine, generator of improved construction, two of which have recently been brought over from New York, and erected at the offices of the Edison Electric Light Company on the Holborn Viaduct, for the working of the installation above referred to. In this installation there will be no less than a thousand full size, or sixteen-candle incandescence electric lamps maintained constantly in operation and which are distributed as according to the list given in the next column. All these lamps will derive their current from one of the two machines which are fixed in the basement of the company's offices, the other machine, which is very similar, being kept in reserve in the event of any accident occurring to the working

* See ENGINEERING, vol. xxxii., page 467.

	Number of Lamps.
In the front lamps for the whole length of the Holborn Viaduct, that is to say, extending from the Old Bailey to Holborn Circles (two Edison's lamps in each lantern)	200
In the illumination of Dr. Parker's City "Temple"	175
In the central station and offices of the Edison Electric Light Company	150
In Messrs. Spiers and Pond's Viaduct Restaurant and Grill Room	75
In one wing of the General Post Office ... Distributed in small numbers throughout the warehouses and shops on the Holborn Viaduct	50
Total	1000

machine, as well as to take its place during periods of repairs.

The illustration on the opposite page is a general view of one of these interesting machines, which consists of an enormous dynamo-electric generator, similar in general design to the great machine at the Paris Exhibition, but differing in several important details of construction, particularly side by side upon the same bedplate and foundation with a horizontal high-pressure Porter engine of 130 horse power, the main shaft of which is a prolongation of the axis of the armature of the generator.

Upon referring to the illustration it will be seen that this generator is of the Edison horizontal type, the magnetic field being produced by a battery of twelve horizontal electro-magnets disposed in three rows of four magnets each, two rows being attached by their ends to the upper pole-piece, and one row to the lower pole-piece, the further ends of all being united by a massive bed plate, seen at the back of the figure. The armature is driven at a speed of 350 revolutions per minute, within a cylindrical space bored out of the very massive pole-piece shown in the front of the illustration, and which are built up of twelve heavy blocks of cast iron held together by long bolts threaded through them, and by surface coupling plates screwed on to three of their faces. The armature, like that of the Paris machine, is of cylindrical form, and is composed first of a core built up of no less than 2200 discs of very thin sheet iron, alternating with discs of tissue paper, while at every foot measured in the direction of its length, it is disc of thick iron to give stability and rigidity to the armature; the whole is squeezed and bolted together by eight longitudinal bolts passing through all the discs, and through a pair of end plates by which the pressure is applied, and the whole is locked with a tube of wood, so as to insulate the armature core from the rest of the machine. The induction portion of the armature is composed of 105 straight longitudinal thick bars of nearly pure copper of trapezoidal cross-section, arranged at equal distances around the core and insulated from it. These 105 copper bars are united at alternate ends to as many copper discs, half of which on one side are strong on to the shaft at one end of the armature and the other half at the other; all the discs are insulated from the shaft and from one another, and the bars are so connected with them that the bars and discs together form a continuous and closed circuit, wound as it were longitudinally around the core. This coupling up is effected as follows: each of the copper bars is connected at each end to the copper disc at that end, and the diametrically opposite edge of the same disc is connected to the corresponding bar at the opposite side of the armature; this bar in its turn is connected to the disc at the other end, and the opposite edge of this disc is connected to the bar next in rotation to the bar we started with, this again to the next disc at the other end, until all the bars and all the discs have been connected together in such a way that a current of electricity transmitted through the armature would pass along one bar, across the disc at one end, back by the next bar, across the disc at the opposite side, then across a to No. 2 disc and back on the opposite side to another disc, so that for all electrical purposes the making up a thick copper coil of extremely low resistance, wound longitudinally over an iron cylinder in a single layer, the various convolutions of which belong at equal angular distances apart around the circumference of the cylinder.

In the disposition of the inductive portion of the armature it is identical with the armature of the ordinary Siemens direct-current machine, but the coupling up is simpler, and the course taken by the currents produced is in consequence somewhat different.

The diameter of the armature when complete is 25 in., its length is 5 ft., and its weight is over four tons. When it is remembered that this mass is revolved within the hollow cylindrical space between the pole-pieces at a speed of 350 revolutions per minute, it will readily be anticipated that if the heavy bars of copper were attached to the armature only at their ends, which are between 4 ft. and 5 ft. apart, and revolving as they do at a circumferential speed of 43 ft. per second, the armature would be speedily destroyed by the bars flying out under the influence of centrifugal force, and coming in contact with the iron pole-pieces which embrace them. To prevent this, the bars are held together at short distances along the length of the armature by coils of steel piano-forte wire bound tightly round the bars over bands of mica, by which they are insulated from them, and some idea may be formed of the high class workmanship and fitting together of this finely constructed machine when we state that although the diameter of the revolving armature is 25 in., that of the cylindrical space within which it revolves is only 26 in., thus allowing but one-eighth of an inch clearance between the induction bars and the pole piece. It is needless, of course, to point out that this accuracy of construction adds very considerably to the efficiency of the machine, by enabling the armature to revolve in a most intense magnetic field than if, through less accurate workmanship, the magnetic poles, to insure the safety of the machine, had to be farther off.

The electro-magnets by which the magnetic field is produced, consist of twelve horizontal cylindrical bars of iron about 5 ft. long, and coiled throughout their whole length with thick insulated copper wire. The coils of three magnets are connected together in two parallel circuits of six coils each, and the resistance of the circuit so arranged, and which form a derived or shunt circuit to that of the machine, is 2 ohms. The resistance of the armature, as will be apparent from a consideration of its construction is practically inconsiderable, measuring only about $\frac{1}{1000}$ of an ohm (.00910 ohm).

The commutator is a cylinder built up of a number of insulated copper sections as in that of the Siemens and Gramme machines, there being as many copper segments as there are induction bars on the armature, and are connected to them by so many radial copper rods attached in such a manner that owing to a slight elasticity at the junction there is no tendency for them to be sheared off in the starting and stopping of the machine, a defect which showed itself in the machines of this type which were first constructed. Upon the cylindrical surface of this commutator are pressed two sets of metallic brushes or collectors mounted in spring fittings attached to a rocking arm—shown in the extreme right of the illustration—by which the angular position of the points at which the brushes make contact with the commutator can be adjusted with respect to the neutral plane of the magnetic field so as to obtain the maximum efficiency of the machine.

The motive power is a horizontal engine at the Porter type, of 130 horse power nominal, fitted with a Porter governor and expansion gear, and with a steam pressure of 120 lb.; it drives the armature which is mounted on the crankshaft at a velocity of 350 revolutions per minute, the steam being supplied by one of Messrs. Babcock and Wilcox's compound tubular boilers. The weight of the machine with its engine and bedplate, which are fixed together, is over 20 tons.

In order to keep the armature cool, thereby protecting its insulation and keeping down its resistance, there is a small blowing fan driven by the engine, and from this blower three pipes are led which communicate with three air channels cast through the pole-pieces, so as to maintain three jets of air constantly playing on the ends of the exterior armature, which, escaping right and left are, during the working of the machine, continually lashing the induction bars with air. The efficiency of this arrangement is proved by the fact that although a perceptibly warm air are, when the apparatus is in action, continually issuing from the two ends of the hollow cylindrical space within which the armature is rotating.

The Edison incandescence lamps, which will be worked on the Holborn installation, possess the general features common to the incandescence lamps of all the systems at present in use, that is to say, they consist of a fine filament of carbon enclosed in an exhausted glass envelope and rendered incandescent by the passage through it of a current of electricity of sufficient strength. We need not refer to all the distinguishing characteristics of this interesting lamp in the present notice, because we intend on an early occasion to give a detailed description of it as well as the method of its manufacture. It is sufficient for our present purpose to point out that the features which distinguish the Edison lamp from those of Mr. Swan and others in lamps, every branch and which distinguish the the material of which the carbon filament is made, and the arrangements by which it is placed in circuit with the source of electricity or generator. The incandescent filament in Mr. Edison's lamp is made of carbonised bamboo fibre, while that of Mr. Swan is of cotton carbonised by a special process, these differing again from the filaments in the Maxim and Lane Fox lamps, the former of which is prepared from paper coated in a residual vapour of gasoline, while the latter consists of carbonised vegetable fibre prepared in a very similar process. The fitting of the Edison lamp is exceedingly simple and efficient, consisting of a screw and a hole or screw forming the terminals of the carbon filament, but otherwise insulated from one another by platinoid-paris, and this little device, which is attached to the stem of the lamp, screws into a corresponding and similarly put together socket consisting of a hollow brass cone and a hollow screw, which are respectively in electric communication with the conductors leading from the generator. When the fitting of a lamp is screwed into this socket the cone on the lamp is, by the action of the screw, drawn firmly into its conical seat, and thus good metallic contact is insured not only between the two parts of this size between the corresponding threads of the two screws, and thus the resistance of the joint reduced to a minimum, and it becomes almost impossible for any of the current to be lost by faulty connection.

The conductors employed on the Holborn installation are similar in construction to those exhibited in Paris, and consist of a pair of copper rods of segments cross-section enclosed in wood gun tubing, the intervening and surrounding space being filled with a bituminous insulating composition. These double conductors or electrici mains are made in a number of sizes, the cross-section of the copper bars, and therefore the diameter of the covering tubing, being proportioned to the amount of electricity to transmit. They are laid along the subway of the Viaduct, branches—the details of which we shall describe in another notice—being taken off at places along their length corresponding to groups of desired circuits or to the various houses to which the current is supplied, and the branch conductors employed for this purpose being similar to in construction, but smaller in size, than the great supply mains with which they are connected.

In order to reduce to a minimum the occurrences of fire through the under heating, through any cause, of conductors, as well as for the protection of the

derived circuit throughout the whole system is fitted, at the point where it joins its corresponding superior main, with a safety guard or cut-off, consisting of a short length of fuse wire or other easily fusible conductor through which the derived current entering the branch from the main is transmitted, and which as long as the strength of the current is not abnormally great, transmits it, as does any other portion of the branch. The moment, however, that from any cause the current becomes strong enough to do damage, the lead wire is fused by it, and the portion of the branch which would otherwise be liable to injury is cut out of the circuit without in any way interfering with the rest of the main circuits or their branches.

Forming an important part of the Edison system are the arrangements for the regulation of the strength of the current to the work it is required to do at any one moment, and this is performed for a whole district entirely in one room at the central station. We shall describe this very characteristic and well-developed feature of the system later on, but we may briefly say that the current passing out of the central station is controlled by a regulator which by varying the resistance of the circuit of the field magnets of the machine, regulates the intensity of the magnetic field and thus weakens or strengthens the current induced in the armature, with a proportionately decreased or increased expenditure of motive power and therefore of consumption of fuel. In the regulating room is an electro-motive-force-indicator consisting of a balanced reflecting galvanometer making its indications by the movement of a spot of light upon a divided scale and showing instantly to the assistant in charge any variation of strength of current produced throughout the whole system by the turning on or extinguishing of any series of lamps. A supplementary indicator is also given by the behaviour of a small series of "pilot lights" in the regulating room and included in the general circuit.

The electricity supplied to each consumer will be measured by a most ingenious meter (which we shall describe in a future notice), placed on his own premises, and under this system those who make use of the light will be as independent of the presence in charge of the apparatus at the central station as gas consumers are at the present moment of the employés at the gas works. They will have complete control of the lights on their premises, and can turn on or extinguish any or all of their lamps without any communication with head-quarters for the *demand* for electricity, in other words, the number of channels opened to the current at any one time is instantly indicated in the regulating room, and the *supply*, that is to say, the strength of the current, can as instantly be adjusted to it.

The arrangements of this very interesting installation have been carried out under the management of Mr. Edward Hibbert Johnson, who is the representative of Mr. Edison in this country in all matters connected with the electric light, and to whom we are indebted for much information.

Within the limits of a preliminary and introductory article, such as this is intended to be, it is impossible to do more than indicate the general features of a system consisting of so many points of interest, but we have in the present notice gone over sufficient ground to show that if the panic was premature which was produced in the gas-share market some three years ago by the announcement that Mr. Edison had discovered a complete and practical system of electric lighting to compete successfully with gas on all its points, Mr. Edison has since made good his claim to the laurels he was thought to have lost by the natural collapse of an unreasonable scare, for, if the permanent working of the installation on the Holborn Viaduct prove as successful in its results as those of the experimental trials have—and there is no reason to suppose it will not—there can be little doubt that as an investment for electric illumination greater in magnitude and importance than has ever preceded it. And we need hardly say we hope that such may prove to be the case.

THOMAS AVELING.

It is with very great regret that we record the death on Tuesday last, the 7th inst., of Mr. Thomas Aveling, the well-known senior partner of the firm of Messrs. Aveling and Porter, of Rochester. Mr. Aveling's decease took place after a very brief illness, which was not at first deemed to be serious, and the news of his death will cause a shock to a wide circle of friends. Mr. Aveling was born at Rye, in Cambridgeshire, on the 11th of September, 1824, and he was thus but little over 57 years of age at the time of his decease. His family was one of the oldest in Cambridgeshire, in which county it has been settled between four and five centuries. His grandfather was high sheriff for Cambridgeshire and Huntingdonshire in 1801. Mr. Aveling's father died when he was very young and his mother subsequently removed to Rochester, where she was married a second time to the Reverend John D'Urban, who for more than twenty years was in clerical charge of the parish of Hoo-Saint-Werburgh. It was in the Hundred of Hoo, and during the latter part of the above-named period, that Mr. Aveling first gained practical experience in agriculture, while later on he became a farmer at Hackinge, in the Weald of Kent.

Mr. Aveling was, however, in many ways more fitted for being an engineer than a farmer, at all events as far farming was carried on in those days, and he was impressed with the fact that a great deal remained to be done to adapt steam power thoroughly to agricultural requirements. This led him to give up farming and establish small works at Rochester for the manufacture and repair of agricultural implements. One of the points to which Mr. Aveling early devoted his attention was the rendering of agricultural engines self-moving, and in 1859 he took out a patent for an arrangement of pitch chain gearing applicable to such engines. Mr. Aveling did not at first build engines himself, but applied this gear to ordinary portables constructed by Messrs. Clayton and Shuttleworth. Later on, however, he commenced engine building on his own account, and in 1865 he exhibited the first of [illegible] engines at the Royal Agricultural Society's [illegible] at Canterbury, while in 1861 (the having been [illegible] joined by Mr. Porter) his firm, Messrs. Aveling Porter, exhibited an engine at the London national Exhibition. It is to be borne in [illegible] that Mr. Aveling's earlier engines were not [illegible] engines in the ordinary acceptation of the te [illegible] simply self-moving agricultural engines not [illegible] to haul after them a heavier load than a th [illegible] machine. Later on, however, the firm of [illegible] and Porter took up the manufacture of [illegible] engines for hauling purposes as well as [illegible] steam ploughing engines, their works a [illegible] developing in size and productive power, and [illegible] reached their present important position.

Of the numerous improvements in agricultural locomotives and traction engines introduced by Mr. Aveling, we can give but a hasty sketch here. The earlier engines the power was, as we have stated, transmitted from the second motion shaft to the driving axle by a pitch chain, and for many years Mr. Aveling was a strong advocate for this form of gear and did much to perfect its manufacture. Thus by the employment of a duplex drilling machine to insure accuracy in the pitch of the links, the use of case-hardened steel for the pins, and by the choice of good proportions, he secured for this chain gear a durability far beyond that which it possessed before he introduced his improvements. He also devised convenient arrangements for tightening the chain when stretched by moving the bearings of the second motion shaft, at the same time maintaining a constant distance between that shaft and the crankshaft, so as not to interfere with the action of the tumbler-gear. The introduction of steel castings, however, and cast steel spur, may be said to have revolutionised traction engine construction, and it led Mr. Aveling to abandon the chain gear entirely for all ordinary engines.

Mr. Aveling was a thorough believer in the benefits of steam jacketting, and upwards of twenty years ago he patented his well-known arrangement in which the cylinder is surrounded by a capacious jacket forming the steam dome, the steam traversing this jacket on its way to the valve chest, which it encircles on the top. This is an arrangement which has now become almost universally adopted by traction engine builders, and it is undoubtedly an admirable one for its purpose. It is to Mr. Aveling also that is due the general adoption of single cylinders for traction purposes. We believe that we are correct in stating that Mr. Aveling was the first to build a traction engine with a single cylinder, and for many years he had to uphold the advantages of that arrangement against great opposition. The sufficiency of the single cylinder for all ordinary conditions is now, however, generally acknowledged, while its simplicity has led to its extended adoption.

A feature connected with Mr. Aveling's earlier practice which deserves notice here, was the arrangement of steering wheel, which he devised about 1860, and which many of our readers will remember as being fitted to the engine exhibited by Messrs. Aveling and Porter in the International Exhibition of 1862. According to this plan, which was for some years adopted by the firm to the exclusion of other arrangements, the leading axle had attached to it a light frame projecting for[illegible] wards, this frame carrying at its front end the vertical axis of a forked spindle, in the fork of which was mounted a sharp-edged wheel bearing on the road. This wheel could be readily diverted by a tiller to either side, and when thus diverted, it led off to the side towards which it was pointed, taking with it the front end of the light frame and so leading round the leading axle. The engine thus followed the pilot wheel as it might be named.

During later years Mr. Aveling's attention was devoted to improvements in detail rather than to the introduction of any radical changes in traction engine construction. Amongst these improvements may be specially noticed the plan of carrying up the side plates of the firebox casing to form the brackets for the crankshaft and countershaft bearings, and in steam ploughing engines for working on the double engine system, the introduction of right and left-hand engines so as to secure that the rope when hauling should in both engines lead on to the side of the drum next the driving pinion, thus relieving the drum spindle of by far the greater part of the strain.

The combination of a traction engine and crane—an arrangement which has [illegible]

[illegible] machine, as well as to take its place during periods of repairs.

In the street lamps for the whole length Number of

[illegible] on the side of his death it may, we think, be safely said that no man living had an extensive practical knowledge of steam haulage on roads as Mr. Aveling, or as thorough an appreciation of the requirements which traction engines ought to fulfil. A firm believer in the great future of steam traction he combined with exceptional experience, keen powers of observation, and abundant energy and good common sense, which served him in good stead in overcoming failures and opposition under which most men would have given way. Of the success which attended his efforts the enormous number of traction engines now in use in Kent alone forms the best record; amongst those being the numerous military engines (adapted for either rail or road service) which he constructed for the use of the Royal Engineers at Chatham and on the perfection of which he bestowed much attention.

Another matter with which Mr. Aveling was most prominently connected was the introduction of road rolling by steam. The idea of employing steam power for this purpose originated with the late Mr. William Clark, when chief engineer to the municipality of Calcutta, and a steam road roller was designed for Mr. Clark by Mr. Batho, then of Birmingham. It was not, however, until the construction of such rollers was taken up by Messrs. Aveling and Porter, that they came into use in this country. As in the case of traction engines, so is that of steam rollers, Mr. Aveling carefully studied the requirements to be fulfilled in practical working, and he introduced successive improvements from time to time as experience showed the weak points of the earlier designs. Mr. Aveling soon appreciated the serious objections which existed to the employment of the very heavy rollers at first thought to be necessary, and he devoted himself to the perfection of machines of comparatively light weight and capable of being readily handled in any thoroughfare. A great point was that, in his traction engines, Mr. Aveling had obtained a very economical

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ON THE MECHANICAL PRODUCTION OF ELECTRIC CURRENTS.—No. I.

THE object of these articles is to lay down in the simplest and most intelligible way the principles which are concerned in the mechanical production of electric currents. Every one knows now that electric lights are produced from powerful currents of electricity generated in a machine containing magnets and coils of wire, and driven by a steam engine, or gas engine, or water-wheel. But of the thousands who have heard that a steam engine can thus provide us with electric currents, how many are there who comprehend the action of the generator or dynamo-electric machine? How many, of engineers even, can explain where the electricity comes from, or how the mechanical power is converted into electrical energy, or what the magnetism of the iron magnets has to do with it all? Take any one of the dynamo-electric machines of the present date—the Siemens, the Gramme, the Brush, or the Edison machine—of each of these there exist descriptions excellent in their way, and sufficient for men already versed in the technicalities of electric science. But to those who have not served an apprenticeship to the technicalities—to all but professed electricians—the action of these machines is almost an unknown mystery. As, however, an understanding of the how and the why of the dynamo-electric machine or generator is the very A B C of electrical engineering, an exposition of the fundamental principles of the mechanical production of electric currents demands an important place in the current science of the day. It will be our endeavour to expound those principles in the plainest terms, while at the same time sacrificing nothing in point of scientific accuracy or of essential detail.

The modern dynamo-electric machine or generator may be regarded as a combination of iron bars and copper wires, certain parts of the machinery being fixed, whilst other parts are driven round by the application of mechanical force. How the movement of copper wires and iron bars in this peculiar arrangement can generate electric currents is the point which we are proposing to make clear. Friction has nothing to do with the matter. The old-fashioned spark-producing "electrical machine" of our youthful days, in which a glass cylinder or disc was rotated by a handle whilst a rubber of silk pressed against it, has nothing in common with the dynamo-electric generator, except that in both something turns upon an axis as a grindstone or the barrel of a barrel-organ may do. In the modern "dynamo" we cannot help having friction at the bearings and contact pieces, it is true, but there should be no other friction. The moving coils of wire or "armature" should rotate freely without touching the iron pole-pieces of the fixed portion of the machine. In fact friction would be fatal to the action of the "dynamo." How then does it act? We will proceed to explain without further delay. There are, however, three fundamental principles to be borne in mind if we would follow the explanation clearly from step to step, and these three principles must be laid down at the very outset.

1. The first principle is that the existence of the energy of electric currents, and also the energy of magnetic attractions, must be sought for not so much *in the wire* that carries the current, *or in the bar of steel or iron* that we call a magnet, as *in the space that surrounds* the wire or the bar.

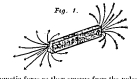
2. The second fundamental principle is that the electric current is, in one sense, quite as much a *magnetic* fact as an electrical fact; and that the wire which carries a current through it has magnetic properties (so long as the current flows) and can attract bits of iron to itself as a steel magnet does.

3. The third principle to be borne in mind is that to do work of any kind, whether mechanical or electrical, requires the expenditure of energy to a certain amount. The steam engine cannot work without its coal, nor the labourer without his food; nor will a flame go on burning without its fuel of some kind or other. Neither can an electric current go on flowing, nor an electric light keep on shedding forth its beams, without a constant supply of energy from some source or other.

The last of these three principles, involving the relation of electric currents to the work they can do and to the energy expended in their production, will be treated of separately and later. Meantime we resume the task of showing how such currents can be produced mechanically, and how magnetism comes in in the process.

Surrounding every magnet there is a "field" or region in which the magnetic forces act. Any small magnet, such for example as a compass needle, when brought into this field of force, exhibits a tendency to set itself in a certain direction. It turns so as to point with its north pole toward the south pole of the magnet, and with its south pole toward the north pole of the magnet; or if it cannot do both these things at once, it takes up an intermediate position under the joint action of the separate forces and sets in along a certain line. Such lines of force run through the magnetic "field" from one pole of the magnet to the other in curves. If we define a line of force as being the line along which a free north-seeking magnetic pole would be urged, then these lines will run from the north pole of the magnet round to the south pole, and pass through the substance of the magnet itself. In Fig. 1 a rough sketch is given of the lines of

Fig. 1.



magnetic force as they emerge from the poles of a bar magnet in iaffis. The arrow heads show the direction in which a free north pole would move. These lines of force are no fiction of the imagination like the lines of latitude and longitude on the globe; they exist and can be rendered visible by the simplest of expedients. When iron filings are sprinkled upon a card or a sheet of glass below which a magnet is placed, the filings set themselves —especially if aided by a gentle tap—along the lines of force. Fig. 2 is a reproduction from nature

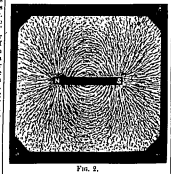


FIG. 2.

of this very experiment, and surpasses any attempt to draw the lines of force artificially. It is impossible to magnetise a magnet without also in this fashion magnetising the space surrounding the magnet; and the space thus filled with the lines of force possesses properties which ordinary unmagnetic space does not possess. These lines give us definite information about the magnetic condition of the space where they are. Their direction shows us the direction of the magnetic forces, and their density shows us the strength of the magnetic forces; for where the force is strongest there we have the lines of force most numerous and most strongly delineated in the scattered filings. To complete this first consideration of the magnetic field surrounding a magnet, we will take a look at Fig. 3, which reproduces the lines of filings as they settle in the field of force opposite the end of a bar magnet. The repulsion of the north pole of the magnet upon the north poles of other magnets would be, of course, in lines diverging radially from the magnet pole.

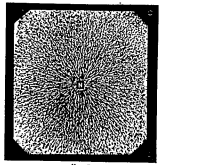


FIG. 3.

We will next consider the space surrounding a wire through which a current of electricity is flowing. This wire has magnetic properties so long as the current continues, and will, like a magnet, act on a compass needle. But the needle never tries to point toward the wire, its tendency is always to set itself broadside to the current and at right angles to it. The "field" of a current flowing up a straight wire is, in fact, not unlike the sketch shown in Fig. 4, where instead of tufted groups we

Fig. 4.

have a sort of magnetic whirl to represent the lines of force. The lines of force of the galvanic field are, indeed, circles or curves which enclose the conducting wire, and their number is proportional to the strength of the current. In the figure, where the current is supposed to be flowing up the wire (shown by the dark arrows), the little arrows show the direction in which a free north pole would be urged round the wire* a south pole would, of course, be urged round the wire in the contrary direction. Now though when we look at the photographs wires, or at any wire carrying a current of electricity, we cannot see these whirls of magnetic force in the surrounding space there is no doubt that they exist there, and that a great part of the energy spent in starting an electric current is spent in producing these magnetic whirls in the surrounding space. There is, however, one way of showing the existence of these lines of force; similar, indeed,

* It will not be out of place here to recall Ampère's ingenious rule for remembering the direction in which a current must flow to make a magnetic needle. "Suppose a man embraces in the wire with the current, and that he turns so as to face the needle, then the north pole of the needle will be deflected towards his left hand."

EXPERIMENTS WITH THE HAND DYNAMO—II.*

By S. H. Borrese.

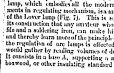
THE "best" light is so called from its form, when produced between two carbon points lying horizontally, being that of a bridge or arch (Ital. *arco*). Fig. 6 represents the "arc" light produced in 1809, by Sir Humphrey Davy, with the battery of the Royal Institution, consisting of 2,000 plates of zinc, each having a surface of 32 square inches. This are exceeded 4in. in length.

The great point to be aimed at, in the production of a good arc light, is the maintenance of a proper distance but when the carbon points when the light becomes unsteady. The voyage of the current (the vibratory motion of the particles) disturbs portions from the positive carbon, and throws them up on the negative carbon; some portion of the carbon is also apparently volatilised, so that the distance between the carbons at last becomes too great for the current to be able to bridge over. To remedy this defect, devices innumerable have been suggested, and patented in the United States.

In the dynamo light at the Exhibition, but will not probably be of any practical use, when an H.P. of about 25 to 40 volts is needed to produce a good steady light.

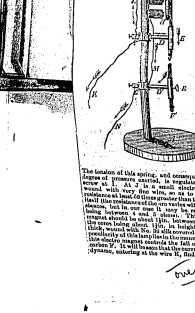
A very simple, and yet effective form of arc lamp, which embodies all the modern improvements in regulating mechanism, is a model of one of the Lever lamp (Fig. 7). This is so simple in its construction that any amateur who can use a file and a soldering iron, can make himself one, and thereby learn more of the principle by which the regulation of arc lamps is effected, than he would gather reading volumes of description. It consists in a base A, supporting a mahogany, basewood, or other insulating standard B, about

Fig. G.



one foot in height, and 3in. in diameter. Two metal stops C and C are fixed 3 inches apart at about 2½in. apart. These carry metal arms D and D to which are attached short pieces of brass tubing F F, through which the carbon rods F and F can just pass freely. The lower carbon can be elevated to any desired height by means of the rack and pinion at F: the fall of the other carbon is prevented by the spring G, which presses a small soft iron armature H against the carbon rod, and thus jams it against the tube.

Fig. 7



The tension of this spring, and consequently the degree of pressure exerted, is regulated by the screw J. At I, a small electro-magnet, wound with fine wire, so as to present a resistance at least 50 times greater than the "arc" resistance, but in our case it may be otherwise, is connected to the rod C above. This electro-magnet should be about 1½in. between the poles, the cross being about 1in. square. The coils, when wound, with No. 36 silk-covered wire, the resistance of this lamp line in the manner in which it is worked, is about that the current from the dynamo, entering at the wire B, finds two paths

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EXPERIMENTS WITH THE HAND DYNAMO—III.*

By S. H. Borrese.

"OUR" dynamo is eminently adapted to our experiments with the induction coil, and will work well and easily (or without fatiguing the operator) any coil capable of giving from 1in. up to 3in. spark. It will be found very easy to use a shunt in working these coils; not only because they present resistance (though that, of course, affects the current), as because the best and most constant arrangement of the induction coil entirely cuts off the current from circulating round the field magnets (except on collision of the sliding stopper, unless a shunt is used; and this interruption of the current is always strongly against the production of the best effects, since the field magnets lose the power to get magnetised in the right direction. About 40 feet of No. 36 iron wire will be found to give the proper resistance for any ordinary-sized coil. In order to get the best results, both in this and in other experiments, it will be best to have at least shunts of stated varying resistances. These are easily made of sufficient accuracy by coiling on a bobbin of wood, or paper, about 1in. in diameter, lengths of No. 36 iron wire, which can then be inclosed in short lengths of glass tubing, the extremities of the wire passing through corks placed at each end of the tube. (Fig. 8 shows the arrangement.)

Since the resistance of No. 36, soft iron wire is not nearly 1 ohm to the foot, it follows that by using five inches of the said soft iron wire, in lengths increasing from 1ft. to 5ft., and inclosing each of these in tube, as above described, we produce a series of rough resistance coils of from 1 ohm to 5 ohms approximate, which may be labelled with their several resistances, and used, as circuit or shunt may require. Whichever shunt be used, it must be found to be so connected to the dynamo as to complete the circuit between the armature and field magnets, when the outer or working circuit (which now becomes a derived circuit) is led from the binding screw A, to start with the armature. As it is of importance that the student should thoroughly understand this point, the proper position for the shunt is shown at Fig. 7, where P and P are the field magnets of the dynamo, S being the armature. The wires from which make connection through the commutator to the binding screws A and A. When we are working our dynamo as a series machine against a small and unvarying resistance, we connect the binding screws A' and B with the outer circuit, in which we need a resistance, or a variable, as does also the binding screw A, which is connected with the field magnet binding screw B by the fixed piece C, and from thence in the direction of the arrows (red) by coupling wire F, into F, round P, to B', which is one of the binding screws and for the outer circuit. From thence the current traverses the outer circuit C, and enters the dynamo by the binding screw A', which is connected with the negative brush of the commutator. But if the outer circuit presents too small a resistance, or is variable, so that the quantity of electricity it allows to circulate round the field magnets is insufficient or unequal, then a shunt is introduced at C, and the outer circuit is completed by coupling wire F, binding screw A and A, to whatever work it is

Fig 8

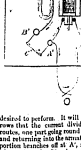
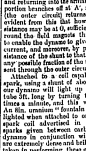


Fig 9



desired to perform. It will be seen by the arrows that the current divides itself along two routes, one part going round A B C F F' C A', the other round the galvanometer, while the other portion traverses C A' A, and passes into the positive terminal of A', and passing into the outer circuit returns at X. It will be evident from this that however great the resistance may be at O, sufficient current will flow round the field magnets through the shunt C, to enable the dynamo to give the due amount of current, and moreover, by increasing the resistance of the shunt to that of the outer circuit, any possible fraction of the current may be sent through the outer circuit.

Attached to a coil capable of giving a 1in. spark, using a shunt of about 1 ohm resistance, our dynamo will light up a Gassiot's vacuum tube 5ft. long by turning the handle about 80 times a minute, and this without any fatigue. An 8in. uranium "fountain" tube is brilliantly lighted when attached to one of the little coils, spark coil advertised in our columns.

The beautiful sparks between carbon points in the dynamo in conjunction with [illegible] are extremely dense and brilliant—more than token in performing these experiments with the coil and dynamo that also be used in heating the given to those who may [illegible] be nearly sure tubes, carbons, &c., as, for [illegible] to break the apparatus [illegible] the shocks inflicted by the coil are extremely severe. A very pretty experiment, illustrative of the power possessed by the rays of high refrangibility, which showed in the electric light, of evoking the phenomenon of phosphorescence, is to arrange the dynamo in connection with the

[illegible] Science Talkers.
[illegible] Scientific Gossip.

Scale 120 mm.

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solution and the regulator resumes its action, but if the [illegible] be turned through the same movement [illegible] it will be found that when the [illegible] the main circuit is re-established, the [illegible] become active and [illegible] the armature [illegible] which causes the lower carbon to ascend also, the shorter [illegible] of course inactive [illegible] the stopping of the positive and bearing of the negative carbon establishes the distance necessary for [illegible] to be interposed, by placing a small phosphorescent tablet (one of any [illegible] sold along with [illegible] between the carbons, and as resistance increases by the lengthening of the arc, but the derived current is interrupted as soon as the [illegible] and opens the circuit; by this arrangement [illegible] the lamp is very prompt in operating the [illegible] Q to its position for locking the upper carbon-holder. Five of these regulators, fed with the best [illegible] Gramme generator for five lights, which we published on page 549 ante, and yielding nearly 1,000 candles, were maintained with air burns power. The [illegible] accompanying this notice have been taken from the *Scientific American*.

AIR-REFRIGERATING MACHINERY.

At the ordinary meeting on Tuesday, the 11th of February, Sir Frederick Bramwell, F.R.S., Vice-President, in the chair, a paper was read "On Air-Refrigerating Machinery and its Applications," by Mr. J. J. Coleman.

The author said that the first practical machine for regulating artificial refrigeration on compressed air was stated by Jonle, Sir William Thomson, Rankine, Clerk Maxwell, and others, and consisted essentially of the fact that atmospheric air having lately been caused to be the vapour of a liquid there was no essential difference in the matter of machines for producing cold, whether air or the vapours of volatile liquids were the agents commonly were employed. Air machines which were in use on board ships afforded a really considerable saving but the [illegible] of the [illegible] point of the liquid, and therefore it was impossible with such machines in get as large a range of cooling as in machines which could be accomplished by air. The machines which Patent required for the liquefaction of oxygen and hydrogen were obtained in sharply defined crystals of crystals of the substances subjected to excess, producing sufficient cold to liquefy air, and by the gradual removal of

In the section of the Association devoted to economic science and statistics (Section F), a highly valuable and interesting paper was read by Professor Silvanus Thompson, D.Sc., "On the Apprenticeship Schools in France," in which the author described in detail the systems adopted in that country of technical education, and the methods in use for the intelligent and intellectual training of artisan apprentices. The paper, which although a lengthy one, we intend, on account of its importance, and the valuable information which it contains, to publish in these columns, was illustrated by a large collection of objects in various branches of industry made by the pupils, as well as by diagrams and results; and to add still more to the practical value, the paper concluded with a number of suggestions for the formation of a sound system of technical education for this country, which would give to the apprentices and artisans of Great Britain the advantages possessed by their Continental brethren with respect to this all-important question. The author laid especial emphasis on the importance of the adoption of a system of instruction based upon drawing, which was, as he expressed it, "the language of the manufacturer, of the handicrafts, and of the constructive industries of all kinds."

The reading of this paper was followed by an interesting and animated discussion, in which Dr. Gladstone, F.R.S., Sir Antonio Brady, Professor Leone Levi, Mr. Britain, and Mrs. Lewis took part, and it was brought to a close by Mr. Mundella, M.P., for Sheffield, who, in an interesting speech, deplored the ignorance which existed in many industries, not only in the minds of the workmen, but in those of the masters and employers of labour; he would, however, express his opinion that the systems of technical training adopted in Germany possessed greater advantages for the English student than those in operation in France.

In the same section Professor Leone Levi read a "Communication upon the Scientific Societies in England to the Advancement of Science in the United Kingdom." Professor Levi commenced his paper by stating that he had been induced to write it in consequence of the renewed attempt to establish in London a building in the metropolis to accommodate the various societies having for their object the advancement of the applied and technical sciences. In it he stated that although in the seventeenth century there were only two scientific societies in this country, there are, at the present time, scientific societies which can claim no less than 60,000 members, or deducting 10 per cent. as representing the proportion of that number who belong to several societies, there are no less than 54,000 individual members. In the discussion which followed, Sir Rawson Rawson, Mr. Hurst, Mr. Britain, and Mr. Mundella, M.P., took part. The last-named gentleman in the course of his remarks said that he considered the letters "F.R.S." a much greater distinction than "M.P." for it could only be the acquisition of great and solid intellectual attainments that could entitle a man to that honour, and he was afraid he would hardly be justified in claiming the same qualification for all the members of the distinguished assembly of which he had the honour of being a member.

In Section G the business commenced on Thursday last by the delivery of the presidential address by Mr. J. Robinson, President of the Institution of Mechanical Engineers. As, however, we publish on another page this interesting address, which was a review of the applications of steel, we need only refer to it in this place. At its conclusion a vote of thanks, proposed by Sir Joseph Whitworth, Bart., F.R.S., and seconded by Mr. W. H. Barlow, C.E., F.R.S., was passed by acclamation.

The first paper read in Section G was one by Mr. Baldwin Latham, C.E., "On the Temperature of Town Water Supplies." In this paper, which we publish on page 168, the author pointed out that the increase of temperature in the supply beyond 53 deg. Fahr. caused the water to have unwholesome properties, and that the temperature of water in a town supply is wholly independent of the temperature of the water at its source of supply, and that without exception, the temperature of the water is the same as that of the ground at the spot and at the depth where the pipes are laid. He called attention to the fact that the temperature of the water supply of a town was of the highest importance from a sanitary point of view, and one which he would be well to investigate very thoroughly in regard to its influence upon certain classes of disease.

Mr. James Glaisher, F.R.S., stated that having been long connected with the office of the Registrar-General, he had often been part of his duty to take the temperature of the Thames water, and he corroborated the remarks of Mr. Latham with regard to the country aspect of the question. It had, he said, long been a recognised fact that cholera and like allied diseases never showed themselves to any great extent until the temperature of the Thames water reached 62 deg. Fahr. He was greatly in favour of the employment of larger water mains than were generally employed, as being much slower in acquiring the temperature of their surroundings than pipes of smaller sectional area.

Captain Douglas Galton, C.B., F.R.S., remarked that water supply pipes should be kept as much as possible below the ground, and he thought that the facts recorded in the paper as well as in the remarks of the speakers who had joined in the discussion constituted a strong argument for the substitution of cisterns by a constant service system.

The President, having thanked Mr. Latham on behalf of the section, called on Mr. Joseph Lucas to read his paper "On the Quantitative Elements in Hydrography." The reading of this paper, which we intend to print *in extenso* on an early occasion, gave rise to a discussion, in which Mr. Baldwin Latham, Mr. C. W. Merrifield, Captain Douglas Galton, and Mr. Grantham took part, and a vote of thanks having been accorded to the author, the President called upon M. Bergeron to read his paper "On Leon Francq's Friction Locomotive," in which the motive power is obtained from a reservoir containing about 700 gallons of water heated by a temperature corresponding to a pressure of 224 lb. to the square inch.

In the discussion which followed, Mr. W. H. Barlow said he considered the system worthy of the most careful consideration, for engines of this class, without fire and without smoke, would be of great value on lines on which there were a number of tunnels.

Captain Galton said he had seen the engine at work in Paris, and he had been most favourably impressed with its working, and he believed that when the use of steam on street tramways is sanctioned by Parliament, engines, such as that described in the paper, would come into general use. After a few remarks from other members of the section the Thursday's business of Section G was brought to a close by a cordial vote of thanks to the author of the paper.

In the evening a soiree was given to the members and associates by the Master Cutler of Sheffield and the Cutlers' Company in the Cutlers' Hall. The gathering was purely a social one, commencing with a promenade and ending with a ball, and as there were no objects of a scientific character exhibited we need only refer to it as having taken place.

Leaving until next week an account of the proceedings of sections on Friday the 22nd of August and following days, we must call the attention of our readers to the deeply interesting discourse of Mr. William Crookes, F.R.S., upon radiant matter, which was delivered to a large audience in the Albert Hall on the evening of that day, and a part of which we publish in our present issue on page 162. It must, we think, be admitted on all sides that Mr. Crookes's lecture, illustrated as it was by a series of the most beautiful experimental illustrations that have ever been brought before an audience, will hereafter be looked upon as the characteristic feature of the Sheffield meeting of the British Association.

To the readers of this journal there was not anything absolutely novel in the facts recorded in this lecture, for the reason that the splendid researches of Mr. Crookes which he brought forward the other evening have already been described and illustrated by us in our articles on "The Trajectory of Molecules,"* and on the last convocazione of the Royal Society,† but such researches can never lose their freshness, and such experiments provide intellectual enjoyment the more often they are seen, and although many of the illustrations had been demonstrated before the Royal Society and elsewhere, they were shown on such a grander scale at Sheffield that they were all, in a very important sense, new experiments. Nothing could have been more successful than this lecture; not one illustration failed, and we venture to say that seldom has it fallen to the lot of a scientific demonstrator or his assistant—and it would be impossible to overpraise the merits of Mr. Crooke's lecture in the case of Mr. Charles H. Gimingham, who not only has manipulated most of the apparatus employed, but has himself constructed with a skill which belongs to him alone the most important and delicate part of it,—seldom we would repeat has it fallen to the lot of a scientific lecturer or his assistant to perform before a large audience such delicate and different demonstrations, and Mr. Crookes must be heartily congratulated not only for the success that he achieved but for the enthusiastic appreciation with which his lecture and illustrations were received by a large and distinguished audience.

At its conclusion a very hearty vote of thanks was proposed by Mr. Spottiswoode, President of the Royal Society, and seconded by Mr. Johnstone Stoney, who was received with loud applause, as it was he who first pronounced the now universally accepted theory of the physical action of the radiometer, out of which the many recent researches of Mr. Crookes have been extended, and to which they bear so intimate a relationship. The vote of thanks having been carried by acclamation, Mr. Crookes, in a brief acknowledgment, said that it was difficult to say which afforded to the scientific investigator the greatest pleasure, the discovery of some philosophical truths or the bringing them before such an audience as the one he now addressed.

LIGHTING BY ELECTRICITY.—NO. IV.

(Lighting Machines Continued.)

We have in former articles described the early magneto-electric machines of Holmes and of the Société d'Alliance* and the single current machines of Gramme† and Siemens.‡ Each of these machines is typical of a class, the last named forming a class by itself. We now come to speak of an order of machines to which the name multiple circuit has been applied, and to which order belong the machines of Lontin, Wallace-Farmer, and Wilde, as well as the multiple circuit machines of Gramme and Siemens.

In the Lontin machine, which we illustrate on the next page, the revolving armature is in the form of a stalagmoid wheel consisting of a central bore C, Fig. 1, into which are fixed ten or more radial bars of soft iron, circular in section and slightly conical in form, marked in the drawing D D D. Each of these radial spokes is wound with a coil of insulated copper wire, the ends of which are connected together in series, and to a central commutator. The armature wheel is fixed on a shaft and revolves in the magnetic field of two powerful electro-magnets A A first virtually into a knee-plate of iron by which they become the two limbs of a "horseshoe" electro-magnet. The ends of the radial magnetic cylinders or fixed valve segments very close to and accrete from the poles of the inducing magnets A A, being of their point of closest proximity with the ends of the line N.N, Fig. 1, by Lenz's law, a coil approaching a north pole of a magnet induces a current of electricity induced in it in one direction, and when receding from the same pole the induced current in the opposite direction, and a coil receding from a north pole has a current induced in it in the same direction as a similar coil approaching a south pole, and *vice versâ*. Bearing these laws in mind, and referring to Fig. 1, it will be seen that when the insulated and revolving in the direction of the arrows, S S, the radial bobbins above the horizontal line N N are receding from the north pole and approaching the south pole, while those below the line N.N. are receding from the south pole; the north pole and approaching the south pole; the currents induced, therefore, in all the bobbins above the line N.N. are similar in direction to one another, but inverse to those below the line N.N. The coils in the arrangement shown in the Gramme machine, coupled together in series as in the Siemens machine, and each pair of contiguous coils in series, therefore in each sector I of the cylindrical commutator, there being as many sectors as there are coils, and insulated from one another by thin strips of ebonite N N. Against the surface of this commutator collectors are pressed by means of springs, the one taking

* See Engineering, vol. xxvii., page 483.
† See Engineering, vol. xxviii., page 398.

* See Engineering, vol. xxvii., page 515.
† See Engineering, page 161 ante.
‡ See Engineering, page 161 ante.

THE "BRUSH" SYSTEM OF ELECTRIC LIGHTING.—No. I.

THE Brush system of electric lighting which during the last two years has in the United States of America been developed into a very important commercial industry, is one of the most interesting systems of illuminating by electricity that has yet been before the public, and we are glad to see that it is at last becoming more and more appreciated in this country, and promises under very able and influential management to take a leading position among the lighting systems of Europe. It has for upwards of twelve months been employed for illuminating the terminus of the Great Eastern Railway at Liverpool-street, and it has within a few weeks been adopted by the Great Western Railway Company for their Paddington Station, and the Charing Cross terminus of the South Eastern Company is now illuminated by the same system. It is about to be applied to light a large area of the City of London, where it will be in competition with both the Siemens and Jablochkoff systems, each of which will have a district of similar area of the City to illuminate, so that the public will soon have an excellent opportunity of comparing it with all the important systems that have been introduced, for the Gramme system is at the same time to be employed at the Cannon-street Station, where the electric currents will be utilised in another distinctive form of lamp.

The Brush, like the Siemens system, includes both generator and regulator peculiar to itself, and may therefore be looked upon as complete in itself, differing in that respect from all those so-called systems which are represented by either a particular form of machine or a special arrangement of lamp, and like the proprietors of the Siemens system, the Brush Company manufacture their own carbons, making the whole installation still more peculiar to themselves.

The Brush machine, a general view of which is given in Fig. 1 (see next page), possesses some points of resemblance to the dynamo-electric machines of Gramme and of Wallace-Farmer, as well as to the magneto-electric machines of M. de Meritens, while at the same time its principle of construction differs from that of all others, and confers upon it at once a special excellence and its originality.

Its point of resemblance to M. Gramme's machine* consists in the fact that its armature is of annular shape, a form of construction first adopted to the purpose by M. Gramme some thirteen years ago. The Brush armature differs, however, from the Gramme ring in the arrangement and disposition of the bobbins of wire with which it is wound, as well as in the way in which the several coils are connected with one another. In the Gramme armature the coils are wound contiguously to one another, so as entirely to envelop the iron core, hiding it completely from view, and they are permanently connected to one another in consecutive series. In the Brush armature the dimetrically opposite bobbins are alone permanently connected together, and a current generated in one pair of bobbins does not necessarily traverse all the others, and in fact never does, as will be pointed out in the course of this notice. Again, the individual coils are separated from one another by a considerable sector of the iron ring, which is of larger sectional area between the coils (see Fig. 2), so that in the revolution of the armature within the magnetic field the coils alter, inasmuch as masses of iron which from their enlarged section are brought into so close proximity to the poles of the field magnets as are the armature of the coils themselves. It is this difference from the Gramme ring which constitutes the similarity between the Brush armature and that of M. de Meritens,† but the Brush machine differs in all other essential respects from the latter machine in the disposition of its coils, in its method of connection, in the method and arrangement of the magnetic field, and in the continuous nature of its current.

The Brush machine however differs altogether from the Gramme generator in the disposition of its field magnets and the relative positions of the revolving bobbins and the magnetic field. In the disposition of its magnets the Brush machine more nearly resembles the Wallace-Farmer apparatus, but their form is entirely different, and the armature of the Wallace-Farmer bears no sort of resemblance to the Brush ring, its coils being more allied to those of M. Lontin's‡ machine than to any other of the characteristic generators. Having thus pointed out the positions occupied by the Brush machine with respect to other typical generators, showing wherein it approaches and wherein it departs from the machines of other systems, we will proceed to describe its construction.

The most characteristic feature of the Brush machine lies in the form and construction of its armature, which consists of a cast-iron ring, the cross section of which is generally rectangular, but in the direction of its circumference it is alternately wide and narrow, as shown in the sketch, Fig. 2, which represents a portion of the iron armature ring and explains its construction better than can be given by description. On reference to this figure it will be seen that the ring is divided up into as many sectors as there are bobbins to be wound, by a number of rectangular depressions or *grooves*; in these the coils of insulated copper wire are wound until the groove is filled up and the flat converging recesses become flush with the face of the intermediate thicker portions or pole-pieces by which they are separated from one another. Fig. 2 is a cross section of one side of the ring taken

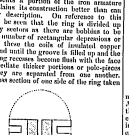

FIG. 3.

through one of these portions, and it will be observed on reference to both figures that the intermediate thicker portions of the ring are grooved out by a series of deep concentric grooves, the object of which is partly to reduce the mass and lessen the weight of the revolving armature, partly for the purpose of ventilating the ring and thus carrying away a portion of the heat generated by the working of the machine, but chiefly for the localisation and isolation of local currents generated by induction in the iron and which would tend not only to reduce the efficiency of the machine by diminishing the magnetic capacity of the armature, but also to produce a heating of the ring, and therefore of the coils, whereby a portion of the current would be lost through their resistance being increased. For a similar reason the periphery of the ring is grooved out deeply so as almost to sever the ring; by this means all cross currents are effectually cut off and induction currents are compelled to flow in directions which are not detrimental to the efficiency of the machine. This again increases the area of radiating or cooling surface, and consequently helps to prevent the armature becoming overheated.

In what is called the sixteen-light machine, which may be regarded as the normal size of the Brush generator, the armature ring is 20 in. in diameter, and it is wound with eight radial coils of cotton-covered copper wire of No. 14 B.W.G., whose visible planes radiate from the axis of rotation, being distributed round the ring at equal angular distances apart of 45 deg. Each coil contains about 900 ft. of wire weighing about twenty pounds, and is wound in the rectangular grooves or spaces shown in Fig. 2, filling up the spaces completely so that the vertical faces of all the coils are flush with the vertical faces of the thicker portions of the iron ring. Fig. 3 is a sketch of the armature ring with all its coils wound, which must be looked upon rather as an explanatory diagram than as an illustration of the proportions of this part of the apparatus. The two sides of each groove, and therefore of each coil of wire, are parallel to the centre line or radial plane of the coil, and by the adoption of that form of bobbin one of the practical difficulties in the winding of annular armatures of the ordinary form is avoided. All the coils are, like those in the Gramme machine, wound in the same direction.

Fig. 4 is a diagram illustrative, not only of the distribution of the coils around the ring, but of the method by which the connections are made; the inner end of each of the coils is connected by a wire to the inner end of the corresponding coil, at the opposite end of the same diameter of the ring, and the outer ends of all the coils are brought through the shaft of the machine, and are connected to corresponding portions of the commutator, where the currents are collected by suitably placed copper plates or brushes. Referring to the diagram, it will be seen that the inner end A^1 of the coil 1 is connected to A^5, which is the inner coil of the coil 5; A^5 is connected to A^9, A^9 to A^1, and so on round the ring, and the outer ends B^1, B^5, B^9, &c., are connected to the commutator by conducting wire insulated from one another. The two free ends of each pair of diametrically opposed coils are, after passing through the shaft of the machine, attached respectively to two diametrically opposite segments of the same commutator, which segments are insulated from one another and from any other pair of coils. The commutator, which is attached to and rotates with the driving shaft of the machine, consists of a set of separate copper rings or flat cylinders, of which there are as many on the shaft as there are pairs of coils on the armature, and each of these cylinders consists of two segments insulated from one another on one side of the shaft by a small air space about one-eighth of an inch wide, and on the other by a piece of copper separated from the segments by two smaller air spaces. The arrangement is shown in Fig. 6, in which A and B are the two segments connected respectively to corresponding coils on opposite sides of the armature, and

FIG. 5

FIG. 6.

attached by an insulating material to the shaft S: C is the copper insulating piece, the object of which is to separate either of the segments, or commutators, which press upon the periphery of the commutator, from either of the segments during the interval occupied by one pair of coils passing the vertical, or in other words through the neutral portion of the magnetic field; this occurs twice in each revolution of the armature, and therefore of the commutator. At the time when any pair of bobbins is in this way cut out of the general circuit, their own circuit is open, so that no current can flow through or be induced in them. By this most ingenious arrangement each pair of coils has in succession in each revolution a period of rest equal to one-quarter of a revolution, and has a current passing through it only for 75 per cent. of the time the machine is running; to it is, in a great measure, due the very small development of heat in the working of the Brush machine, and it presents also another important element of efficiency to the machine, namely, that each pair of bobbins as it passes the neutral portion of the magnetic field, and is therefore incapable of doing work and contributing electromotive force to the general current, is itself cut out of the circuit, and thus two causes operating against the efficiency of the machine are eliminated; the first is one common to most generators which have, like that in the Gramme machine, a permanently closed circuit, namely, that the currents generated in the bobbins have two routes open to them, the one through the conductors and commutator to the brushes, and the other through the idle bobbins, and thus by a species of short

* See ENGINEERING, vol. xxxiii., page 62.
† *Ibid.*, vol. xxxii., page 372.
‡ *Ibid.*, vol. xxxii., page 171.

ON THE MECHANICAL PRODUCTION OF ELECTRIC CURRENTS.—No. II.

In the first article on this subject, published last week (see ENGINEERING, page 77), we described how the electric current, or rather the wire through which it flows, possesses for the time magnetic properties, and is surrounded by lines of force. It was further shown how magnetism can be produced from electric currents, a spiral coil of wire through which a current is sent acting like a magnet.

The next point to be studied is the magnetic property of a single loop of the wire through which an electric current flows. Fig. 9 represents

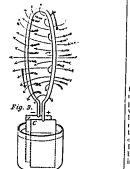

Fig. 9.

single voltaic cell containing the usual plates of zinc and copper dipping into acid to generate a current in the old-fashioned way. The current flows from the zinc plate through the liquid to the copper plate, and from thence it flows round the wire ring or circuit back to the zinc plate. Here the lines of magnetic force in the surrounding space are no longer only whirls like those drawn in Figs. 4 and 6, for they react on one another and become nearly parallel where they pass through the middle of the ring. The thick arrows show the direction of the electric current, the fine arrows are the lines of magnetic force, and show the paths along which a free north pole would be urged. All the front face, where the arrow-heads are, will be like the south pole of a magnet. All the other face of the ring will be like the south pole of a magnet. Our ring resembles a flat magnet, one face all north pole the other face all south pole. Such a magnet is sometimes called a "magnetic shell."*

Since the circuit through which the current is flowing has these magnetic properties, it can attract other magnets or repel them according to circumstances.

If a magnet be placed near the circuit, so that its north pole N is opposite that side of the circuit which acts as a south pole, the magnet and the circuit will attract one another. The lines of force that radiate from the end of the magnet, curve round and coalesce with some of those of the circuit. It was shown by the late Professor Clerk Maxwell that every portion of a circuit is acted upon by a force urging it in such a direction as to make it enclose within its embrace the greatest possible number of lines of force. This proposition, which has been termed "Maxwell's Rule," is very important, because it can be so readily applied in many cases, and will enable one so easily to think out the actual reaction in any particular case. The rule is illustrated by the sketch shown in Fig. 10, where a bar magnet has been placed with its north pole opposite the south face of the circuit of the coil. The lines of force of the magnet are drawn into the ring and coalesce with those due to the current. According to Faraday's mode of regarding the actions in the magnetic field there is a tendency for the lines of force to shorten themselves. This would occur if either the magnet were pulled into the circuit, or the circuit were moved up towards the magnet. Each attracts the other, and whichever of them is free to move will move in obedience to the attraction. And the motion will in either case be such as to increase the total number of lines of force that pass through of the circuit. Lest it should be thought that Fig. 10 is

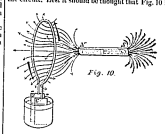
Fig. 10.

inverted or overdrawn, we reproduce as actual magnetic "field" made in the manner described in the preceding article. Fig. 11 is a kind of sectional view of Fig. 10, the circuit being represented merely by two circular spots or holes above and below the middle line, the current flowing towards the spectator through the lower spot, and passing in front of the figure to the upper hole where it flows down. Into this circuit the pole N is attracted, the tendency being to draw as many lines of force as possible into the embrace of the circuit.

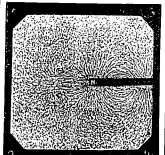

Fig. 11.

So far as the reasoning about these mutual actions of magnets and currents is concerned, it would therefore appear that the lines of force are the really important feature to be understood and studied. All our reasons about the attractions of magnets would be equally well thought out if there were no corporeal magnets there at all, only collections of lines of force. Bars of iron and steel may be regarded as convenient conductors of the lines of force; and the poles of magnets are simply the places where the lines of force run out of the metal into the air or *vice versâ*. Electric currents also may be reasoned about, and their magnetic actions foretold quite irrespective of the copper wire that acts as a conductor: for here there are not even any poles; the lines of force or magnetic whirls are wholly outside the metal. There is an important difference, however, to be observed between the case of the lines of force of the current, and that of the lines of force of the magnet. The lines of force of the magnet *are* the magnet so far as magnetic forces are concerned; for a piece of soft iron laid along the lines of force thereby becomes a magnet and remains a magnet as long as the lines of force pass through it. But the lines of force crossing through a circuit are not the same thing as the current of electricity that flows round the circuit. You may take a loop of wire and put the poles of magnets on each side of it so that the lines of force pass through in great numbers from one face to the other, but if you have them there even for months and years the mere presence of these lines of force will not create an electric current even of the feeblest kind. There must be motion to induce a current of electricity to flow in a wire circuit.

Faraday's great discovery was, in fact, that when the pole of a magnet is moved into, or moved out of, a coil of wire, the motion produces, while it lasts, currents of electricity in the coil. Such currents are known as "induced currents"; and the action is called magneto-electric "induction." The momentary current produced by plunging the magnet pole into the wire coil or circuit is found to be in the opposite direction to that in which a current must be sent if it were desired to attract the magnet pole into the coil. If the reader will look back to Fig. 10 he will see that a north magnet pole is being attracted in from behind into a circuit round which, as he views it, the current flows in an opposite sense to that in which the hands of a clock move round. Now, compare this figure with Fig. 12,

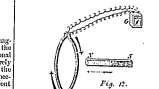

Fig. 12.

which represents the generation of a momentary induced current by the act of moving the north pole N towards a wire ring, which is in this case connected with a little detector galvanometer G. The momentary current flows round the circuit (as seen by the spectator from the front) in the *same sense* as the movement of the hands of a clock. The induced current which results from the motion is found, then, for he is in a direction exactly opposed to that of the current that would itself produce the same movement of the magnet pole. If the north pole instead of being moved towards or into the circuit were moved away from the circuit, this motion will also induce a transient current to flow round the wire, but this time the current will be in the same sense as that in Fig. 10, in the opposite sense to that in Fig. 12. Pulling the magnet pole away sets up a current in the reverse direction to that set up by pushing the pole nearer. In both cases the currents only last while the motion lasts.

Note in the first article it was pointed out that the lines of force of the magnet indicate not only the direction, but the strength of the magnetic forces. The stronger the pole of the magnet is, the greater will be the *number of lines of force* that radiate from its poles. The strength of the current that flows round a circuit is also proportional to the number of lines of force which are thereby caused to pass (as in Fig. 9) through the circuit. The stronger the current, the more numerous the lines of force that thread themselves through the circuit. When a magnet is moved near a circuit near it, it is found that any alteration in the number of lines of force that cross the circuit is accompanied by the production of a current. Referring once more to Fig. 10, we will call the direction of the current round the circuit as that figure the *positive* direction; and to define this direction we may remark that if we were to view the circuit from such a point as to look along the lines of force in their own direction, the direction of the current round the circuit will appear to be the same as that of the hands of a clock moving round a dial. If the magnet N S be now drawn away from the circuit so that fewer lines of force pass through the circuit, experiment shows the result that a current flowing in a contrary sense will be for the moment increased in strength, the former in strength being proportional to the rate of *decrease* in the number of lines of force. Fig. 10, on the other hand, if the magnet were pushed up toward the circuit, the current in the circuit would be momentarily reduced in strength, the reduction in strength being proportional to the rate of increase in the number of lines of force.

Similar considerations apply in the case of the simple circuit and the magnet shown in Fig. 12. In this circuit there is no current flowing so long as the magnet is at rest; but if the magnet be

* The rule for telling which face of the magnetic shell (or of the loop circuit) is north and which south in its magnetic properties is the following. If as you look at the circuit the current is flowing in the same apparent direction as the hands of a clock move, then the face you are looking at is a south face. If the current flow the opposite way round to the hands of a clock then it is the north pole face that you are looking at.

ON THE MECHANICAL PRODUCTION OF ELECTRIC CURRENTS.—No. III.*

We have in two preceding articles (see pages 37 and 101 *ante*) explained how by expending mechanical power in moving a coil of wire past the pole of a magnet, or by moving the pole of a magnet past a coil of wire, we can produce momentary currents of electricity in the coil. We have insisted upon explaining this action by observing the lines of force in the surrounding space, and laid down the rule that the strength of the current so induced in the circuit was proportional to the rate of decrease in the number of lines of force that cross through the circuit.

It will have been observed that in all these actions it is the *relative motion* of magnet and coil that is concerned. It matters not whether the magnet moves towards the coil or the coil towards the magnet, the result is the same, an increase in the lines of force threading through the coils, a decrease in the potential energy of the system, and the production of a momentary inverse current. In the actual construction, however, of almost every kind of dynamo-electric machine, the magnets are fixed while the coils move. This is merely for the sufficient reason that the coils are usually lighter than the magnets, and therefore it would be absurd from an engineering point of view to make the moving parts heavier than the fixed parts. In the generators of Pacinotti, Gramme, Wilde, Siemens, Brush, and Edison, the magnets are fixed while the coils rotate. In Lontin's dividing machine and in a few other generators, however, there is an exception. The magnets attached to a central axis revolve, while the numerous coils in which it is desired to generate currents are fixed upon an external frame.

The next step in explaining how the production of continuous currents in one direction is accomplished in a typical generator will be a consideration of the effect of moving a ring of wire up to a magnet and passing it over its pole.

In Fig. 13 is shown a single ring or coil of wire to serve as a circuit, and beyond it a magnet is shown with its north pole facing the ring. From what has been already laid down it is easy to see what will be the result of moving the ring along towards the magnet. While the ring approaches the north pole, as in the first case of the figure, the lines of force that thread through the ring will be increasing in number, and there will be an *inverse* current (*r*—one which is in a direction inverse to that which would cause the pole N to be attracted; compare the figure of case I with Fig. 10, and note the direction of the arrows). Moreover, even after the ring has been moved as far as the pole N there will still be an inverse current so long as the ring by moving forward is increasing the number of lines of force that it embraces. Comparison with Fig. 2 and Fig. 11 will show that there will be an increase in the number of lines of force until the ring has got as far as the centre or neutral line of the magnet. The second figure of Fig. 13 represents matters up to

Fig. 13.

that point. But now if the forward motion of the ring be continued towards the pole S and beyond it, the number of lines of force that thread themselves through the ring will diminish, and therefore from the moment that it passes the middle point of the magnet a direct current will be induced in it, as shown by the arrows in cases 3 and 4, and there will continue so long as the ring recedes from S.

Again, suppose we have our ring or coil between the two powerful magnetic poles, as indicated in Fig. 14. We will suppose that our coil is moving in a circular path between the poles S and N, which are respectively a south and a north pole. The lines of force will run across in almost straight lines from N to S. We will consider what occurs in the coil as it moves round the upper half of the circular path, its first position being on the left, its last horizontal with its plane very nearly along the lines of force, so that almost none of them pass through it. As it rises and turns round the number of lines of force that thread through the coil increases until it arrives at c^1, where the number

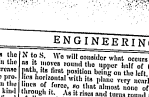

Fig. 14.

that pass through is a maximum. All this time an inverse current will, therefore, be generated in it. After passing c^1, and although it is getting nearer N, the number of lines of force that cross through the coil are decreasing, because it is gradually turning round flat-ways again. From c^1 onwards there will, therefore, be a direct current induced in the coil. Nor does the direct current cease when the coil arrives at the point nearest N, for now, though not shown in Fig. 14, as the coil goes along the lower semicircle the lines of force will begin again to thread through it, but this time they enter the other side of the coil to that which they entered before. There will, therefore, be an increase in the number of lines of force applied negatively, which is, of course, equivalent to a still further decrease. This will go on until the coil arrives at c^2, where the negative increase is a maximum. All the way round the right-hand half of the figure, from c^1 to c^2, there will be a direct current induced in the coil. From c^2 onward and round the left-hand half of the figure up to c^1 there will be an inverse current generated. To render such a some device is needed to turn the inverse currents on the left-hand half so that they shall flow into the wires—that go, say, to feed an electric light—in the reverse way to that in which the direct currents flow into them. For if we never find which is already flowing we thereby bring it into the *direct* relation. The device for accomplishing this end is called a *commutator*, and the line $c^1 c^2$, which marks out the boundary between the currents that are direct and those that are inverse, is known as the "line of commutation."

Fig. 15 is a skeleton diagram of the working parts of a Gramme dynamo-electric generator; it is drawn from a model devised by Professor Silvanus Thompson, of Bristol. The well-known ring armature employed in all the machines of Gramme, as well as in the earlier generator of

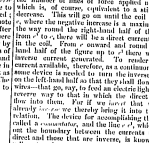

Fig. 15.

Pacinotti, and the later machines of Schuckert, Brush, and Burgin, is the principal feature. It rotates between the poles S N of an electro-magnet of a U form with vertical limbs. The commutator consists of a number of separate bars or strips of copper fixed round the periphery of the axle, while above and below are the contact-brushes which touch the uppermost and lowermost pieces of the commutator respectively. In the model the ring is encrypped by a continuous helix of twelve turns; each one of these twelve turns being connected with one of the twelve copper strips of the commutator. In the drawing the armature is supposed to rotate in the same direction as the hands of a clock. The separate turns or coils in the upper half of the ring armature are therefore moving from S towards N, while those of the lower half are moving from N towards S. As in Fig. 14, so here, there will be direct currents generated in all the coils that are on the right-hand side of the diameter of commutation $c^1 c^2$, and inverse currents in all the coils on the left. The little arrows show the directions of these currents. By following out the various turns of the spiral it will be seen that the separate currents induced in the individual turns of the spiral on the left of $c^1 c^2$ are in the same direction along the wire, and therefore all help one another in producing a strong current, though the electromotive force in each may not be equal. A fashion, having one way of helping another in unison strong pull, though the individual horses may not be equally strong. In these coils the strongest induced electromotive force is, as a matter of fact, in the right-hand half of the spiral the individual currents are all moving in the other direction. Up each side of the ring armature, therefore, there is a strong current flowing, drawing electricity from the lowest point and urging it towards the topmost points. Now the lines of the commutator, which are here represented cut-on in a ring surrounding the axle, are all separate and insulated from one another and from that axis. If electricity were to flow into one of them it would have to flow back again, for there is nowhere for it to flow to; the bars of the commutator local nowhere. This is, however, not the case for the two bars of the commutator first occupied the highest and lowest points. They touch against the contact brushes which communicate with wires of the external circuit. So the electricity that flows up both right and left of the ring armature will flow into the upper contact brush and thence into the leading wire of the circuit, which therefore has a constant current urged though it. A corresponding action goes on at the lower contact brush; from this point electricity is drawn both to the right and to the left, being supplied by the inner wires of the circuit. The current thus furnished is practically continuous; for though the contact is made first against one bar of the commutator and then against another as fast as they arrive at the line $c^1 c^2$, it is clear that the currents on the two sides of the ring armature will always be flowing towards that point at which the contact is made. Neither is there any break in the continuity of the current generated, because one bar of the commutator does not leave off to touch the brushes until the next bar came up to contact, and because there always are a certain number of turns of the spiral both on the right and on the left in which the elementary currents are being induced. In the actual dynamo-electric generators the coils of the armatures are of course made up of many turns of wire. In the common Gramme ring, for example, there are hundreds or thousands of turns, and these are grouped in twenty-four sections, the wire at the end of each section being joined to the wire at the beginning of the next, and the junction connected directly with one of the twenty-four bars of the commutator.*

Up to this point nothing has been said specifically about the best way of making the magnet poles S and N as powerful as possible. All our later arguments simply treated N as the north pole and S as the south pole of a strong magnet. And in the earliest machine for producing currents then by the mechanical movement of coils in the presence of magnets, the magnets used to produce the requisite "field" of force were ordinary magnets of hard steel. Hence the name of "magneto-electric machine" assigned to the older instruments invented by Pixii, Saxton, Holmes, Nollet, and Siemens. Hence also arose the name "magneto-electricity" for the currents produced by induction in these machines; for it was at first thought by some that the electric currents that were generated in these *other* machines, and which consisted of *rapidly* alternating currents, were due to some kind of electricity other than that which flowed round the coils of famously out of a voltaic battery. But we know now that electricity, whether the same be frictional, voltaic, magnetic, or thermal, is all the same. The term magneto-electricity is therefore happily dropping out of use. A little later, machines were made in which permanent steel magnets were replaced by electro-magnets. Generators on this principle were constructed by Wilde and by Ladd. A small

* The reader, of course, knows that there are other armatures besides the ring armatures of the Pacinotti, Gramme, and Brush machines; there are, for example, the drum armatures of the Siemens machines of modern type, and of Edison's generators. Their action can be explained on the same manner, however.

DESCRIPTION OF AN ELECTRO-MAGNETIC ENGINE FOR TURNING MACHINERY.

A CORRESPONDENT, referring to a statement made in our issue for September 15th, asks for further particulars of Sturgeon's electro-magnetic engine. As this was one of the first electro-magnetic engines, we give the following extract from notes our predecessor, in October, 1850, Vol. I., p. 73. Sturgeon's "Annals of Electricity," which is out of our readers' being sure that it will interest a wider circle.

"Fig. 17 represents a steel permanent horse-shoe magnet of the form of the engine. The two opposite corners of the base board are fitted with two upright pillars, which carry a brass cross piece, in the centre of which is a screw, the point of which plays within a small cup of steel, which turns freely in two metallic caps, one of which is in the centre of the base board, and the other at the centre of the cross piece. About half way up the shaft are two circular channels, one above the other, as seen in the figure. Through the centre of these channels, and at right angles to their planes, the shaft passes, and is fixed to them. Lower down, the shaft passes through the centre of an opening in the cross piece, supported by two short pillars. On this cross piece, and concentric with the shaft, are fixed four equidistant metallic plates, supported by screws, each by narrow radial openings. Near the top of the shaft, and at right angles to it, is fixed a compound bar magnet, each magnet of which is about eighteen inches long, one inch broad, and half an inch thick. Near to the bottom of the shaft is fixed another similar compound magnet, with its poles in the opposite direction to the former. Its poles coincide with the shaft, and at an equal distance from each other, are fixed in the base board the lower extremities of four cylindrical bars of soft iron, each of which is enclosed by six coils of copper wire. The coils under each cylinder are connected to each other by intervening ones of silk. Each set of extremities of these copper wires is collected to one each copper wire from the coils and is of the temporary magnets; it will by this means be attracted by the former, and at the same time repelled by the latter. Hence it will be urged by both these forces towards the pole A. If now the circuit be completed, so that the voltaic connection be broken from before the pole N arrives at A, the attraction of the iron bar will become necessary, but the momentum of the iron will carry the pole N to B beyond the neutral point. Now conceive that the pendent wires have been carried from their two contrasted plates to the next in succession. The currents by this means have been reversed in the coils, and a corresponding reversion of polarity must take place in the vertical iron bars; hence when the pole N has just passed the first bar, and whilst still in motion by its acquired momentum, it will again be urged on by two other forces, in a similar manner as they do the first, after the circuit being changed by polarity, it will now repel the pole N at and draw it round, whilst at the same time it will be attracted by the next bar in succession. And in consequence of similar changes of polarity taking place in all the four bars, the pole N will be continually revolving. All that has been said respecting the pole N applies equally to the opposite pole S of the same magnet. So that by this means the magnet and its appendages are continually urged on by two successive attractions and repulsions; and by considering that the lower magnet N S is, by the contrivance also urged on at the same time and in a similar manner, by four other like forces, it will easily be understood that the two magnets, with the shaft to which they are attached, are kept in motion by eight forces, four of which are attractive and four repulsive. Such is the contrivance for keeping the machine in motion. To the upper end of the shaft is attached a vertical spindle, carrying an endless screw near its upper extremity, and revolving in the shaft's bracket, in a collar in the upper cross piece. Near to the lower end of this spindle is a fly with three arms, equidistant from each other, and each terminating with a heavy brass crescent. It was originally the fly of a roasting jack. The endless screw works in the teeth of a toothed wheel, also a part of the old jack. The other of this wheel runs in a frame attached at right angles to the upper cross piece. This engine was constructed in the autumn of 1832, and was exhibited for the first time in London, on March 23rd, 1833, at a lecture on electro-magnetism, which I delivered at the Society Library and Scientific Institution. And notwithstanding its then rude appearance, the Committee were so highly pleased with its structure and performance, that they expressed a wish to have it brought forward again, and hear it explained as soon as there was another opportunity. I was consequently honoured with an engagement to continue and extend my course of lectures in the following June; and in the interim my engine was worked well, and excited a great deal of curiosity among the scientific gentlemen who did believe me to be a fortunate and by no means a contemptible character. Since that time I have had others made, which I have improved upon, and which I am pleased to say is working for me now, pumping water, &c., and without the least trouble or attention, except to put on the position by the large model at seven o'clock. But as I once erred greatly when I thought it might be improved, it has long since been taken by, and another one is now building. The old one, however, is still in existence."

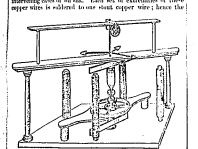

Fig. 17

From "Annals of Electricity," April, 1837, Vol. I., page 278:—

"In the first number of these 'Annals,' I have described an electro-magnetic engine, by means of which pieces of machinery are put in motion. I have now to announce that I have succeeded in propelling a boat, and also a locomotive carriage, by the power of electro-magnetism. The particulars of their construction will be communicated as soon as their present rude state is sufficiently corrected for their appearance in public.

"W. S."

Vols. II. and III. of the "Annals" have been enriched, but no further notice appears of the electro-magnetic locomotive.

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NOTICE OF MEETING.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, March 14th, at 8 p.m. Papers to be read and discussed: "The Design and Construction of Harbours," by Mr. Vernon Harcourt; and "On the Stability of Structures against the Wind," by John Dunbar.

ENGINEERING.

FRIDAY, MARCH 10, 1882.

THE LIGHTNING ROD CONFERENCE.

THE devastation produced by lightning is fortunately not so considerable in England as in many other countries, and this may account for the fact that no rules have ever been drawn up to guide the general public in the erection of lightning conductors—except by private individuals. In France, however, a Commission was appointed by Government on the Academy were requested by Government on several occasions to draw up such rules, and the practice in France is consequently very much more uniform than in this country. This want being felt, the Meteorological Society issued invitations in May, 1878, to the Royal Institute of British Architects, to the Physical Society, and to the Society of Telegraph Engineers, and delegates were chosen by each society to confer on the drawing up a report on the subject. Had the matter been taken up by Government it is probable that the Royal Society would have been asked to report; but inasmuch as there was no less than seven Fellows of thisociety on the Conference it may be conceded that the report almost carries upon it the stamp of our great scientific society.

That confuse to a feeling of disappointment in perusing the report, which occupies only nineteen pages of large letter-press, which contains several suggestions of a doubtful character, without giving any reasons for them, and which omits many matters of scientific interest, which were certainly to be expected from so distinguished a Conference. The principal labours and the greatest success lie in the appendices, which occupy 200 pages of closely printed matter, and which give in a condensed form a vast amount of historical information on the subject. The members of the Conference divided this labour, and a most valuable level of reference is the result. The small advance in the knowledge of the lightning discharges makes it the impossibility of carrying out experiments except with electricity of a much lower potential. Authentic history is therefore of the greatest importance, and all records written by engineers and careful observers are worthy of the utmost value. The Appendices of the Conference enable the student to easily get at any desired information, and any further investigation is assisted by the excellent catalogue of works upon lightning conductors in Appendix G.

The report recommends that each terminal rod should be provided with a platinum point, the central point being a few inches higher than the others, and fixed by the opinion of Mr. Preece, Appendix B, that "each conductor should end in one platinum point," and that "there is no disadvantage whatever in multiplying these points," as it is understood. The report next recommends copper as the material for a conductor although giving a comparison with iron and steel much in favour of the latter metal. As regards the size of it is considered a section of 0.1 of a square inch inch for copper and of 0.64 of a square inch for iron are recommended. Attention is called to the shape of a conductor, and the desirability of its being free from any joints and the cleaning of the foot of the conductor to protect it from the thief, the nut being there is shown in the sections. The references to the attachment of a conductor to a building, and it is stated that it will not compress the rod but that it shall hold it firmly, and yet shall allow for the expansion of the conductor. A screw section to a gas main is not only permitted when other lightning rod is advocated as an efficient arrangement at all times, although an accident in Hatfield, N.S., is mentioned in which the Provincial buildings narrowly escaped destruction by fire occasioned by a lightning rod being struck which had been in use for a time in this way. We also note that in a rocky soil dry situation it is recommended that only 3 cwt. or 4 cwt. of iron at the foot of the conductor in addition to the ordinary earth system. We understand the 3 cwt. or 4 cwt. of iron will have upon the electric discharge is not explained, although it would be very interesting to learn.

The space protected by a lightning rod receives considerable attention, this being capable of one of the members of the conference. His views, however, are not fully endorsed, and the more guarded opinions quoted from the War Office instructions of 1873 (which are printed in one of the Appendices) are practically adopted. And here we would state that the more recent instructions issued by the War Office last year are not quoted or mentioned, nor are the last Instructions issued by the Admiralty in 1880. The recommendations of the Conference on the height of the upper terminal are illogical, as the matter is first stated to be one which may be left entirely to the option of architects and engineers, whereas in the following sentence the lofty rods often used in France, and the low rods used in England are regarded as "opposite errors."

Concerning the testing of conductors an annual examination both visual and electrical is recommended, and various apparatus are noted. "The simplest and best is effective as regards testing the efficiency of the conductor, but not that of the earth connexion;" but inasmuch as the earth connexion is exactly that which is of complicated, and frequently requires repair, and is also the part which being under ground can only be examined electrically, it would not have been anticipated that a testing apparatus which could be used only for the conductor and not for the earth connexion, would have been recommended as the "best," although it might easily be "simplest." This apparatus is made after designs which were furnished by Mr. Preece, who saw a similar arrangement in France.

The Conference recommends that all masses of metal in a building (church bells in a well-protected spire excepted, reason not stated), whether internal or external, should be connected to each other and to a conductor, or to the earth. Clerk-Maxwell, who followed up theoretically by such beautiful mathematical processes as many of the discoveries due to the experimental researches of Faraday, considered that masses of metal should be treated differently according to their position; internal masses being kept apart from the system of conductors, but the external masses being connected thereto.

The report concludes with the code of rules which seem to err on the side of brevity; indeed some details of importance are omitted altogether. For instance, in the case of large buildings with flat roofs the spacing of the points and of the conductors, as well as the number and the less positions of earth connexions, are not mentioned, nor whether surface as well as deep earth connexions are to be used. It is recommended in the instructions drawn up by the French Academy of Science that "the rules appear to be drawn up without much care; for instance, where it is stated that "the lower end of a conductor should be buried in permanently damp soil," and that it adds "hence proximity to drains is desirable." We were always under the impression that drains produce dryness in soils. Again, in the same rule we find, "a strip of copper tape may be laid from the bottom of the rod to the nearest gas or water main, not secretly to a lead pipe." The use of the word secretly is probably intended as no easy connexion to a soil metal pipe is deprecated universally in the report.

The line of reasoning which appears in some of the rules does not carry conviction. Thus, in the rule about "collectors" it is stated that "undoubted instances occur in the explosion of fire-damp in collieries through sparks from atmospheric electricity being led into the mine by the wire ropes of the shafts and the iron rails of the galleries. The same, the lead gear of all shafts should be protected by proper lightning conductors." As the writer knows, however, is not necessarily good but in the mine, it would, perhaps, be preferable to "earth" the lead gear by a wire down the shaft, the iron rails of the galleries being connected to the same, and earth by means of the bank and at the various seams, and at the bottom of the pit. At all events, some reasons should be given for the belief that protecting the head gear with a proper lightning conductor—if "earthing" the conductor as laid down in the rule for "earth connexion" in the previous paragraph, would avail the evil. The head gear, the winding engines, and the boilers are, we believe, already afford a suitable system of "earthing" which would appear to require no special lightning conductor.

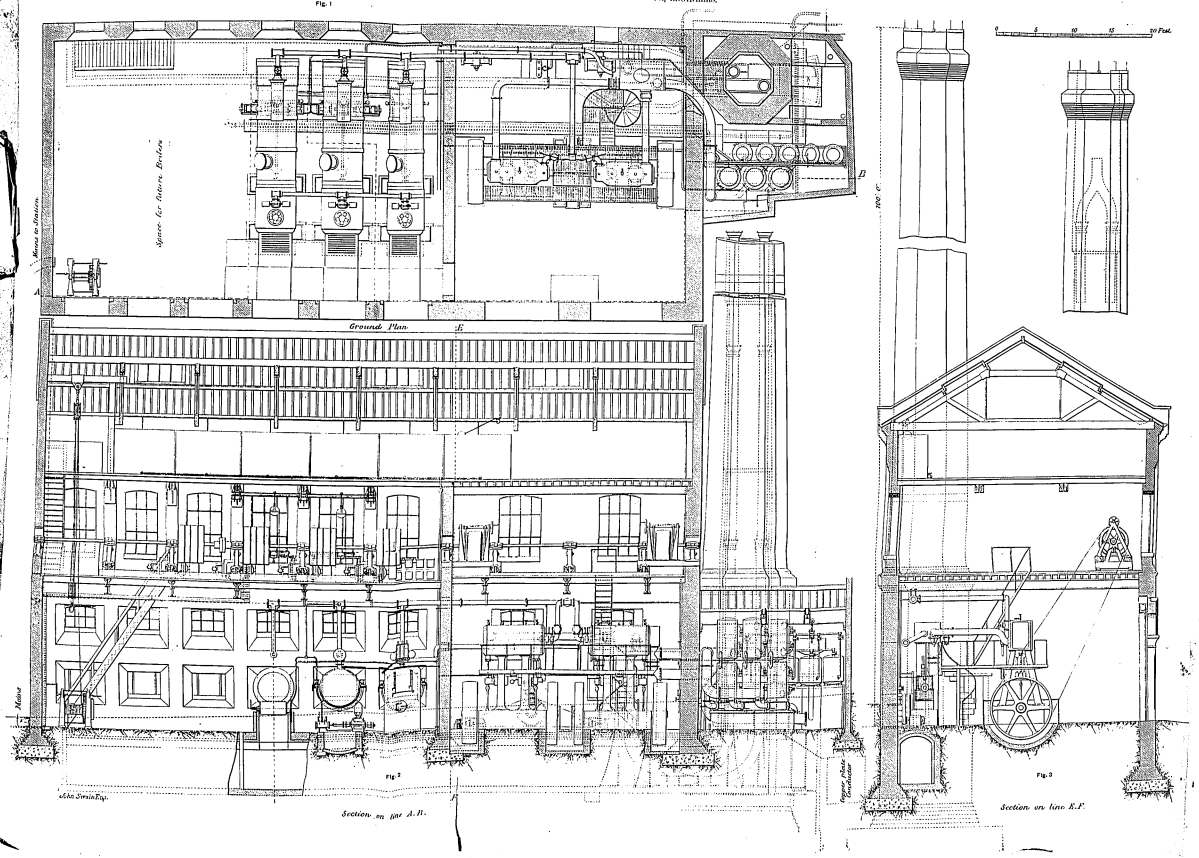
It is most unfortunate that the rules and the report have not been drawn up in a fuller and more convincing manner, as something of the kind of unquestioned authority was still we are compelled to think, still is much required.

THE TRIDANTEPEC SHIP RAILWAY.

In our issue of the 2nd December last we gave a description of the proposed Tehuantepec Railway, by which Captain J. B. Eads, the celebrated American engineer, undertakes to transport laden ships up to a gross weight of 6000 tons, fully laden ships up to 4 fathoms. The plan meets across the American Isthmus, and is, as against with considerable support in America, as against the rival canal schemes of Panama and Nicaragua, on account of its commercial advantages in requiring much less money and time for construction, and also because commercially, and from a military point of view, it is much more favourable to American interests. Tehuantepec is 1250 miles nearer to the North American coast than the Isthmus of Panama, and this additional distance would have to be gone over by a vessel sailing from any of the

THE VICTORIA ELECTRIC LIGHTING STATION OF THE SWAN-EDISON COMPANY, PIMLICO.

MESSRS. R. E. CROMPTON AND CO., ENGINEERS.



The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, MAY 9, 1884.

SELF-REGULATING DYNAMO MACHINES.—I.

By W. B. ESSON.

IN lighting by incandescence where all the lamps are arranged in parallel circuits, and where in consequence of such arrangement the resistance of the circuit is approximately in inverse proportion to the number of lamps alight, it becomes a matter of great importance to regulate the difference of potential of the system, so that the brightness of each group of lamps is practically independent of the others. To fulfil this condition perfectly, the difference of potential between the positive and negative mains ought to be uniform at every point in the system, and this difference of potential ought to be independent of the number of lamps alight. It is very easy to arrange the leading and returning mains in such a way as to make the difference of potential for each group of lamps uniform when the whole or any particular number of lamps are supplied with current; but by no practicable method of arranging the leading wires yet devised have we been able to obtain constancy, and necessarily any increase or decrease in the particular number of lamps alight must affect to a certain extent the brightness of the whole. The difficulty is introduced on account of the leading wires having a certain resistance, and since this resistance is constant, while the current is a variable, depending on the number of lamps alight, it follows that the E.M.F. expended in the leads, and that available for the lamps are also variables, depending on the number of lamps alight. In the absence of any method of arranging leads for incandescence lighting so that the difference of potential shall be constant at all points for every current passing into the system, it appears that the best plan to adopt is that of keeping the potential constant at the point where the mains are supplied, and to proportion the area of the mains so that the variation which can be produced at any point in the system by the greatest variation in the number of lamps lighted shall not be excessive. A simple calculation enables this to be done readily.

Various methods other than that we are about to consider have been devised from time to time, for the purpose of maintaining a constant difference of potentials at the terminals of the dynamo; the best known being that employed by Edison, which consists in introducing a resistance into the field-magnet circuit of his shunt machines; this resistance being increased as the lamps are diminished, and diminished as the lamps are increased. But this method, although it may answer well enough in practice, depends upon the vigilance of an attendant, who is supposed to introduce the resistance at the right moment, and it is open to the further objection that the very movement which we wish to prevent—namely, the increase in the difference of potentials must take place before the attendant becomes aware of the necessity for acting.

To maintain a constant difference of potential at the terminals of the machine, self-regulating dynamos have been devised which, as implied by their name, electrically adjust themselves, and generate a current which may vary within wide limits to suit circumstances, while the potential remains approximately constant. These dynamos are designed to run at a constant speed, although in some cases a variation of five per cent. is necessary to produce the required regulation, and in consequence of this constancy of uniform speed, in which, be it remembered, the great advantage of the self-regulating dynamo lies, the condition of constant potential is made to depend upon the efficiency of steam-engine governors, which have been brought to a high degree of perfection.

A self-regulating dynamo partakes partly of the character of a magneto machine, and partly of the nature of a series machine. It has wound on its field magnets two coils, one of which having few turns through it an approximately constant current, produces a constant excitation of the field magnets, which is the condition for a magneto machine, the other causing an excitation of the magnets approximately proportional to the current which is the condition for a series machine.

We must carefully distinguish between a constant difference of potential at the terminals of the dynamo and a constant E.M.F. Necessarily the E.M.F. must increase as the current increases, on account of the increased E.M.F. required to send the additional current through the armature and series coil. The connections of a self-regulating dynamo are shown in Fig. 1. A is the armature of the machine; S the series coil on the field magnets through which all the current generated by the dynamo must flow; s a high resistance shunt coil, also on the field magnets shunted from the terminals T and T. By hypothesis the difference of potential between T and T, is constant, therefore the current through s is constant, and the strength of field due to the shunt coil is constant. The series coil S, and the armature taken together, constitute a series machine, and the strength of field added to the magnets by the former is approximately proportional to the current. The shunt coil and the armature taken together constitute a magneto machine, and the relation between the current and E.M.F. in such a machine we have now to determine.

It is frequently assumed that the difference of potential at the brushes of a magneto or separately excited dynamo, when a current C is flowing, is simply $E - Cr$, where R is the difference of potential at the brushes when the machine is running on open circuit, and r is the resistance of the armature. The difference of potential is always less than this formula would show, and there are other causes besides the resistance of the armature to which the fall of potential must partly be attributed, which, moreover, are of great importance in this relation. We have to consider

(a) The reaction of the armature on the field magnets.
(b) The resistance of the armature.
(c) The effect of self-induction in the armature coils.

When a current flows through the armature coils in a dynamo, the armature itself becomes a magnet and creates a magnetic field, which opposes the stronger field created by the field magnets. Since the E.M.F. of a dynamo depends not simply on the strength of the field produced by the magnets, but on the strength of the resultant field produced by the magnets and armature combined, the E.M.F. must be reduced when a current flows through the armature, and if the magnetic moment of the armature is small, compared with that of the field magnets, as should always be the case in a well-designed machine, the reduction of E.M.F. due to this current flowing through the armature will be approximately proportional to the current. If, then, E is the E.M.F. of a separately excited dynamo when running on open circuit, when a current C flows through the armature, the E.M.F. becomes $E - C\phi$, where ϕ is a constant depending on the construction of the machine.

Of this quantity, $E - C\phi$, a part $= Cr$ is expended in sending the current through the armature, the latter having a resistance of r, to obtain the difference of potential at the brushes, this part, which is not available for external work, must be deducted from the E.M.F. of the machine, and the fall of potential at the brushes, due to the reaction of the armature on the magnets, and the resistance of the former consequently becomes

$$C(\phi + r).$$

If E be, as formerly, the difference of potential at the brushes when the machine is running on open circuit, the potential, now that a current C flows, is

$$E - C(\phi + r).$$

But there is still another reduction to be made for the potential at the brushes, due to the self-induction of the rotating armature. If we have two adjacent coils, a and b, lying parallel to each other, we know that if a current is suddenly started in a, a current in inverse direction is momentarily induced in b, this latter current depending upon what is termed the mutual induction of the

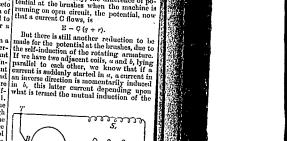


Fig 1.

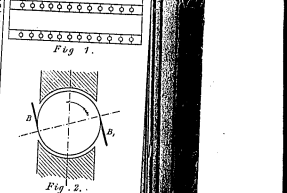


Fig 2.

coils. But if we have a single coil and start a current in it, we find that the different turns of which this coil is made up act upon each other, in the same way as the current started in the coil a acted upon the coil b. In the case of the two coils the induced current in b flowed in a direction such as to oppose or retard the current in a, and in some way the current in each turn of the single coil induces an opposing E.M.F. in the adjacent turns, and the current, in consequence of this retardation, does not at once attain its full strength. This opposing E.M.F. is said to be due to *self-induction*. Let us see how it affects the working of a dynamo machine. *Fig. 2* represents the armature and field-magnets of a dynamo, the brushes being at B and B, and the machine rotating in the direction of the arrow. *Now* in all the coils on the top half of the armature between B and B, the current flows in an opposite direction to

The English Mechanic

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FRIDAY, MAY 30, 1884.

SELF-REGULATING DYNAMO MACHINES.—II.

By W. B. Esson.

(Continued from p. 262.)

WHEN the home circuit is open the shunt wire has to supply an excitation to the field-magnets such that the e.m.f. at the terminals of the machine T and T, when running at its proper speed, shall be that required for the effective lighting of the lamps, and, as stated in our last article, this e.m.f. is by the combined effect of the shunt and series coils to be kept constant for all values of the current up to the maximum for which the machine is designed.

Given, then, the carcase of a machine, the armature of which is wound with a certain number of convolutions, we have to obtain a particular result from the shunt wire, and since this is quite independent of the series wire, there is no necessity, for the present, to trouble ourselves about that part of the machine. Looking at the diagram (Fig. 1), it will be

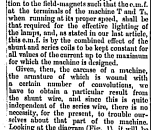
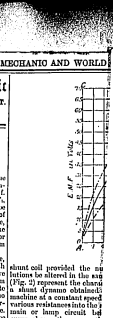


Fig. 1.

seen that we have a closed circuit through the armature A, series coil B, and shunt coil S', the lamp circuit being open. For the purpose of simplifying matters we shall assume that in consequence of the high resistance of the shunt coil as compared with the combined resistance of the armature and series wire, the whole of the E.M.F. of the machine appears at the terminals T and T'. We shall also neglect the increased resistance of the armature due to self-induction, since the current flowing is very small.

The resistance of the shunt wire ought to be as large as possible; the higher its resist-



shunt coil provided the number of turns be altered in the same (Fig. 2) represent the characteristic shunt dynamo obtained by machine at a constant speed with various resistances into the main or lamp circuit before shown the connections. The e.m.f. and the current flowing through the armature the connection between the in the magnet coils, and the the magnets are thereby ances along A B represent amperes, and vertical distances volts. With reference to this description, while between the e.m.f. and one a machine in which the and armature form one M. Depres and others have an increase or reduction the ordinates will give the a machine in which the armature pressed or diminished in the the same way it has to the lengths of the abscissæ correspond to the number of magnets of a new machine machine appears at the terminals T and T'. We shall also neglect the increased resistance of the armature due to self-induction, since the current flowing is very small.

The resistance of the shunt wire ought to be as large as possible; the higher its resist-

former to the new speed, drawn to scale, and the required to obtain by re-constructing or describing a sufficient solution for the number of sistance of the shunt wire self-regulating machine will give to construct. The number of magnets of wrought-iron, long by dia. dia., and ture 600 convolutions of dia., which would carry heating, a current of 18 amp

As will have been gathered from the resistance of the depend to a great extent on the machine. The higher higher may the resistance of be made, and the greater of course the efficiency. In dynamos, generally speaking, of the shunt is from 200 to of the armature.

In the present article, we how, by a method of consistance and the number of shunt wire may be approxi from experiments made with machine, which has accessible magnets, a large number of, and requires a small exciting machine, however, may be in which case its field magnets excited by another machine the brushes for each different must being measured, and the down in a curve similar to D this experiment there will be ing through the armature (the required for the voltameter) shown on the curve may be ar when, as in ordinary working flowing through the shunt and the armature), but if this small, as it usually will be, the introduce may be neglected. out such a curve, the number on the magnets and the re fine wire coils of the series may be determined. An illustrated. Suppose we have a which under ordinary work amperes and 450 volts at 1,200 per minute; further assume its field magnets 2,200 and on its armature 1,1 tions; keeping the speed 1,500, we plot out the cu the connection between the exciting current, and select some curve where the magnets are saturated, to represent the dy it is desired to saturate the m shunt coil. Let this particul cate 250 volts, with an excite 2·3 amperes. But we require difference lamps 50 volts, a on the armature will therefore 1500 + 50 = 200, the ares being, as compared with 250 areas, in the ratio of 200 : 250.

The ampère-turns on the field-magnets must be proportional to the ohms 250 volts were 2·3 × 2·3 = 5·29 ohms, and we know that with the resistance of 5·29 ohms the number of convolutions on the armature

cells are very conveniently shaped for stacking in any odd corner, and are preferably of wood with a lining of sheet-copper. The oxide of copper is bought in a hydrated form from the smelters, but is readily reoxidised in a small coal; caustic soda is employed instead of potash, and the purified chloride is oxide of zinc, a white pigment, which is fit is stated, sells at £20 per ton. This is zinc to construct. The metal being recrystallised all the materials are recovered available again, except the metallic zinc, which now appears in increased bulk as an oxide. One ton of zinc yields a ton and a quarter of the oxide, so that deducting the cost of the zinc from the price obtained for the oxide we have, on paper, a cell which yields electricity for nothing. It is obvious that, in practice, there will be the cost of collecting and revivifying the materials and of preparing them for market; but, looking to the convenient manner in which the battery can be arranged, the absence of any unpleasant gases, the duration of the action, and the fact that there is no waste while the current is not being utilised, it will be understood that there is a very promising future for the cells of copper oxide, or, as we have called, the "Domestic Primary Battery." According to Ferguson's offices a battery of 45 cells gives 40 volts and 16 amperes, works for a month without attention, and occupies very little space.

BREMAN'S IMPROVEMENTS IN ELECTRIC CIRCUITS.

IT is very well known to electricians that in electric light installations where the main conductors are of great length there is considerable reduction of potential at the ends further from the generators; for that reason lamps of different qualities are employed in parts of the circuit, and the whole is balanced in a tolerably effective manner. Mr. J. R. Breman, of Early Grant-road, W., has recently patented a method of distributing electric energy, whereby the distribution of electricity, in which he uses balancing resistances and two or more generators at parts of the circuit, the batteries or coils of batteries being so arranged or constructed as to produce currents of practically equal or nearly equal electromotive force and equal or nearly equal volume of quantity.

It is not in all cases necessary that the electromotive force of each of the batteries should be equal or nearly equal, although this would be generally more economical or convenient. For instance, there may be three batteries, two dynamos and 12 lamps; the current producing in each dynamo being, say, 10 amperes, the resistance of each lamp being 2 ohms, therefore the total electromotive force required to force the 10 amperes through those lamps, assuming that the leads and batteries are without resistance, is 12 × 2 × 10 = 240 volts. And if dynamo A produces 250 volts, dynamo B 220 volts, and dynamo C 260 volts, we have the necessary electromotive forces for doing the work; or each dynamo would produce an electromotive force of 240·3 volts, when the same result would be obtained.

Neither is it in all cases necessary to the invention that the current produced by the batteries should be approximately equally equal. For instance, a dynamo B fall of pressure being separately excited and their fields kept constant) produces, say, 20 amperes and dynamo A and C only 10 amperes each, then the electromotive force of dynamo B must be of such a higher potential as to overcome the resistance of batteries A and C to the extra 10 amperes passing through them, and the armatures A and C must have conductors of sufficient current-carrying capacity to allow the passage of the greater current with safety.

The + conductor from the first battery is taken by a convenient route towards the second battery, and alongside and parallel to the − conductor of the second battery, and the + conductor of the second battery is taken by a convenient route towards the third battery, and alongside and parallel to the − conductor of the third battery, and the + conductor of the third battery is carried in the same manner to the next, and this arrangement is continued until the + conductor of the last battery proceeds towards the first battery and alongside and parallel to the — conductor of the first battery.

When the conductors are in parallel, the external circuit of adjacent or following batteries is completed by interposing resistances, automatic or otherwise, lamps, motors, or any other means of translating device or devices, alone or in conjunction with resistances, automatic or otherwise, either in multiple arc or multiple series, or any convenient combination between the + conductor of the one battery and the − conductor of the following battery.

By means of these balancing resistances the electromotive force on all the parallels may be kept equal, notwithstanding the removal from any parallel of one or more translating devices, lamps, for example.

It is obvious that if all resistances, lamps, motors, or other translating devices are cut off from the circuit, because any two contiguous batteries there will be a short circuit. In this case the circuit can be completed by introducing suitable balancing resistances of the proper current-carrying capacity. The circuit can be completed by "earth," or by the conductors or conductors, and then by any suitable means keep the work required to be produced by the batteries at the proper point.

The purpose of the balancing resistances is to transmit at all times the same amount of current shall be circulating in the conductors, however many or few translating devices may be in the circuit.

Any suitable balancing resistances may be employed, and the work done in these balancing resistances may be used, when practicable, in forming or charging secondary batteries, in electrolysing, in the decomposition of chemicals, or in the production of any other useful effect, according to the locality where the batteries may be situated.

As the invention can be applied in a variety of ways to lighting and all work requiring the transmission of current to a distance, it is difficult to give Mr. Breman's claim, which is:—

The arrangement of appliances for distributing and translating electricity by means of suitable and convenient batteries in series, the circuits between them being closed by the interposition between the positive and negative conductors, or positive and negative poles, of adjacent batteries of suitable and convenient resistance, alone or in combination with suitable and convenient translating devices; the translating devices being either alone or in combination with resistances, and being either in series, series multiple, multiple arc, multiple series, or any other convenient combination.

a series of earthquake shocks. As to the cause of earthquakes, we can do little more than conjecture. It is easy to understand that where forces so tremendous as those which recently destroyed Krakatoa are at work, and especially when pent up, they may give rise to upheavals and subsidences of the surface crust over many hundreds of square miles; but the actual nature of the forces, and the conditions in which they exist, is beyond research. It may be that water in the spheroidal state suddenly flashes into steam, and finding an inadequate vent forces up the superficial crust of the earth; or it may be that steam is suddenly condensed, and the roofs of gigantic cavities fall in; or again, it may be the sudden snap of deep-seated rocks, no longer able to resist a prolonged and intense strain. Of earthquakes proper (as distinguished from the effects produced by volcanic eruptions), especially when they extend over large areas, there is much reason to suppose that they are caused by the rupture of rocks forming what may be termed the supports of the earth's crust. Assuming that the earth has a fluid interior, which is slowly cooling and contracting, it follows that the crust will crack, and, falling in, may produce volcanic eruptions, which, in turn, by the shock of explosion, may start cracks which produce earthquakes. Those who desire to learn what facts or what arguments are brought to bear on these questions may be referred to Mallet's papers in the British Association reports for 1847 and subsequent years; to the *Journal* of the Geological Society, and to the numerous special works dealing with the subject, including the "Physics of the Earth's Crust," by the Rev. O. Fisher, which we reviewed in Vol. XXXIV. p. 582, and the standard textbooks of geology.

THE DYNAMO: HOW MADE AND HOW USED.—XVIII.*

By Selimo R. Bottone.

§40. TWO binding screws are now to be inserted into the base-board, to which the wires proceeding from the limbs of field magnet must be clamped. These should be placed about 1½in. from the side of each limb, the wires proceeding therefrom being denuded of their covering and sandpapered at the extremities where they are clamped to the binding screws. These binding screws (as also those connected

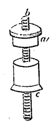


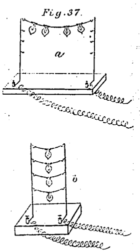
Fig. 36.

with the brushes) should, for the convenience of being able to couple up at one and the same time, two or more wires, be of the pattern shown at Fig. 36, in which case the extremities of the field-magnets may be also formed into rings, as shown at Fig. 35a, and either clamped down to the base-board by passing the long screw *c* (Fig. 35) into the ring, or, the nut *a* having been removed *pro tem.*, the ring may be slipped over the screw *b*, and then clamped by the nut *a*.

Connection is now to be made between the binding screw attached to the current-sending or positive brush (the one which we have marked with a paper label), and the binding screw coupled to the wire, starting from the *inside* of the limb of the field-magnet (see Fig. 32c) by means of a short length of No. 16 copper wire, well cleaned, bent into rings at the ends, and clamped down as advised above.

If all the instructions have been carefully carried out, more especially those contained in the last six paragraphs, we shall find that on rotating the flywheel a powerful current will flow between the two remaining binding screws—viz., the one connected with the outside wire of

Fig. 37.



the field-magnets, and the other with the negative brush of the commutator, a current which will be sufficient to heat to bright redness 4½in. to 5in. of No. 42 platinum wire, or to light four 5-candle power lamps, arranged in parallel arc.

The current actually flowing through the circuit (the number of ampères) will naturally depend largely on the resistance interposed between the poles, that is to say, between the binding screws connected with the outside wire of the field-magnet, and the negative brush of the commutators respectively: and since the magnetism of the field-magnet depends entirely on the amount of current flowing around it, and

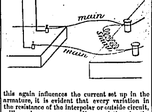


Fig. 38.

this again influences the current set up in the armature, it is evident that every variation in the resistance of the interpolar or outside circuit, will produce a corresponding variation in the current, if the dynamo be connected up as above described; and that a very much larger current will traverse the circuit when the resistance is small, than when the resistance is great. When the machine is doing its best work, that is to say, when the resistance of the interpolar is equal to the internal resistance of the machine, the current is equal to that of eight or ten Bunsen's cells against an equal resistance. Sometimes it is necessary to send the current through a greater resistance; in this case, in order not to weaken too greatly the magnetism of the field-magnet by diminishing so greatly the current, it is necessary to shunt off a portion of the current, and sent it round the limbs of the field-magnet by another circuit, which diminishes the total resistance.

To render this clearer, let us suppose that we wish to light up four 5-candle lamps, having each an approximate resistance of 8 ohms, and requiring a current of about one ampère each to cause them to give out their proper light. If we arrange them in series, as in Fig. 37a, when the total resistance is the sum of their separate resistances = 32 ohms, then, as the electromotive force of our machine when at best is about 10 volts, so $\frac{10}{32}$ represents the current flowing through the lamps, supposing even that the dynamo lost no power by the diminution of current (which it does to a very great extent), and this current is not sufficient to light the lamps. But if we arrange the lamps in parallel arc, as at Fig. 37b, then the total resistance falls to a quarter of one single lamp; that is to say, it is equal to two ohms only: hence, the current now flowing

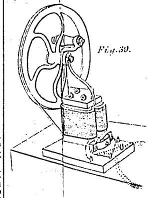


Fig. 39.

becomes $\frac{10}{2}$ = 5 ampères, and this divided among the four lamps gives 1¼ ampères each, which is ample.

Again, we find that coupling up one single lamp to the dynamo presents too great a resistance, so that no light is given off, since not sufficient current can pass round the field magnets to give an electromotive force of 10 volts. But if we insert a "shunt," consisting of about a dozen inches of No. 30 iron wire, between the two binding screws aforesaid, as shown at Fig. 38, and then connect the lamp also to the said screws or terminals, more current circulates round the field magnets, since two roads are now open to the current, the field magnet becomes more powerfully magnetic, and in its turn induces a much more powerful current in the armature, and so on until current enough is produced to light up the lamp. The resistance of the "shunt" to be inserted between the terminals, to produce the best result, will depend on the resistance of the interpolar. If this latter be low, no shunt (or one of very great resistance) will be required; but if the resistance of the interpolar be very high, the resistance of the "shunt" must be correspondingly low, or else not enough current will pass to magnetise the field magnet, and the dynamo will give no current.

Fig. 39 represents the dynamo completed.

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Engineering — Feb. 13, 1885.

DRIVING DYNAMOS.

On page 156 we illustrate several systems of driving dynamos devised and carried into execution by Messrs. Mather and Platt, of Salford Iron Works, Manchester. Figs. 1 and 2 show an arrangement for driving a dynamo by helical wheel gearing. The engine is one of Mather and Platt's usual double-cylinder diagonal engines with cylinders 8 in. in diameter and 10 in. stroke. As will be seen, the bed is of a rigid form and suitable for an engine running at a high speed. The crank is of the ordinary double-sweep form and the crosshead and slides are cylindrical. The engine is fitted with the well-known Mather and Platt patent metallic piston, and it is regulated by a Pickering governor attached to the steam supply pipe and driven from the crankshaft by a pair of bevel wheels.

The engine has long brass bearings, the crankshaft bearing on the driving side being made extra long. The flywheel is formed into an internal spurwheel with double helical teeth, the boss of the wheel being turned and let into the crankshaft bearing, which is bored out to receive it. By this means the strain on the crankshaft is one of torsion only, and the wheels are more rigid and are kept in their proper relative positions so that the teeth are always in full gear. This wheel gears with a pinion keyed on a shaft carried through the engine bed, and which is coupled direct to the dynamo shaft by means of a flexible coupling. It will thus be seen that any slight irregularity or jar in the engine or first pair of wheels is lost in the shaft and coupling before reaching the revolving armature of the dynamo, which is of the greatest importance on account of its weight and speed, and from the fact that any springing of the shaft, however small, is intensified by the unequal magnetic stresses which are at once brought into action. The wheels of the engine and dynamo are in the proportion of 6 to 1, the former making 175 revolutions per minute. In an internal wheel the friction is less than in ordinary spur gearing, as the stresses are more nearly tangential to the pitch line of the wheels. There is very little wear in the wheels, and no parts requiring replacement. When the wheels are once set they require no further adjustment or attention. By using double helical teeth in connection with an internal wheel the number of teeth in gear at any instant is increased, so that a finer pitch can be used, which reduces the noise so as to be almost unnoticeable. The engine is shown in the engravings driving one of Mather and Platt's new compound wound dynamos for 150 to 200 twenty-candle power lamps, giving 100 volts electromotive force at 1050 revolutions per minute. Fig. 3 illustrates the same system of driving applied to a similar dynamo, but the engine in this case is of the single-cylinder oblique type. The cylinder is 10 in. in diameter by 12 in. stroke. The wheels are the same proportion as before, viz., 6 to 1, and the engine makes 175 revolutions per minute. The crankshaft is of the best hammered scrap and is carried in long adjustable brass bearings. The connecting-rod is also of wrought iron having adjustable brasses at both ends and is connected to the crosshead by a steel pin. The slide is of cast iron bored to suit the circular crosshead. The engine is fitted with a Mather and Platt patent piston, with a steel piston-rod, and the regulation is effected, as in the first case, by a Pickering governor driven by a strap from the crankshaft. The driving is effected through a shaft and flexible coupling just as in the previous arrangement.

Fig. 4 illustrates an arrangement of short-belt driving applied to the same dynamo and diagonal engine described with reference to Figs. 1 and 2. The engine is the same as before described except that in the place of the helical gearing the flywheel is turned for belt driving. The proportion of the wheels and the speed of the engine are the same as before. In order to give the strap more grip on the pulley of the dynamo a very effective arrangement is used. This consists of a swivelling arm which carries at one end a pulley riding loose on a stud. The lower end of the arm is formed into a wheel quadrant gearing into a worm carried on a spindle at the end of the bed of the dynamo. By turning a handwheel keyed on the end of the worm spindle, the arm, and with it the pulley, is raised or lowered, and thus the strap is wrapped less or more round the pulley as required, giving a neat and effective strap-driving in a small space. By this arrangement a long strap is unnecessary, and less strain is put on the driving side of the strap and also on the dynamo shaft, by giving more pulley surface to the belt. Figs. 5 and 6 show the above arrangement of belt driving applied to the same dynamo, but with the single-cylinder engine before described in place of the diagonal engine.

The advantages of these methods of driving are not confined to ship lighting. In mills and workshops it is often desirable to place the dynamo in the engine-room, so that it may require no further attendance than from the man in charge of the main engines. The space is usually in such cases very confined, excluding the possibility of driving by a long belt. The method last described has been very effectively employed by Messrs. Mather and Platt in installations at the Theatre Royal and Comedy Theatre in Manchester for driving two 250-lamp Edison-Hopkinson dynamos. It may also be advantageously used with gas engines for house lighting, as it enables the engine and dynamo to be fixed on a single bedplate.

Figs. 7 to 9 illustrate a new form of dynamo manufactured by Messrs. Mather and Platt. This machine is a modification of the original Gramme generator, carried out on the same principle as Dr. John Hopkinson's reconstruction of the Edison dynamo. The mass of iron in the magnets and core of the armature is very largely increased, and the length of the magnetic circuit is shortened. The machine has a double magnetic circuit which, though slightly diminishing the efficiency, greatly increases its compactness and symmetry of form. The cores of the magnets are made of wrought iron, and are let into cast-iron pole-pieces, which have an increased section over the wrought iron. The lower pole-piece is extended to form the bed of the machine, thus securing great compactness, and keeping the centre of gravity of the moving parts as low as possible. The armature of the machine has a free space left along the shaft to secure internal ventilation, and the commutators are large compared with the general dimensions, in order to diminish the sparking by giving as large a surface of contact as possible between the brushes and commutator bars. The commutators of all the machines have forty bars of toughened brass, and are insulated with mica.

In the machines for 100 lamps and for high outputs, there is a double brush on each rocking bar capable of separate adjustment with an elastic forward thrust and butt contact. The machines are all compound wound for constant potential at the terminals, the series coils being external to the shunt coils. These arrangements have increased the efficiency of the machine so that those of the new type are not much inferior in efficiency to the Edison-Hopkinson machine, which has probably very nearly the highest duty attainable. The perfect ventilation and low resistance of the armature enables these dynamos to carry a large load in proportion to their size without heating. In fact, the load on the armature is determined by quite other considerations than that of heating. Each machine is provided with a switch board carried on the upper yoke, and fitted with a main plug switch and suitable terminals.

Particulars of Mather and Platt's Dynamos.

	Number of 20 Candle-Power Lamps.	Electromotive Force in Volts.	Output in Ampères.	Speed.	Extreme Dimensions. Length. ft. in.	Height.	Breadth.	Size of Pulley.	Price £
1	30 to 40	50	50	1650	2 3	1 2	1 9	8×4	45
2	50 ,, 60	50	75	1150	2 8	1 2	1 10	8×4½	70
3	100 ,, 120	100	80	1100	3 4	1 6	2 4	10×6	90
4	150 ,, 200	100	120	1050	3 6	1 7	2 6	12×9	150
5	300 ,, 350	100	220	850	4 3	1 10	3 2	14×9	200

Messrs. Mather and Platt are at present manufacturing dynamos of the type described, of the sizes given in the annexed Table.

THE EDISON-HOPKINSON DYNAMO.

We have received from Messrs. Mather and Platt, of Salford, the following account of a prolonged and practical trial of an Edison-Hopkinson dynamo constructed by them and designed to give a current of 250 ampères with an electromotive force of 55 volts.

Description of Machine.—The dynamo is of the latest Edison-Hopkinson type with a short armature. The exterior dimensions are, length, 56 in.; breadth, 36 in.; and height, 40 in.; and the net weight of the machine complete is 32 cwt.

The commutator is of copper with mica insulation, and has 48 bars; and is provided with double brushes independently adjustable. The magnets are shunt-wound.

	Ohms.
The magnet resistance is	7.84
The armature resistance is	0.068

The dynamo is designed for a continuous load of 250 ampères, and 55 volts, and is run at a speed of 900 revolutions per minute.

The efficiency of the machine is deduced from the following figures:

	Watts.	Horse-Power.
Total electrical power developed	= 16,216	= 21.74
Loss in magnets	= 691	= 0.51
,, armature	= 720	= 0.96
Power available in outer circuit when run as in test ...	= 15,025	= 20.28

Hence,

	Per cent.
Electrical efficiency	= 93
Loss in magnets.	= 3.4
,, armature	= 4.6

The following are particulars of the test to which this machine has been subjected:

The dynamo was arranged for driving by an ordinary strap from a double-cylinder engine made by Mather and Platt, and carried on slide rails to admit of the belt being tightened if required. One of Sir William Thomson's graduated potential galvanometers was permanently coupled to the machine to give a continuous indication of the electromotive force between the terminals, and arrangements were made for measuring the current by means of a current galvanometer also of Sir William Thomson's graduated type.

The temperatures of the bearings were measured throughout the test by means of thermometers placed in mercury cups attached to the bearings, and a continuous record was kept of the temperature of the room.

The speed was indicated by a tachometer attached to the engine, and the revolutions of the dynamo counted from time to time with a counter.

The load was maintained constant throughout the test, as nearly as possible at 250 ampères, and 55 volts, measured at the terminals. This is ten per cent. above the normal load for which the machine is intended.

The machine was started on December 30th, and run for five hours, when the temperatures were taken as follows:

Room, 17 deg. C.; pulley bearing, 35 deg. C.; commutator bearing, 36 deg. C.; magnets, 35 deg. C.; armature, 76 deg. C.; commutator, 70 deg. C.

At the end of twelve hours' run the temperatures were again taken:

Room, 20 deg. C.; pulley bearing, 36 deg. C.; commutator bearing, 36 deg. C.; magnets, 35 deg. C.; armature, 81 deg. C.; commutator, 75 deg. C.

Again at the end of twenty-four hours the temperatures were: Room, 15 deg. C.; pulley bearing, 30 deg. C.; commutator bearing, 29 deg. C.; magnets, 31 deg. C.; armature, 76 deg. C.; commutator, 74 deg. Showing that at the end of twelve hours the maximum temperatures had been reached in all parts of the machine. Subsequently, throughout the entire run of three weeks' duration, the temperatures did not vary more than was accounted for by variations in the temperature of the room.

The speed maintained throughout the run varied from 910 to 925 revolutions, with the full load, and the armature and magnets warm.

The machine was run continuously, stopping ten minutes daily to read the temperatures of the armature and commutator, and for Sunday, until January 6th, when it was stopped in order to take out the armature and have it examined to determine if there were any sign of charring or deterioration in the insulation of the wire; and in order carefully to examine the commutator. The examination was conducted by Mr. Blackburn on behalf of the Edison and Swan United Company, and no change whatever was observable either in the insulation of the wires of the armature or in the commutator.

It was then decided to run the machine absolutely continuously for a fortnight without any break whatever, with the full load of 250 ampères. This test concluded on January 20th.

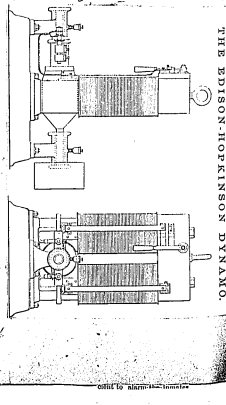
Throughout the whole of this continuous run for fourteen days there was never the slightest sparking at the commutator, the brushes and magnets remained at a uniform temperature throughout, and the temperature of the commutator at the end of the run was 70 deg. C., practically the same temperature as at the end of twelve hours. One set of brushes were used without change of adjustment for twelve days, and all the end were found to be worn down uniformly ⅛ in.

The commutator was perfectly smooth, and showed no signs of wear or grooving, and the armature had stood the run without the slightest swelling or any sign whatever of change in the insulation.

These tests were undertaken by Mather and Platt at the request of the Edison and Swan Company, in order to show the durability of the Edison-Hopkinson dynamo under a long and continuous strain with a load of 10 per cent. in excess of that for which the machine is sold. The conditions of the test were formulated by Mr. Allright and Mr. Blackburn on behalf of the Edison and Swan Company, and it was superintended by them and their representative, Mr. Crompton, during the entire run.

It proved conclusively that a dynamo of this type may be run continuously without any change in its working parts or deterioration in the insulation of the copper conductors or change in their resistance, and that the wear is exclusively confined to the commutator and copper brushes, and that, with regard to the former, three weeks' run is not sufficient to produce any visible wear, and that the brushes last much longer than is usually supposed, one set being capable of lasting a year on a machine running on an average three hours a day.

Engineering—Jan. 30, 1885.



THE EDISON-HOPKINSON DYNAMO.

Consult to alarm-bell tunnies

Eng'neering - Jan 6 1882

Dynamo-Electric Machinery. By S. P. Thompson, B.A., D.Sc. London: E. and F. N. Spon. 1881.

The appearance of the present volume is caused by the demand for copies of the Cantor Lectures on Dynamo - Electric Machinery, delivered by the author before the Society of Arts in the autumn of 1882. Yet in no sense can the work before us be considered a mere reprint of the lectures, a large amount of matter having been added, to render it a complete manual of existing types of dynamo-electric machinery, those matters having simply an historic interest being very judiciously omitted. The present work is the first in which the theory, the design, and the working of dynamos have received thorough investigation, and we are pleased to see that this is done in a practical way; the mathematical calculations do not include several of the smaller secondary matters at work in a machine, and although much simpler than many of the more complicated formulæ found in other papers, give practically as true results. The volume, although written more especially for students of electro-technics, to whom we can most thoroughly recommend it on account of the comprehensive and practical way in which the subject is treated, will be of service to all practical and theoretical electricians, and the former will find many valuable hints given by the author in discussing the different points of the machines.

In the first chapter, Professor Thompson considers the term dynamo-electric machine and defines it as a "machine for converting energy in the form of dynamical power into energy in the form of electric currents by the operation of setting conductors to rotate in a magnetic field," which is a happily expressed explanation of the action which takes place. In the following chapter the discovery of Faraday that electric currents are generated in conductors by moving them in a magnetic field is discussed, and this leads to the principles on which dynamo-electric machines are constructed, and to their classification into three main groups. These are as follows: 1. Dynamos in which there is rotation of a coil or coils in a uniform field of force, such rotation being effected round an axis in the plane of the coil or one parallel to such an axis, such as the Gramme, Siemens (Alteneck), Edison, Lontin Burgin, Schuckert, &c., machines. 2. Dynamos in which there is translation of coils to different parts of a complex field of varying strength, or of opposite sign (most of these machines, but by no means all, supplying alternating currents), such as the Pixii, Wallace-Farmer, Siemens (alternate), Gordon, Ayrton and Perry, Edison (old), Thomson-Farmer (alternate), Thomson (school dynamo), De Meritens, &c., machines. 3. Dynamos having a conductor rotating so as to produce a continuous increase in the number of lines of force cut, by the device of sliding one part of the conductor on or round the magnet, or on another part of the circuit, such as the Faraday disc, Siemens unipolar, and Crompton machines. The only machine which does not fall within any of these classes is the toothed-armature of Edison, in which the coils are wound to and fro at the ends of a large toothed, instead of being simply rotated on a spindle. The Elphinstone-Vincent and four-pole Schuckert and Gülcher machines are included in the first class, being really compound machines. This classification is far more comprehensive than the old way of dividing machines into continuous or alternating-current, cylindrical, disc-wound (spider, drum), self-regulating, &c., and a complete summary of Professor Thompson's classification will greatly aid the reader in understanding the subsequent chapters of the work and in obtaining a clear grasp of the subject. Chapter III. treats in detail of the different classes of dynamos and their constituent parts under their several headings, the diagrams being exceedingly clear. The reasons for particular forms of structure or arrangement of parts are also given in a clear and precise manner, and some of the faults of existing machines are indicated and will be found worthy of special attention. The succeeding chapter explains, by the aid of curves, the induction of currents in armatures and the distribution of potentials around the collector, and also the mode of investigating these curves. It concludes by a lucid explanation of the Siemens ring, after which the author states that the Gramme pattern of ring armature, so far from being an improvement on the old Pacinotti ring, is distinctly a retrograde step, always supposing that the cost of construction, liability to heating, and other kindred matters, be equal for the two, in which conclusion we thoroughly agree. The reactions in the armature and magnetic field form the subject of Chapter V., and the author attributes the lead which it is necessary to give to the brushes to this cause, and infers that the magnetic moment of the field magnets ought to be very great as compared with that of the armature so as to reduce this lead. To effect this he advises that an unusual quantity of iron of the softest kind should be employed for the field magnet cores. This idea appears latterly to have been acted upon by several prominent makers with good results. He next considers certain effects due to self-induction and to mutual induction, amongst which is the apparent increase of resistance in the armature coils proportional to the speed, which may be diminished by employing more iron in the core and fewer turns of wire. The chapter on the government of dynamos deals with the various methods of exciting the field magnetism, viz., by one of the four simple methods, as in the magneto, separately excited; series and shunt dynamos, respectively; and by various combinations of them for obtaining a constant potential as required. By combining the following arrangements, viz., the series with the separately-excited, the magneto, the shunt, or the shunt to the working circuit only, a constant potential can be obtained at a certain speed, these combinations including Professor Perry's arrangement of introducing a separate magneto or separately-wound dynamo into the circuit of a series dynamo. If a constant current is required the shunt arrangement is combined with the separately-excited magneto, or series arrangement. This chapter concludes with a description of methods of automatic regulation effected by the aid of electro-magnets acting on resistances or on the steam supply of the driving engine, or if a constant current is required by driving the dynamo by a dynamometric governor to maintain a constant torque or turning moment. From these few cursory remarks it will be seen that this part of the work deals thoroughly and efficiently with the whole subject of the government of dynamo-electric generators. Chapters VII., VIII., and IX., containing seventy-six pages, describe the various types of machines under the three classes mentioned above; the machines are fully illustrated and their special points clearly indicated in an impartial manner. In Chapters X. to XV., (inclusive) algebraic expressions are found for the electromotive force, the current and the economic coefficient of the principal types of dynamos, an expression being first found for the average electromotive force induced in a single coil rotating in a uniform magnetic field which leads to the consideration of magneto, separately-excited, series, and shunt dynamos, and finally to the various forms of compound machines derived to give either a constant potential or current. We notice a few printer's errors amongst the formulæ, and also a slight algebraical error, several times repeated, occurring in the latter part of Chapter XV., which, however, does not affect the results arrived at; in giving the critical speed of a dynamo for a constant current, the constant in the formulæ should be a divisor and not a multiplier.

Chapter XVI. deals with alternate current dynamos, the results of which are greatly affected by the retardation of magnetism and the self-induction in the coils. The retardation increases with the speed and affects the ratio between the self-induction and the resistance, and is less if the machine is designed to be driven at a slow speed and the coefficient of self-induction is small compared with the resistance of the circuit. The coefficient of self-induction represents the number of lines of force which the circuit would possess or induce on itself, if the current flowing in it were one absolute unit. These most valuable chapters (X.—XVI.) will undoubtedly prove of special interest to electricians having to design dynamo-electric machinery, for, as above stated, the formulæ are simpler than those hitherto published, and should be within the grasp of the average designer. The geometrical theory of the dynamo is studied by the aid of graphic diagrams, and particularly by the use of "characteristic" curves, which have to the dynamo a very similar relation to that which the indicator diagram bears to the steam engine. The characteristic curve represents the relation existing between the total electromotive force and the current (which vary with the outside resistance), and as, by multiplying the electromotive force by the current, we get the horse-power, it is easy to mark off the horse-power required for each particular case. The curve illustrating the relation between the available or external electromotive force and the current, entitled by the author the "external characteristic" curve, differs slightly from the characteristic curve, is more generally useful for many calculations, and is evidently more readily obtained. These curves indicate, when their scale is known, the horse-power at which the dynamo works, and also at what horse-power it may be worked to the greatest profit, and, though the scale is not known, the form of the curve affords definite information as to the condition of working of the machine. The chapter also gives various examples of the use of these and other curves, which will be found to possess a considerable amount of interest and also of utility.

The succeeding eight chapters treat of dynamo-electric machines considered as motors, or machines for converting the energy of electric currents into energy of mechanical motion. In Chapter XIX., which discusses the theory of electric motors, the author gives Jacobi's law of maximum work of an electric motor supplied with currents from a source of given electromotive force, which is as follows: The maximum work given out by a motor is a maximum when the motor is geared to run at such a speed that the current is reduced to half the strength that it would have if the motor was stopped; *i.e.*, that the back electromotive force of the motor is equal to half the electromotive force of the current supplied to it. The author then deduces from this law—which is often erroneously given in text-books as the law of maximum efficiency—that no motor working at its maximum activity could convert more than 50 per cent. of the electric energy supplied into actual work. It is very interesting to compare this law with Siemens' law of efficiency, which is given later on in this chapter. This law is as follows: The useful work done by the motor is to the electric energy supplied, as the counter electromotive force set up by the rotation of the motor is to the electromotive force supplied to it, and this shows that by letting the motor run so fast that the counter electromotive force is nearly equal to the electromotive force supplied, the efficiency will be nearly equal to unity. Special forms of motors are fully discussed and explained in Chapter XXI., and the succeeding chapter describes several forms of governing gear for motors, including Hopkinson's, Beckmann's, and Ayrton and Perry's. The relation of speed and torque of motors to the current supplied is discussed in the next chapter. Chapter XXIV. treats of the governance of motors by centrifugal, dynamometric, and electric governors, and by the methods of winding the field magnets. Several motor problems are graphically solved in Chapter XXV. The concluding chapter describes the methods of testing dynamos, including the tests of the resistances of the various coils and connections, and of the insulation of the working parts and tons of efficiency under various loads and of electrical output at different speeds. There are six appendices which discuss respectively the measurement of self-induction in a coil; the measurement of mutual induction between two coils; formulæ used for electro-magnets; fundamental equations of dynamo-electric machines and the theory of M. Deubert; the alleged magnetising; and the movement of the neutral point, and will be found well worthy of perusal.

In conclusion we would again commend the present work to all our readers, which will increase the high reputation of its author, and will doubtless long be quoted as an authority on the special subject of which it treats. The work is got up in good style, and is well and sufficiently illustrated throughout.

Engineering - Feb. 4/55

High Tension Current Dynamos.

The danger incurred by the use of very high tension current dynamos, in addition to one of the most serious obstacles to the development of electric lighting from large central stations. A French electrician, M. d'Arsonval, Professor at the College de France, has recently (Jan. 26) communicated a paper to the Academy of Sciences in which he explains how he has been enabled to render the employment of such machines absolutely free from danger. He introduces the subject by the often-repeated remark, that it is not so much the tension of that which is the source of peril, as the counter current, set up at the moment of breaking or making contact. It is on this account that with equal tension, alternating currents are usually less dangerous than those of maximum efficiency—that is, currents of opposite values, succeeding each other suddenly, produce physiological effects vastly more energetic than continuous currents. M. d'Arsonval concludes from this, that a series coil machine giving currents of equal tension and equal strength may be very unequally dangerous, and that even a current that may be dangerous in one circuit need not be so in another. To avoid this risk it is sufficient to prevent the extra current to traverse the body of the experimenter, and to do this it is only necessary to place in connection with the terminals of the dynamo a series of small voltameters with lead plates and acidulated water, in sufficient number that the electromotive force of polarisation may be greater than the electromotive force of the machine. This arrangement is claimed to set up an absolute barrier for the direct current, whilst the extra current passes freely. At the moment when the circuit is broken the extra current traverses the voltameters, and the safety of the experimenter is guaranteed. The efficiency of this method can be very easily tested.

The Engineer Nov. 13, 1885

DRIVING DYNAMO-ELECTRIC MACHINES.

THE paper of which we published an abstract on page 388 rejects an idea which was even more prevalent amongst electricians a year or two ago than it is now; namely, that electricity must be brought into play to control the admission of steam to a steam engine, if sufficient exactness to secure uniformity of speed is to be obtained. The governor of an engine, we are told in the paper referred to, "should be sufficiently sensitive and trustworthy in action to keep the engine within 5 per cent. of its normal speed, with a load varying 10 per cent., and a boiler pressure varying 10 lb. per square inch. No mechanical governor will do this, and consequently great vigilance has to be exercised on the part of the attendant." We have no intention of suggesting that a good and simple electric governor is not at all a desirable thing, but we believe we express the opinion of a good many practical electrical engineers when we say that even if the above statement as to the requirements of a good governor were not only beyond the power of any mechanical governor, and equally beyond the power of any electrical governor, such requirements are wholly unnecessary in practice, and a well-considered installation would never make such a demand upon the governing capacity of any engine. Whether this is so or not, it is quite certain that the inference is that not one of the many installations of different sizes now in successful work is driven by an engine which has the required governing power. There are, however, plenty of engines running that under ordinary conditions of variation of load and boiler pressure are running within less than 5 per cent. of the normal speed. They are not, however, running with loads constantly varying from 100 to 10 and 10 to 100, and inasmuch as no anticipatory governor has yet been devised, it is quite certain that an engine can work within 5 per cent. under such ranges of load. Some seven tests on the power of a good governor and automatic cut-off were put upon one or two of the large engines used at the recent Health Exhibition, when the large strips there used, and transmitting over 300 indicated horse-power, suddenly broke, thus reducing a load of almost 10,000,000 foot-pounds per minute to nothing. The engines did not, however, perceptibly increase their speed; but there is no doubt that if the load had been suddenly put on as taken off, a great change would have been observable. The range of 10 per cent. is not very much less than the whole load, and if nine-tenths of a load is to be taken off and put on again as suddenly, it is quite certain that no governor, electric or otherwise, if actuated by the speed of the engine or a current which is affected by that speed, can cut off and re-admit steam without some loss of time; and a departure of more than 5 per cent. from the normal speed must result, though that departure may have but a brief period of duration. With a slow speed engine making, say, 100 revolutions per minute, a considerable portion of at least two strokes must be made with a steam cut-off and admission determined by the instant load and speed. That is to say, that in the case of a load dropping, say, 90 per cent. just as steam is cut off, that stroke will be performed by that cylinder full of steam; and the velocity must increase, for no governor will act to let the steam out again in such a case. In the half stroke or so thus made the velocity will, as admitted, increase, but the increase will in no case be sufficient to cut off steam nine-tenths earlier than in the previous stroke. The range through which a load may vary with a given range of departure from normal speed of rotation will be a function inversely proportionate to that normal speed, if the range of action of governor or cut-off gear be as great per revolution in the fast engine as in the slow. If the greater part of two strokes, for instance, is required by the engine to accommodate itself to such a large change of load, the high-speed engine running at 500 revolutions per minute will have the advantage, inasmuch as one revolution, instead of being 1 per cent., will only be 0·2 of 1 per cent. The actual difference in the power of the slow and the fast engines to accommodate themselves to such great changes is not, however, anything like this, for the slow engines used for the purpose are fitted usually with a good cut-off gear which will act in as little time as the governing gear or, the fast engine, and consequently the fast engine will depart none per cent. from normal speed than the slow engine, while the inertia of the heavy engine and fly-wheel comes into play and gives it the advantage.

This, however, does not alter the fact that, either as large a range of regulating power is wholly unnecessary, or else that all existing sets of electric lighting plant must be very badly driven. Everyone knows that the latter is not the case, and electrical engineers amongst the rest. A variation in the load of 10 per cent. does not occur frequently, and it would be very injudicious to complicate an engine with governing gear that would vary its speed, and make it run like the engine of a steam steering gear. During the first two or three years of the recent great growth of electric lighting, electricians almost invariably made steady running impossible by one error. They underestimated the power required. No engine can run at a uniform speed with a varying load unless its maximum power is considerably above the maximum load. The first necessity to steady running is power, and this electricians have now learned or are learning. They have at last listened to the engine builders, or perhaps it may be said that a new race of engineers electricians—have come to work in hand or are called in to act in concert with the electrician. Instead of talking of 10 per cent. range of load, we talk only of the range of load resulting from cutting out or putting in a percentage of the lamps in circuit, or of the change of load that takes place gradually at arranged times, then we may say that a mechanical governor will meet the requirements. Portable engines with a common governor, but well above their work, have been called in to work installations, and have done it well; and every large engine builder of reputation has engines running in stock that will show a uniformity in working that cannot be deemed insufficient for any electrical purposes, provided the power is sufficient. The writer of the paper already referred to speaks of an electrical governor working "in perfect synchronism with the load or work to be done, and save the valve in its best position until a change is made either in the load or in the steam pressure." This is simply an impossibility. Perfect synchronism cannot characterise the movements of a driver and a driven if the driven is to be indirectly affected by a change in the speed of the driver. The driven must always follow the driver, and as no electrical governor can only act with difference of current or of potential, it must be indirectly connected to valves and pistons, or otherwise, with the steam cut-off, and hence it is impossible to yet prove that an electrical governor can control an engine better than a good governor and cut-off gear. The author of the paper describes an electric governor which he puts forward as a means of doing that which he says no mechanical governor and no self-regulating or compound dynamo can do. But it may safely be said that none of the practical electrical engineers would think of using the electrical apparatus he has described with the lead idea of either governing an engine or of saving lamps; its action would be less certain and no quicker than a mechanical governor, and an apparatus depending on small friction gear of the kind used, for its action would certainly save no lamps, which would not be safe with a compound dynamo driven by any engine.

Electrical governors might be usefully employed to govern the dynamo-electric machine, but it certain that nothing yet shown will do what a good automatic cut-off gear will not do.

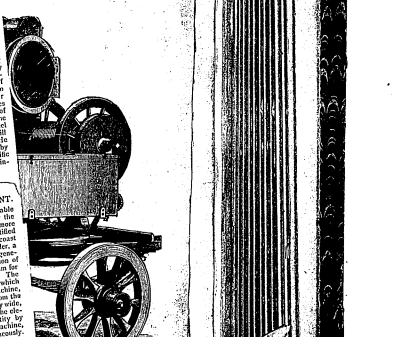
Next to Albert Memorial

EFFECTS OF HEAT ON THE ENDING QUALITIES OF IRON.

FEW weeks since we noticed the results of a interesting series of experi ndence of temperature on and steel and iron which ha F. Barnaby, the resident A ENGLAND." That gentleman has of tests with samples of low of accentuating the heat or be that is neither cold nor hot sh ding, and is unsafe to work ese are given in a copiously ry of which was kindly s ic by Mr. Barnaby upon sample ufactured by Messrs. C. Cam en and Co., the Butterley Comp ven, of the Milton and Elsecar I many experiments made, Mr. B number which show the general ults obtained. He observes y similar to steel in the fractures are different, for h temperatures shown by him part, fractures nearly wholly count of its homogeneous charac perature shown fractures in the ne of the bars or layers of which ir plates being made from a pile inside up of rious bars according to the weight, size, and ality of the plate required, when the ultimate rivet which occurs, these pieces of gauge ns steel, and only occur when the furnace or ce, &c., from the rusticity of the material, but verter, &c., from the rusticity of the material, but ly set by accident into the mass. It is not taken in n the case of iron, if great heat is not taken in making the piles for rolling, and also care be used in ge, laminations will frequently occur, as proved by nese experiments, Mr. Barnaby endeavoured to ascer- esting the iron at various degrees of temperature, and ain that which is most dangerous, and he is of opinion that at from 700° to 750° F. it is most liable to fail in bending than if bent cold. In his former port it is shown that these different temperatures have the effect of lineally increasing the tensile strength the material, and to show that the iron or steel is ecidifying, which together with the bending, will is considerably stiffened. This, he thinks, will account for the falling off in its bending qualities. He states that he has arrived at these temperatures by the colour of the heated iron as given in scientific erbooks. The report is of a very interesting and in- structive character.

PORTABLE ELECTRIC LIGHT PLANT.

THE interesting on page 336 illustrates a portable electric light plant of a type adopted by the French government for service in the army, more especially for throwing a powerful light upon fortified positions. It also intended as a Field notes. defence. The plant consists of a Gramme gome three-cylinder fleshwood engine, the invention of otor and regulator, a reflector, the invention of Colonel Mangin, of the French army, and a drum for carrying a certain length of conducting wire. The whole is mounted on a four-wheeled carriage, which may be drawn by two horses. The Gramme machine, which is of 3 horse-power, is driven direct from the engine. The electro-magnets are flat and very wide, and the bobbin between them revolves vertically by means of a commutator mounted on the machine, and the changes may be effected instantaneously. When the electro-magnetic parts of the machine are coupled for quantity, with an expenditure of 6 horse-power, the light produced varying from 500 to 1200 Carcel burners, or 5000 candle-power. When coupled for tension, the machine revolves with a velocity of 1200 revolutions per minute, with an expenditure of 8 horse-power,



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Tools. For certain purposes it has been found desirable to have a longer or thin; and arrangements are in progress now tank will be accommodate in Hanley, where the

In rating the limestone, it was not necessary to have a great number of experiments, each at a different speed; but usually only three experiments, each at a different speed, 2 feet, and 3 feet per second, were employed, at first. All the intermediate speeds were found by interpolation between these three experiments. The experiments with water at 1 foot, 2, and 3 feet per second, were made accurate to 5 per cent., and the rate curve of this water at the above the method of this water and of water at the the water, the speed, in feet per second, the abscissas represent the speed, in feet per second, the abscissas represent the ordinates the resistance in pounds. The curves of tares of tons. 10 and 15 tons are similar curves, and the ordinates were from the results of Mr. 1 by proportion between the values in the scales for 10 tons and 15 tons. It is unnecessary to explain this similarity any further, as the mathematical considerations which are found on submission will not be entered into here. Any small errors which may have been in the experiments may arise from draughts of air or from the system employed in measuring the water passing the measure. For obvious reasons the deflections of the jet of water from the vertical, as was at first tried in screen by testing the on the end of the rain rod, and making an experiment in the opposite direction after a sufficient interval of time. But it was found that this method, whilst eliminating the error from fortuitous variation of currents, due to draughts or other accidental causes, introduced a fresh error from the fact that there was always a current against the direction of the rod, due to the wake of the water disturbance, and to the wind of the truck in the previous run. To avoid this the practice now has been adopted to experiment in one direction (say from north to south), to return instantly from south to north at the same speed, and then thereby to obliterate as far as possible the effect on the current; then lift the rain rod to the next speed, and travel slowly back from north to south; and then replace the meter to face northwards, and repeat the experiments from south to north. By means of such a pair of experiments, or still better of two pairs, the two error due to currents.

Thanks having been passed to the authors of the paper,

Mr. Marvel and Mr. Tomlinson seconded a vote of thanks to the Institution of Civil Engineers for the use of their rooms. The resolution having been agreed to, the proceedings terminated.

RECENT PROGRESS IN DYNAMO-ELECTRIC MACHINES.*

By Professor SILVANUS P. THOMPSON, B.A., D.Sc., M.S.T.E., University College, Bristol.

(Concluded from page 434.)

The Victoria dynamo is self-regulating, having all the eight field-magnet coils doubly wound, with main circuit coils and shunt coils round each limb. The electrical details of this machine is wonderfully straight. In a 10" machine, with a mean diameter of coil of 14", the following figures were obtained:—Open circuit, 58 volts; 10 amperes, 59·5 volts; 20 amperes, 61 volts; 30 amperes, 62·7 volts; 90 amperes, 39·9 volts; 120 amperes, 20 volts. It will be seen that the current at first practically drops a little; but it is under these circumstances that the engine speed has been observed in practice, so that the cessation of the electrical between the mains is somewhat better than the figures would show. In actual practice, the regulation is marvellous. I have myself opened the circuit of a Victoria dynamo whilst at the very best speed, 1,200 revs., 100 lamps at a distance, I lamp attached to the terminals of the machine, and switching the mains with from two hundred to two thousand lamps were suddenly extinguished. The solitary lamp on the machine did not even flicker, and there was no shake at the brushes. The sparking was so slight as practically to fail whether this machine was on an open or short circuit, or whether it was doing full work. The lead was but very little at all loads. The brushes are of copper gauze, and as a result of this kind. According to measurements made by Mr. Crompton, the resistance of this electrical brush is 0·0000 the figures called, the factor of conversion of this brush is 99·2 per cent. The commercial efficiency is 89·5 per cent. These values assume the B.A. unit of resistance as the true ohm, which we have already probably proved to be not quite so high. Some of these machines are wound for 1,000 volts. The armature of these machines have a spherical activity, slightly lighter, and an efficiency slightly lower, than the Victoria machine. The field-magnet coils are wound with a single wire, and the field-magnet cores have undergone external energy in making the field. These remarks refer, of course, to a comparison between machines of the same size and speed. The Victoria dynamo to work at an equal electromotive force. A larger machine, however, having eight poles, and running at half the speed, and round the ring, has also been constructed by the Anglo-American Company. The armature (fig. 12) has two rings, each 12" in diameter, and 4" wide, and 1" thick. The ring has 192 sections, three layers of wire being wound therefore, between each pole and the adjacent pole of the surrounding ring. An end-on view of the collector is represented with three situated at 90°, 180°, and 270° distance from the first. Only two brushes are required.

Of either singular commentary upon the real superiority of such a machine as the Victoria ring-type of the Edmund type, and of the much-vaunted ring armatures to which we have so often referred, that, although the Victoria machine is a new and improved dynamo, and although the great merit of Edmund, is there is a fair-sizing armature, retaining within a crown of 12 poles. Elaborate illustrations of this machine, and of the details of the Victoria, will be found in the *Revue Industrielle* of January 9, 1884. From this article it appears that the Victoria dynamo of Mr. Gramme for new machines still requires some modification before it can take it quite a successful machine. I measured this dynamo myself, and found it to work quite as well as the multipolar dynamos of Mr. Siemens, and, moreover, nearly mending one another. The pole-pieces are of iron, round, nearly meeting one another. The armature is of Siemens drum form, with a single wire coil sparking at the brushes and leading of the collector segments. The field-magnet coils are of copper ribbon, and are not subdivided. Think of the friction of the brushes upon the collector, and the complication of the latter, and the labour of making and repairing it. I am quite prepared to say that in England we should not think of designing dynamo machines with such a collector. It might suggest itself to us to put two brushes at 90° from each other, with the two coils of field-magnet in circuit with them, and then established at the last Heer Brothers, of Zurich, and has been constructed by the Oerlikon Company. The machine has eight poles in the ring, two compound coils on each pole, and a collector of 128 segments. The speed is 1,000 revolutions, and the output 100 amperes at 100 volts. The present drum is 20" in diameter, and 100 volts. The present drum is 20" in diameter, and 10" long. There is little difference between this machine and the Victoria machine of Gülcher, and the Edmund machine of Schuckert-Mercadier dynamos, which, however, are not multipolar machines. The Victoria machine differs from the Edmund machine in the fact that the latter has a single wire coil on the armature, whilst the Victoria has a ribbon coil. The Victoria machine differs from the Schuckert-Mercadier machine in the fact that the latter has a single wire coil on the armature, whilst the Victoria has a ribbon coil. The Victoria machine differs from the Schuckert-Mercadier machine in the fact that the latter has a single wire coil on the armature, whilst the Victoria has a ribbon coil.

Before leaving the subject of ring-armatures, I should like to refer to a form, recently described by Professor Ayrton and Mr. Perry, of the total length of wire being reduced to the least possible limit, and the resistance to be a small fraction of the total resistance of the armature.

* Read before the Society of Arts, February 20, 1884. We are indebted to the Council of the Society of Arts for the use of the illustrations of the whole resistance of the circuit; and it is possible to reduce the waste due to eddy currents in the armature core without any gain whatever, if, by this spreading, the lines of force in the field. The real reason is, as the following: that the multipolar disc armatures appear to be a step backward, their excellent ventilation; second, their freedom from liability to be injured by the flying of the coils by the tangential inertia (often miscalled centrifugal force) at high speeds; and, third, their low retardation of current to scale; and then replace the meter to face northwards, and repeat the experiments from south to north. By this means of such a pair of experiments, or still better of two pairs, the two error due to currents.

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sane weight of rail the railway would carry a greater weight. For agricultural purposes it was a great advantage to have joints, so that there were no loose parts, because with unskilled labour these loose parts were easily lost. He was at present constructing a little railway seventy miles long for conveying wheat and passengers in the Bombay Presidency—a 20-lb. rail with a trough-formed sleeper, which imbedded itself better in the ballast than a elevated sleeper. The gauge was 2 feet 6 inches, and the engineering expenses had been less than one of the road. With such extreme lightness the safest principle was to follow that of the permanent and heavier gauge railways.

Mr. Hartley said he should have been glad if the author of the paper had given a little more data about M. Decauville's cars. The cars were very light, and were not calculated to stand the rough work constantly found upon contractors' lines. He thought the fixed points in portable railways were not very good. Supposing they had to turn off in the middle of a train of waggons with as a fixed point in order to avoid another every truck as it came along to the switch. It was far better to have a moveable switch, and so to diverge the waggons in the proper method.

Mr. Corbett, M.P., said although of course great credit was due to M. Decauville, he thought the greatest credit was due to Mr. Hamilton, who for many years used the narrow gauge railway in transporting iron ore steel from one department to the other at Crewe. His impression was that military men ought to adopt portable railways very much more than they had done. There was a committee sitting at the present time to enquire into the question of transport. The transport in nearly every war had broken down, and he believed that in the last Indian war the transport broke down tremendously. In the discussion in the House with reference to appointing the committee, he pointed out the mistake that the Government had made in the Egyptian war, that three days' provisions for four or five large locomotives, several first, second, and third class carriages and waggons; and when they got to Egypt they had not made the slightest arrangement to take them out of the ships, and not a single locomotive or waggon was landed.

Mr. Cochrane said, with regard to fixed points, it was a well-known fact that the object of these lines was not to attain high speed, and the greatest speed referred to in the paper was one of forty miles an hour. The lines in Tunis, because fixed points were admirably adapted for the purpose.

M. Flateau, in replying on behalf of M. Decauville, who was unable to be present, said that in the case of a line for farming purposes, the sleeper was much shallower than it would be made for heavier earthwork or for a tunnel. He had occasion to conduct an experiment a short time back, in which the line was put down on slanghter ground. The fish plates were not even bolted together; four locomotives and several trucks which were charged 2 tons each, were passed over the line, and although the rails could not find any place where the dish sleeper had given way. With regard to the shoe plates, the experience was that the use was not so very practical; after it had been lying for some time in the ground, it would get rusty and could not be replaced. M. Decauville had adopted several different systems of buffers, and in the case of heavy earthworks a spring buffer was used. As to the turntables, he had assisted at experiments in the transport of guns, and they found that a gun weighing 4½ tons could be turned perfectly easily.

The president then returned the thanks of the meeting to the author of the paper, and the proceedings were adjourned.

(To be concluded in our next issue.)

RECENT PROGRESS IN DYNAMO-ELECTRIC MACHINES.*

By Professor SILVANUS P. THOMPSON, B.A., D.Sc., of University College, Bristol.

TWELVE months ago I had the honour of delivering in this place a course of three Cantor Lectures on "Dynamo-electric Machinery." In the first of those lectures, the author of dynamos, and to follow out a physical theory of the machine, the construction of such machines has been begun. In the second lecture, a large number of actual machines, chiefly of the Gramme type, were described and compared with one another and with the theory. In the third lecture, the dynamo was considered in its function as an electrical motor. As the present paper has no connection or supplementary to the Cantor Lectures, it will be convenient briefly to review the features of progress which seem to-night under the heads of the different order of topics. I, therefore, take up first the subject of Theory. There are, in fact, three distinct theories of the dynamo: (1) a physical theory, dealing with the lines of force and the lines of current in which these two sets of quantities are made, without further enquiry into their origin or law, the basis of all the work done by Dr. Hopkinson; (2) a theory, founded upon the mathematical laws of electric induction and of theoretical mechanics; and (3) a mathematical theory, based upon the possibility of representing the action of a dynamo by a so-called "characteristic" of the machine, a theory originally devised by Dr. Hopkinson, and subsequently developed by Fröhlich, Dupuy, and others. The last of these theories is the simplest. It has not received any great or striking development in the past year, but it is well to be reminded that during the past year, this proved itself to be the most convenient for practical purposes in constructional dynamo-machines. One use only to which this was made of characteristics by Mr. Kapp in his articles on the "Counter" of "compound" dynamos, and still more recently by Dr. Hopkinson, in solving certain problems in the electrical transmission of energy, to see how invariable the method is.

In the algebraic theory much progress has been made during the past year; and there certainly was room for it. Mr. Swinburne's has published, in the *Journal de Physique* for July 1883, a long mathematical article, the object of which is to deduce by mathematical methods the dynamo, taking into account not only the action of self-induction in the circuit, but also that of the turns of the wound coils upon one another, and upon the armature. It is a question whether he has not still omitted some terms of quite as great an importance as those he has retained in the complicated formula deduced by him. Another paper, equally by Lesser Clausius has published in Wiedemann's *Annalen*, for which the author has, I suppose, a mathematical theory of dynamo electric machines for sale. I mention it only that I may continue to say, for years here, that any other yet put forward. Without shirking any of the mathematical difficulties presented by the equations of mutual induction between, and self-induction in, the various organs of the machine, and by the absolute incompetence of all our formula for connecting the magnetism of a molecule with the strength of the magnetising current, Professor Clausius has succeeded in putting the equations into a shape, not only for more evidentially from the point of view of completeness, but in framing these equations in a manner that must commend itself to every engineer. The relative simplicity attained by Clausius is, in fact, due to his total exclusion of a set of arbitrary constants, each one of which having values that must be determined by experiment, for each machine or type of machine. The number of new symbols then introduced is considerable; and it would be very desirable to find names for the separate constants to be determined. An excellent translation of the paper in the *Philosophical Magazine* of this year, and another is in process of publication in the *Electrician*, in which journal the series of articles on the theory of dynamo-electric machines from the pen of Professor G. J. Lodge is still continued. It cannot be said even yet that the mathematical theory of the dynamo is near completion. A further study of the papers by Professor Clausius is required to see whether this article will deal with some of those which the graphic method of Mr. Kapp has left untouched, for example, in determining the proper quantities of wire for the shunt and series bobbins for "compound" machines, and in finding the best shape to give to magnets and armatures.

Turning to the physical theory of the dynamo, there is much to record. Our knowledge of the lines of force which go to form the field magnets and armatures of dynamos, has received considerable additions from Professor Ayrton and Perry, Professor Fleeming Jenkin, Professor Fitzgerald, and others. The re is a good deal of this knowledge which is not yet published, and I have several new results to announce as the result of my own observations. Let me first refer to the end-plate matter mentioned in my Cantor Lectures, namely, the distribution of potential round the end-plate of an armature. Mr. W. H. Preece, in a paper read before the Society of Telegraph Engineers, has given a very full and clear account of the distribution of potential round the end-plate of the Siemens armature, and has explained the method of observing it. Mr. Preece has also described the method of observing the lines of force in the interior of the armature, and the lines of the dynamo, and the other lines of force in the interior of the armature, and the lines of force in the interior

1000-LIGHT FERRANTI ELECTRIC GENERATOR.

CONSTRUCTED BY THE HAMMOND ELECTRIC LIGHT COMPANY, LONDON.

(For Description, see Page 333.)

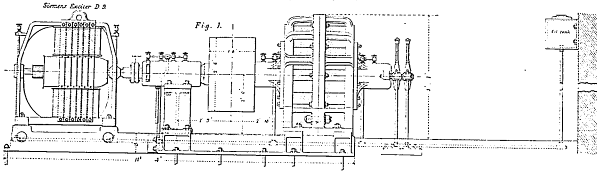


Fig. 1.

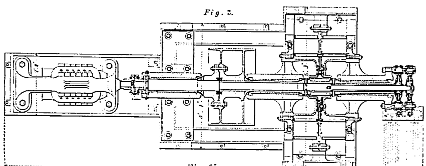


Fig. 2.

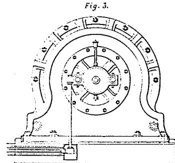


Fig. 3.

1000-LIGHT FERRANTI ELECTRIC GENERATOR.

CONSTRUCTED BY THE HAMMOND ELECTRIC LIGHT COMPANY, LONDON.

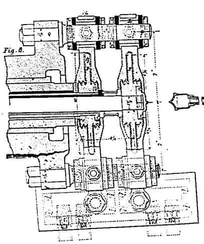


Fig. 8.

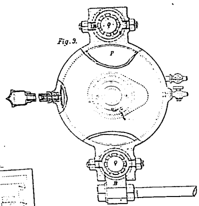
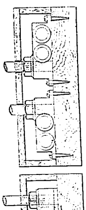


Fig. 9.



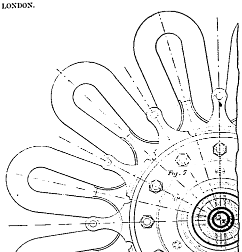


Fig. 7

ELECTRIC LIGHTING AT THE INTERNATIONAL HEALTH EXHIBITION.

No. VIII.

Since the close of the Fisheries Exhibition, Messrs. Ferranti, Thompson, and Ince have combined with the Hammond Electric Light Company, the business being carried on under the name of the latter firm. Consequently, although the Ferranti machine forms one of the most interesting exhibits at the Healtheries, it is now to be found in the catalogue under the name of the Hammond Company, who in addition exhibit a 40-light Brush machine, and thus provide both incandescence and arc lighting. The Brush lamps are mostly situated in the grounds, but neither they nor the dynamos by which they are fed, call for an extended notice at our hands, for probably no system has received so much attention from the press and has undergone less modification since its introduction than this.

The incandescence lighting is effected by a large Ferranti dynamo capable of supplying 1000 lamps, and similar in construction to that which we illustrate on the present page and on pages 332 and 336. The one shown in the engravings is part of an electric light plant recently erected by the Hammond Company at the works of Messrs. Colman and Co., of Norwich.

Fig. 1 is an elevation of the dynamo and the Siemens machine by which it is excited, mounted together on one baseplate. Fig. 2 is a sectional plan; Fig. 3 an end elevation of the Ferranti dynamo; Figs. 4 to 6 show enlarged sections of the armature driving boss and the connections; Fig. 7 is an elevation of the same; and Figs. 8 and 9 are sections of the new mercury collectors, showing the connections to the main leads. Since last we illustrated this dynamo considerable improvements have been made in its general construction. The main frame of this size of machine is made up of four parts. The sides have each 24 magnet cores cast upon them, and likewise carry, by means of arms or brackets (Figs. 1 and 3), an outer ring which serves to bolt the machine together and also to protect the armature. Round one-half of this ring a recess is turned and a corresponding projection is formed on the other, thus insuring that the two parts of the machine shall come true together. The bearing bosses are cast separately for ease in machining and also to allow of the bearings being got at easily.

The principal dimensions are shown on Figs. 1, 2, and 3. The weight of the cast-iron frame is 3 tons. When complete, without the pulley, the dynamo weighs 4 tons 10 cwt. The magnets are wound with double cotton covered wire 3.5 mm. in diameter, each coil being built on a separate mould and slipped on to its magnet core afterwards. The coils are forty-eight in number, and when coupled up in series have a resistance of 16 ohms. In practical use the two sides are coupled up parallel, and an exciting current of 30 ampères is used. The main bearings are 18½ in. long; they are of phosphor-bronze, close bushes being used. The spindle is Whitworth fluid compressed steel made hollow for lightness, and also to carry the main conductors to the outside collectors. Its diameter in the bearings is 4½ in. The enlarged section (Fig. 4) shows the method of insulating and fixing the armature and the conductors. For convenience the section in Fig. 4 does not follow a straight line through the armature, but is bent at the centre 30 deg. The reason of this is that each arm or division of the armature is different from the one at either side of it, and consequently if the section followed a straight line it would only illustrate one-half of the arrangements for the collection of the current.

Referring to Fig. 4, C is the hollow armature spindle, carrying within it two concentric copper conductors, to which all the copper strips on the armature are electrically connected at their ends. Upon this spindle there is mounted the driving boss D, which is fixed by two feather keys. The boss is made in two parts, like a face coupling, and the screws by which the halves are united bind it against a ring E on the shaft, and thus it is prevented from moving endwise. This boss has half as many arms as there are sinuosities in the armature, that is, six, and as shown in Fig. 4, it secures every alternate depression by a screw F. The armature is entirely insulated from both sides of the boss and from the screws by vulcanised fibre, which is represented in the engraving by the black spaces. Outside the driving boss, but electrically separated from it, there is the outer boss G G, likewise made in two parts, and furnished with six arms which correspond to the six indentations or depressions of the armature not provided for by the arms on the driving boss. These arms have rivets and ferrules, as shown in the lower part of Fig. 4, but unlike those on the driving boss they are connected, one by one, to one set of ends of the strips on the armature, and thus the boss G provides a path for the current on its way to the collectors.

The other set of ends of the strips are connected at equal distances to a brass star or shaping piece H which forms a foundation for the armature. The arms of the star, as shown in Fig. 4, are cut off on a level with the rivets F F. The current is led from the star by the studs I I to the ring J J, and through it and the studs K K to the copper tube L L, on the end of which there is mounted one of the collector discs. The other current passes, as already explained, through the boss G and the studs M, to the internal conductor N, and the other collector disc. These two conductors are first fixed in place with ivory distance pieces, and then a fluid non-conductor is forced into the intervening spaces, and in setting unites the whole into one solid mass.

The armature is of the well-known Ferranti type (Fig. 7) and needs no general description. In the machine from which our illustrations are taken, it consists of eight strips of bare copper tape 9.5 mm.

ruined the speculation, and the works are now falling into decay.

The Gatineau Valley Railway is chartered to turn off from the Pacific Railway at Hull Station, 118 miles from Montreal, and to run up the Gatineau valley to the Desert Village, a thriving settlement at the mouth of the Desert River, and up this latter valley the road will some day be continued by James Bay, the southern prolongation of the Hudson's Bay, where in the neighbourhood probably of the old Moose Factory, the first and for years the principal trading post of the Hudson's Bay Company, will arise the new northern emporium of Canada, 465 miles north of Ottawa. There is an immense territory surrounding Moose Factory, Mesonna, comprising some 300,000 or 400,000 square miles, about which till lately but little was known, but which gives promise of being some day valuable. Moose Factory is in the latitude of London, and the temperature, though more varied, will average for the year round about the same as London. To the north of it on the eastern shore of the Hudson Bay are large deposits of coal and ironstone, whilst further south copper and other minerals are known to exist. The forest has been in a great measure burnt off by successive forest fires, and the ground that once was productive has been taken possession of, over large areas, by mosses and parasitical plants that impoverish the soil, making it wet and pasty; but that there are in this great isolated district some valuable resources, the testimony of all who have examined the country abundantly proves.

The Aylmer branch also comes in at Hull Station from the north-east, eight miles long to the foot of Lake Duchisne, an expansion of the Ottawa River. From this lake the rapids commence which, almost continuous for eight miles, terminate in the great Chaudière Falls of the river, at the city of Ottawa. This branch is now being extended by means of the Pontiac and Pacific Railway, some 70 or 80 miles through Pontiac county, to form an outlet for the produce principally of the forest and the farms of that district, which has not yet been nearly so fully occupied as from the good land it possesses and its proximity to the city of Ottawa it deserves to be. Hull, on the east bank of the Ottawa, opposite to the capital, is itself a city, and contains a population of over 8000 souls. It is on this side of the river that most of the large sawmills are built whose operations are on such a vast scale that some of them employ directly and indirectly 2000 men, and in some of the lumber yards there are often to be found prepared for market 20,000,000 ft. of sawn lumber in different sizes, ready to be shipped at a moment's notice.

Crossing the great bridge over the Ottawa, of which at the time of its erection, a full description was given (see ENGINEERING, vol. xxxi., page 357), the Pacific Railway comes to the end of its first section in the city of Ottawa, 120 miles from Montreal. It is scarcely a quarter of a century since the little village of Bytown, named after Colonel By, the engineer of the Rideau Canal, which here joins the Ottawa River and continues its navigation to the foot of Lake Ontario, emerged from insignificance, being selected by the Queen to be the capital of Canada, and became the city of Ottawa. It is now rapidly becoming an important railway centre in addition. The Pacific Company have practically four lines radiating from it to Montreal and Aylmer on the Quebec side of the river, the main line to the west, and their Brockville line on the Ontario side. Besides these they will shortly have a fifth important line when the Canadian Pacific Railway is open, which gives them a railway communication of their own to Toronto, Lake Huron, and the west, and they are now working as lessees the old Ottawa and Prescott Railway to the St. Lawrence and Ogdensburgh. Besides this the Canada Atlantic opens up a new district to Montreal and the north, the Gatineau valley and the Pontiac lines will open up two entirely new and at present isolated countries to the north, and at least two other chartered railways will probably shortly be completed on the Ontario side of the river to the south and west. The city of Ottawa itself is fast growing in wealth and population, the increasing work in the Government offices, the large lumbering establishments, and the concentrating railways are all adding to its population and importance, whilst factories and other permanent establishments are gradually increasing its wealth and influence.

The route forward is by the old Canada Central Railway, which became absorbed into the Pacific

[illegible] CORRESPONDENT

in the spring of 1881 (see ENGINEERING, vol. xxxi. pages 236, 196, and 245). In December, 1877, the two old roads, the Brockville and Ottawa and the Canada Central, which was then a line from Ottawa to Pembroke, amalgamated under the latter name, and in the spring of 1878 entered into a contract with the Government to extend their road to Callander, from which place the Pacific Railway was to commence, for which work they were to have a subvention of 12,000 dols. per mile for 128 miles, or 1,440,000 dols. altogether, Mr. Duncan M'Intyre taking a sub-contract from the company to execute the work. In 1879 Messrs. M'Intyre and Worthington, after considerable negotiation, completed the purchase of the old railway, and assumed the control. It was then on the 5 ft. 6 in. gauge, very much run down, and the rolling stock almost worn out. The new owners at once proceeded to put the line in order, equip it with new rolling stock on the standard gauge, and replace the old iron with new steel rails laid 44 lb. per yard. The works were at the same time pushed forward on the extension from Pembroke west, and by the end of June, 1880, the rails were laid to Chalk River, 21 miles, and the bridge over that river was being built. The old rails and rolling stock of the wide gauge were used for this work, and after the line was ballasted, new steel rails on the ordinary gauge were laid down and the line transferred to the company. By December, 1880, the line was finished to Mackay, 48 miles, while construction trains were running 10 miles further. On the 18th October, 1881, the railway was officially opened to Mattawa, 91 miles from Pembroke, the members of the Cabinet and a large party taking their places on the opening train.

The route from Ottawa as now worked runs for 29 miles over the Canada Central to Carleton Place, which is now, however, a very much more important depôt than in the old days of the struggling pioneer line. The Brockville line, which turns off here to the south, being connected not only with the Grand Trunk as before, but is now continued through the town and by a tunnel or ferry which takes the freight cars across the St. Lawrence without breaking bulk, with the Utica and Black River Railway in the State of New York. By this means a new and short route is opened direct to Lake Ontario and New York, Boston, and Philadelphia, and to Montreal by Prescott and forward by the Intercolonial Railway to Chalk River, the end of the second locomotive division, 126 miles from Ottawa and 246 miles from Montreal. Pembroke was till lately the terminus of the line, but the alteration to Chalk River was made as a more equitable division of the distance and a faster day's work for the men. The line west of Pembroke closely follows the south bank of the Ottawa River, and all the way to Mattawa is close to colonisation road which is made by the Ontario Government in connection with the free grants of land laid out through this section. Round Pembroke and half way to Chalk River the land is pretty good, but as the traveller goes west it gradually becomes rougher, and less and less valuable. The construction of the railway involved in places some very heavy work, and some long cutting west of Mackay, 600 ft. in length, was over 20 ft. in solid gneiss. To secure stability, trestling had to be largely resorted to, over which the trains could work to be completed, leaving the filling up to be contracted for and delayed the work in hand. West of Chalk River the road is pretty good, but at the Deux Rivières, 30 miles from Pembroke, the traveller goes west it gradually becomes rougher, and less and less valuable. The construction of the railway involved in places some very heavy work, and some long cutting west of Mackay, 600 ft. in length, was over 20 ft. in solid gneiss. To secure stability, trestling had to be largely resorted to, over which the trains could work to be completed, leaving the filling up to be contracted for and delayed the work in hand. West of Chalk River the road is pretty good, but at the Deux Rivières, 30 miles from Pembroke, the traveller goes over a considerable range of hills, and the road is very rough and hilly, and the rolling stock shows worn out. The new owners at once proceeded to put the line in order, equip it with new rolling stock on the standard gauge, and replace the old iron with new steel rails laid 44 lb. per yard. The works were at the same time pushed forward on the extension from Pembroke west, and by the end of June, 1880, the rails were laid to Chalk River, 21 miles, and the bridge over that river was being built. The old rails and rolling stock of the wide gauge were used for this work, and after the line was ballasted, new steel rails on the ordinary gauge were laid down and the line transferred to the company. By December, 1880, the line was finished to Mackay, 48 miles, while construction trains were running 10 miles further. On the 18th October, 1881, the railway was officially opened to Mattawa, 91 miles from Pembroke, the members of the Cabinet and a large party taking their places on the opening train.

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Mattawa is a pretty little village of yesterday. Here the great River Ottawa majestically sweeping down from the north, for it has here 500 miles from its source, is joined by the Mattawa from the west in a broad beautiful sheet of water from whence the combined stream continues its eastern course towards the ocean. On the point of land between the two rivers, the Hudson's Bay Company built a fort, which still remains surrounded by their reserve, whilst the village clustering round the railway station is on the south side of the Mattawa. It has already a population of 1000, and as this will always be the place where the lumbering supplies of the Upper Ottawa will leave the rail-

[illegible] CORRECT NUMBER OF DIVISIONS on [illegible]

way and take to the more primitive canoe, besides being the very paradise for tourists and sportsmen, this place will always have a steady permanent business of its own. There are already two sawmills erected here, and it is still a matter of doubt whether as railways are extended towards the great forest, sawmills will not work nearer to the source of their business, and send their sawn lumber by the railway rather than logs by the water. The lumbering on the Ottawa is an immense business; and it is estimated that the total cut of timber in this valley for the season of 1883 was not less than 800,000,000 ft., board measure, over 1,000,000 tons weight of boards. This is exclusive of the enormous quantity of railway ties or sleepers, telegraph poles, fencing, and other special timber that is procured to an enormous extent upon some of the tributaries of the great river.

After leaving Mattawa the country somewhat improves in appearance, and some very good farms are already dotting the landscape. Over this country the road was pushed rapidly, and by August of 1882 Callander was reached, or rather the point 120 miles from Pembroke, where Callendar was to be, and where the Pacific Railway proper was to begin, but as the whole system was now merged into one concern this is now only a roadside station of very unpretending importance. By the end of the year the rails were laid to the North Bay of Lake Nipissing, 19 miles west of Callender, 148 miles from Chalk River, and the end of the third locomotive division into which the whole road is cut up for the convenience of working.

TESTING DYNAMO MACHINES.

(Concluded from page 372).

Kempe and Fergusson's Electrical Resistance Counter.—The metal frame F F F (Fig. 5), into which is mounted the whole mechanism, is supported within a wooden casing. In the frame F F are fitted seven pinions *a*, *b*, *c*, *d*, *e*, *f*, *g* (Fig. 6), each of the pinions *b*, *c*, *d*, *e*, *f*, *g* is fitted a small cam *o*; and to the pinions *a*, *d*, *c*, *f*, *g* is fitted a multiplying wheel having ten times as many teeth as the pinions. These multiplying wheels do not gear into the pinions as in other counters of similar construction, but are free of each other. Upon the frames F F is fixed, free to move, a second frame A A, which carries five wheels *h*, *i*, *k*, *l*, *m*; these wheels are of the same size as the multiplying wheels, and are so arranged as to connect the first multiplying wheel and the seven pinions with each other. Whenever the instrument is in operation, the magnet M attracts and releases its armature, and the second lever L actuates the ratchet wheel R, and so sets the pinions *a* in motion; the counter will thus act on any ordinary electrical counter. We shall now describe the very ingenious mechanism by which the pinions *b*, *c*, *d*, *e*, *f*, *g* with their pointers, are placed at zero.

On turning the shaft H by the handle the cams C¹ and C² fixed to the shaft, are brought into action. The cam C¹ pushes the frame A A to the right, causing it to recede from the main set of pinions, whilst the two pins *p* and *p*¹ are fixed in the frame A A, and slide in the V-formed recess *x x* in the frame F F. Thus the main set of pinions and multiplying wheels are disengaged and become free. On further turning the handle the second cam C² becomes engaged in the bar B B. This bar has seven recesses in which, when at zero, the seven cams *o*, *o*, *o*, *o*, *o*, *o* can turn unhindered; but, whenever this bar is pushed by the cam C² to the left, the small cams *o*, *o* will be forced in the direction that their pins will allow, that is, by the cams thus pressed on the pinions and the pointers at zero, as shown in Fig. 7. On further turning the handle the cam C² disengages itself from the frame A A, and the bar B B is pulled back by the small springs S¹ S², and the five wheels engage again into the pinions and five multiplying wheels, which are still held by the bar B B. But as soon as the whole of the wheels engage in gear the cam C² releases the bar B B, which is then pulled back by the spiral spring S³, thus leaving the small cams *o*, *o*, *o*, *o*, *o*, *o* free, and the counter is ready for a new experiment.

This very interesting and original instrument has been of great service during the tests before us, and whenever a perfectly steady working engine is used during the experiment, no further and more reliable counter is required.

The engine employed by Mr. Heinrichs in these tests was an eight horse-power portable by Messrs. Marshall and Co., of Gainsborough. The speed could

London – Engineering – May 7 '85

THE EDISON SWAN EXHIBIT.

The Edison and Swan Company undertake the lighting of the entrance, the vestibule, and the South Court. In the former they place 400 Swan lamps of 16 candle-power, and in the two latter 200 lamps, partly of Swan and partly of Edison manufacture. The lamps will be placed alternately on separate circuits, one-half being driven by Edison-Hopkinson dynamos and the other by Edison "D" dynamos, the two batteries being on different engines, so as to avoid all the lights being extinguished at one time. The Edison-Hopkinson dynamos are the long 10-in. type designed to run at 800 revolutions and feed 450 lamps, requiring a current of 110 volts.

The original Edison dynamo has received great improvement at the hands of Dr. John Hopkinson, and while its general appearance has remained the same, its output has been very largely increased as the effect of new proportions in the magnets, pole-pieces, and coils. The result is that while the size of the machine has been decreased, and its weight reduced, the number of lamps that it will feed has been largely augmented and the efficiency has been raised. The latest type of machine is illustrated on page 445, where there is represented a dynamo designed to furnish a current of 250 ampères with an electro-motive force of 55 volts. The exterior dimensions are: Length, 56 in.; breadth, 36 in.; and height, 60 in., the net weight being 32 cwt. The resistance of the magnet coils is 7.54 ohms, and that of the armature .059 ohm. The commutator has forty divisions formed of copper bars insulated with mica, and the helix runs at 900 revolutions per minute. The efficiency of the machine is deduced from the following figures:

	Watts.	Horse-Power.
Total electrical power developed	16,246	21.78
Loss in magnets	691	0.54
,, armature	730	0.96
Power available in outer circuit when run with a current of 275 ampères and an electro-motive force of 55 volts ...	15,315	20.28
Hence		Per Cent.
Electrical efficiency	=	93.1
Loss in magnets	=	2.4
,, armature	=	4.5

A machine of this description will be shown in the Eastern Arcade, which has been run continuously for a fortnight without any stoppage whatever; at the end of this time the commutator was found to be quite smooth, and the brushes to have only worn $\frac{1}{16}$ in. There are two brushes on each holder, and they are independently adjustable.

There will be five L. Edison dynamos (page 445), each feeding 150 lamps. This type of machine needs very little explanation, as it has already been before the public for a long time. There are four columns on the field magnets, and a switch is mounted on the upper crossbar.

The general appearance of the Swan and Edison lamps is shown by the views on page 447, the former lamps being shown singly under a shade, and the latter in a five-armed group.

Messrs. Mather and Platt, of Salford, were from the first associated with the Manchester branch of the Edison Company, and built dynamos for them. Recently, however, they have brought out a dynamo machine of their own, and have devised several forms of driving gear designed to supersede the use of excessively high-speed engines. The engine and machine that this firm is showing at South Kensington is illustrated in Figs. 1, 2, 3, and 4, page 445, from which it will be seen that a pair of diagonal cylinders 8 in. in diameter by 10 in. stroke, drive on to a crankshaft fitted with a fly-wheel which is connected by a belt to the pulley on the dynamo. In order to give the strap more grip, it is carried round a tightening pulley riding loose on a stud fixed in a swivelling arm. The lower end of the arm is formed into a wheel quadrant gearing into a worm carried on a spindle at the end of the bed of the dynamo. By turning a handwheel on the spindle, the arm, and with it the pulley, is raised or lowered, and thus the strap is wrapped less or more round the pulley, as required, giving a neat and effective strap driving in a small space. The engine makes 175 revolutions per minute, and the gearing is in the proportion of 6 to 1. The dynamo is a modification of the Gramme machine, following the lines adopted by Dr. John Hopkinson in his reconstruction of the Edison generator. The magnet cores are of wrought iron, and are fitted with pole-pieces of enlarged section, the lower of which forms the bedplate of the machine. The commutator is formed of forty bars of toughened brass, and is of considerably larger section than is usual; it is provided with two brushes at each side, capable of separate adjustment, and arranged with elastic forks and thrust and butt contact. The machine is compound wound, and by reason of its efficient ventilation is capable of carrying a very heavy current, the one illustrated being designed to feed 200 lamps. The following is a list of Mather and Platt's dynamos:

No.	Number of 16-Candle Power Lamps to be fed.	Electromotive Force in Volts.	Current, in Ampères.	Speed.	Extreme Dimensions. Length.		Breadth.		Height.	
					ft.	in.	ft.	in.	ft.	in.
1	50 to 80	50	50	1650	2	7	2	1	2	6 × 4
2	81 — 120	50	75	1350	2	8	2	2	2	10 × 4
3	121 — 150	100	75	1650	3	1	2	6	3	0 × 4
4	150 — 200	100	100	1350	3	4	2	8	3	10 × 6
5	201 — 250	100	125	1050	4	0	3	0	4	1 × 6

A machine of this type, capable of feeding 250 lamps, is employed in lighting the stores occupied by the machinery of the Edison and Swan United Company, and for working lamps in connection with various ship fittings.

Cassell's Magazine
London – May 1885

E. G.

Dynamos and Danger.

Dynamo-electric machines giving what are called "high tension currents"—that is to say, currents of high electro-motive force, say 1,000 to 3,000 volts—are known to have proved fatal to persons receiving the shock through their bodies by touching the two poles of the machine, or bare wires connected to them, at the same instant. It is not easy to suggest a remedy for this sense of things unless it be carefulness, combined with protection of the wires, or the disuse of such machines altogether, since they are not absolutely necessary to electric lighting. M. d'Arsonval, a French electrician, points out, however, that most of the accidents which have occurred were due to the "extra current" set up at the moment of making or breaking the dynamo circuit, and not to the normal current itself. He also proposes to correct this evil by absorbing these extra currents into secondary batteries, or voltameters, connected in series between the poles of the machine or across the two wires of the circuit. These voltameters are made of small lead plates immersed in dilute sulphuric acid, and as many are taken as will give a counter electro-motive force equal or greater than that of the dynamo. Having a high resistance they do not "shunt circuit," or shunt aside the current; but at the moment of closing or opening the circuit of the dynamo they absorb the extra spark, thus guarding the engineer of the dynamo against the evil effects of a shock from it.

Menlo Park Scrapbook, Cat. 1028

No. 18. "Phenomena General"

This scrapbook covers the years 1873-1881. It contains clippings about various phenomena, such as electrical phenomena, unusual atmospheric conditions, the aurora borealis, and the conductive properties of selenium. There are 140 numbered pages.

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Phenomena

18

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Feb 1976 Feb 15 76

ELECTRICAL DISCHARGES IN VACUO.*

By WARREN DE LA RUE, HUGO W. MÜLLER, and WILLIAM SPOTTISWOODE.

Some results obtained in working with a chloride of silver battery of 1080 cells, in connection with vacuum-tubes, appear to be of sufficient interest to induce us to communicate them to the Society, in anticipation of the more detailed account of an investigation which is now being prosecuted, and which it is intended to continue shortly with a battery of 5000 cells, and possibly with a far greater number.

The battery used up till now consists of 1080 cells, each being formed of a glass tube 6 inches (15·24 c.m.) long and 1 of an inch (2·0 c.m.) internal diameter: these are closed with a vulcanized rubber stopper (perb), perforated excentrically to permit the insertion of a zinc rod, carefully amalgamated, ⅛ to ⅜ (0·32 c.m.) of an inch in diameter, and 4·5 inches (11·43 c.m.) long. The other element consists of a flattened silver wire, passing by the side of the cork to the bottom of the tube, and covered—at the upper part above the chloride of silver, and until it passes the stopper—with thin sheet gutta-percha, for insulation, and to protect it from the action of the sulphur in the vulcanized corks: these wires are ⅛ of an inch (0·16 c.m.) broad and 8 inches (20·32 c.m.) long. In the bottom of the tube is placed 232·25 grains (14·59 grms.) chloride of silver in powder,—this constitutes the electrolyte; above the chloride of silver is poured a solution of common salt, containing 28 grms. chloride of sodium to 1 litre (1752 grains to 1 gallon) of water, to within about 1 inch (2·54 c.m.) of the cork. The connection between adjoining cells is made by passing a short piece of india-rubber tube over the zinc rod of one cell, and drawing the silver wire of the next cell through it so as to press against the zinc. The closing of the cells by means of a cork prevents the evaporation of water, and not only avoids this serious inconvenience, but also contributes to the effectiveness of the insulation. The tubes are

* A Paper read before the Royal Society.

height of fall 0·15". M. Spring thinks the formation of the drops has no influence on the velocity of flow; still, each of his experiments shows a diminution in the flow from the free orifice. M. Spring finds further that the influence of temperature adds itself to that of height of fall.

Coming now to the electrical phenomena, M. Spring demonstrates directly the production of electricity through formation of drops of mercury in the flow of the liquid from capillary tubes, and he proves that this production is not in the least due to friction of the mercury in the tube. This quantity of free electricity produced is of course very small, and only rendered sensible by apparatus of extreme delicacy, the idea of which was borrowed from M. Zollner. M. Spring was not able to assure himself experimentally that the mercury dropped is heated—although that an electric current traversing the mercury column from the exterior to the interior produces a very considerable increase and the inverse current a decrease in the quantity of mercury flowing out; and he was careful to eliminate all the secondary actions whose intervention was to be suspected. This influence exercised by electricity on the flow of mercury drop by drop leads him to conclude that the formation of the drops must be the cause of a production of electricity.

Lastly, he has observed that it is in dry atmosphere not having any electrical action on the mercury that the velocity of flow is greatest, and that there is a sensible retardation if the atmosphere is moist, or if it is of a nature to be capable of combining with mercury. According to him, the heating produced by neutralisation of the two electricities in the mercury drop, when these electricities have not to produce decomposition in the atmospheric medium, diminishes the capillary constant, and thus produces an increase in the velocity of flow; while, if the electricity of the drops is employed to separate the constituent elements of the surrounding atmosphere, this heating no longer exists, and there results a diminution in the velocity of flow. Perhaps to this the modifications in the state of aggregation of bodies which may be connected with the phenomena called catalytic. The above analysis will be sufficient to show the importance of the phenomena discovered by M. Spring in relation to the study of molecular actions.

LARY TUBES, AND THE ELECTRIC PHENOMENA ACCOMPANYING IT.

In a former communication to the Belgian Academy M. Spring enunciated, as a principle, that *every change in attractive energy is accompanied by a change in the electric state of bodies*—a principle of vast application, if generally verified. In a further memoir he investigates the electrical phenomena accompanying the flow of mercury in capillary tubes, with the view of verifying one of the consequences of this principle.

Considering the velocity of the flow, he studies the influence exercised on it by temperature, the capillary mesniscus, electricity, and the surrounding atmosphere. The influence of temperature is very sensible, with a height of fall of about 0·37". M. Spring has found that the weight of mercury flowing at the successive temperatures of 0°, 20°, 55°, 85°, were represented by the numbers 212, 228, 248, 261.

The influence of capillary mesniscus is also well marked; thus, with a height of fall of 0·39" M. Spring found that the weight of mercury which flowed with the orifice immersed was about 342 grammes, with free orifice 334. This influence is more considerable the less the fall, till the limit is reached at which the flow by drops ceases with a

Production of the Electric Effluve.—M. A. Bollet.

—The author, in experimenting upon the electrical action of the effluve, makes use of the following arrangement:—Two narrow tubes, filled with graphite in powder and calcined, and are parallel to and distant from each other. They are inserted with their whole length in a test-tube about 18 centimetres in length, and they terminate each with a platinum wire communicating with the exterior. The wire of one of these tubes traverses the test-tube to its upper part; the other is bent back in a downward direction. Two orifices enter the test-tube: the one exists at the summit, and the other penetrates to 2 or 3 centimetres of and the space to collect them. The effluve is produced in the space between the two carbon conductors.

Telegraph Jour. Feb 15 1878
Nat. Dec. 15 78

Electric After-currents in Iron Rods.

It was discovered by Villari that if a rod of iron or steel through which a current has passed be agitated, an after-current is again set up in the same direction as the original current. He explained the phenomenon on the hypothesis that the rod is transversely magnetized by the current, and employing Ampere's theory of molecular currents, that these currents arrange themselves in concentric circles round the axis of the rod. Now, when the rod is agitated after the interruption of the current, the molecular magnets tend to mingle themselves irregularly again, and in doing so generate an induction current called by Villari an "agitation current." Prof. H. Streintz, at the Royal Academy of Sciences of Vienna, has recently, shown how to calculate the magnetic force exerted on the molecules exercuts by the original current in the rod. The problem is a case of Ampere's second theorem, that a rectilinear current of infinite length acts upon a pole of a magnet with a force inversely proportional to the perpendicular distance of the pole from the conductor. In the case in question we have to calculate the action of a circular surface (the rod being cut by) filled with uniform mass upon a mass-point situated in the surface. But a circular line with uniform mass exerts no action on a point situated in the enclosed surface, while it acts on an external point in the same plane as if the mass of the circle were collected in the centre. Therefore the force exerted upon a magnetic pole situated at the distance r from the axis $\rho = \frac{kr}{\pi}$, in which k is a constant, and π the semi-diameter of the rod. The total moment upon all the molecular magnets contained in the rod is then $\pi = \kappa / a$ where κ is a constant and l is the length of the rod.

Telegraph Jour. Nov 15 1878
Nat. Nov 15 1878

Producing the Electric Glow.

M. Boillot has invented an apparatus which gives a very bright glow in gases with a comparatively feeble electric tension. It consists of a glass tube 50 centimetres long and several millimetres internal diameter, filled with powdered carbon, and hermetically closed; but having a platinum electrode sealed into each end. This line tube is enclosed in a second medium sized tube so as to leave a very narrow annular space between. These concentric tubes are then enclosed in a third wider one, and the space between the second and third tubes is also packed with powdered carbon. An electrode is also inserted into this carbon, and the ends of the latter are stiffened with shellac to prevent them falling out. The extremities of this larger tube are open. Different gases are then passed up the annular space between the inner and middle tubes, and when the terminals of the poles of an induction coil, fed by several cells, are connected to the carbons, a phosphorescent glow is seen to traverse the gas all along the tubes. By means of a medium sized induction coil and three or four Bunsen cells, M. Boillot has produced 20 milligrammes of ozone for every litre of oxygen gas submitted to the discharge.

Telegraph Jour. Jan 15 1878

Action of Light on Selenium.

Recent experiments of Mr. R. Sabine on this subject (see the *Phil. Mag.* for June) tend to prove that the impinging light effects a true decrease in the resistance of the selenium, rather than this of electro-motive force in the same direction as that of the battery.

Telegraph Jour. Jan 1 1878
Elec Jour Jan 1. 1878

ON THE INFLUENCE OF LIGHT UPON THE CONDUCTIVITY OF CRYSTALLINE SELENIUM.

By Werner Siemens.

The property of crystalline selenium first described by Willoughby Smith, and more closely studied by Sale,* viz. that in the illuminated condition it is a better conductor of electricity than in darkness, I have further investigated, and established the correctness of the facts. The specific conductivity however, of selenium made crystalline by heating to 100° or 150° C. is very slight and extraordinarily variable; the augmentation of the conductivity by illumination it also very inconstant; no dependence of the conductivity upon the illumination. But by protracted heating of amorphous selenium up to the temperature of 210° C., and *perature at 210° C.* (at which, with longer duration crystalline state), I succeeded in producing another modification of crystalline selenium, which possesses and permanently retains a considerably greater conductivity, and conducts electricity after the manner of metals, its conducting-power diminishing with rise of temperature. Also the action of the light upon it is far greater, and appears to be perfectly constant. By fusing into coarsely granular selenium two flat spirals of wire, at a distance of about 1 millim. from each other, between two thin plates of mica, I produced an extraordinarily sensitive photometer. With it obscure heat-rays are *without direct influence* upon the conductivity, which *is diminished by* heating the selenium; while diffused daylight doubles it, and direct sun-light in some circumstances raises it to *more than tenfold*. The augmentation of the conductivity of the coarsely granular selenium by illumination proceeds with extraordinary rapidity. Likewise the lessening of it on shutting off the light appears to commence instantaneously; yet a longer time elapses before the state corresponding to darkness is completely restored. The increment at the commencement of illumination is not proportional to the light-intensity, but a function of it which comes nearer to the ratio of the square root of that intensity.

I refer communicating details on this interesting property until the conclusion of my experiments, thereby fortifying that I hope to be able to utilize them for the construction of a reliable photometer. —*Monatsbericht der kön. preuss. Akademie der Wissenschaften zu Berlin*, 1875, p. 280.—*Philosophical Magazine.*

upon. No information was given to the meeting as to the ... likely to be pressed by the Government of the United States with regard to the concession obtained by the Direct Company under 41st. was, at least, a misapprehension. This is the more surprising, seeing that Mr. Pender might have justified his opinion by that of an American Senator, which has recently taken up the cudgels on behalf of the Company. We learn from that journal that "the authority for foreign conditions under which cables connecting foreign countries may be loaded on the shores of the United States, if it exists at all, resides solely in Congress, and until Congress sees fit to legislate on the subject, which it has not yet done, there is no power which can in any way interfere with the continental operation of the cable at Duxbury." But with all deference to our contemporary, this statement, at any rate, is in one sense decided error. We were inclined to think that if the matter was put it is represented to be in the columns of the *Journal of the Telegraph*, Mr. Pender would have long since secured the shareholders of the Direct Company that they had nothing to fear from the Assertion Government. His silence on this recent meeting, with such a piece of knowledge, has been severely startling. Besides, our contemporary evidently only guesses as to what Congress can do and what it cannot do, or the words, "if it exists at all," would surely have been left out of an otherwise positive declaration.

There might have been some little unpleasantness at the extraordinary meeting of the Mediterranean Extension Telegraph Company; but the shareholders present gave Sir James Carmichael the "cheer bill of health" he asked for, and the report and accounts were adopted. We notice it was asked why there was only one auditor to the company, and the reply was given that the company could not afford a second. Although the meeting otherwise appointed an honorary auditor, we are disposed to think that there might, under any circumstances, be two paid auditors. There is such a thing as being very wise and penny foolish.

We suppose the member of the board of the Eastern Extension Telegraph Company, who is shortly to be dispatched to Australia, is not the chairman. Important as the duplication of the company's cable may be, Mr. Pender probably feels that his presence in this country is of more importance at the moment. Otherwise, we should think the journey would suit him, and he would certainly return home with a greater popularity on telegraphy. The company is, we learn, soon to have purchased by the Australian Government, nor is it likely to buy, unless the Australian Government make a very tempting offer.

Since 1873 there have been a good deal of discussion respecting the failure of the negotiations between the Sheffield and the Great Northern and Midland Railway Companies; but the interest is now dying out. The agreement signed by the directors of the Sheffield Company was, of course, intended for a defeasor, but it utterly failed in its object. It is all very well for Sir Edward Watkin to assert that the Sheffield dividend will be 4½ per cent. for the current half-year. Probably it may. But to make that probability the ground of holding out for a perpetual dividend, when since 1849 the Company has never declared a dividend of 4 per cent., was manifestly absurd. The directors of the Great Northern and Midland Companies would have but the confidence of their shareholders at once had they consented to entertain the demand at all.

The directors of the Tower Circle Completion Company have, we believe, obtained the money they required, in spite of what we have stigmatized as unfair opposition on the part of the Metropolitan Board, and, subsequently, hostility from the City editor of the *Times*. In the statement which have from time to time been passed upon Mr. Crump we do not agree. We are persuaded that the influence of the *Times*' City articles is, on the whole, a potent for good than in days of yore, and we do not doubt that most of the persons who denounce Mr. Crump as an ignoramus or cuplines, have been wounded, in some way or other, by his righteous maledictions. But every now and then the public, and respecting the Inner Circle Completion Company we do fancy Mr. Crump made a mistake. It is true that the outset palpable that he did not look upon the scheme with favour, and although Mr. Parkes, in a temperate remonstrance, appeared to us to refute his criticism, he not only did not offer to make amends, but gave the Company another and more cruel stab. That the directors have succeeded in getting what they wanted, is not because investors are not guided by what the *Times* says, but because, for once, the City editor was manifestly wanted in argument.

"The Railway Autocracy; a question of vital importance to shareholders and directors alike overlooked," is the title of a somewhat stinging pamphlet from the pen of Mr. Edwin Phillips, the editor of the *Railway Service Gazette*. We cannot, however, agree with Mr. Phillips' main proposition which is, that a railway board can do anything, and we regret that Mr. Bass should have endorsed the theory, cleverly worked out though it be. We may, on another occasion, examine some of the arguments used in support of it.

SELENIUM.

By T. Fletcher, A.S.T.E.

The element selenium, owing to its great rarity and consequent costliness, has hitherto been but little known; and, but for the science of electricity, it would probably have remained so, more especially as neither it, nor any compound of it, has been employed in the arts. Of late years, however, a considerable amount of interest has attached to selenium in consequence of certain very remarkable characteristics which have been noticed in making experiments with it for electrical purposes. It is thought, therefore, that a slight sketch of these characteristics may not be out of place in these columns.

Selenium (*Σελήνη, the moon*), was discovered by Berzelius, and belongs to the class of elements which, like phosphorous, &c., appear to rank midway between the metals and the non-metals. It is obtained chiefly from Sweden, where it is found in certain pyrites used in the manufacture of sulphuric acid.

Selenium, like phosphorous, is susceptible of existing in three allotropic conditions (1), a red amorphous powder, fusing a little above 100° C.; (2), vitreous, brittle, deep brown, with metallic lustre, tasteless and odourless, a non-conductor of heat and electricity: this form becomes plastic above 100° C., and if heated to a little over 200° C. becomes crystalline and conducting: (3), crystalline rhumboidal prisms, which melt at 217° C. and boil at 700° C., and which can be obtained from the solution in bisulphide of carbon. It is only this latter form which is fit for electrical use. Its specific gravity is about 4·8.

During the laying of the 1865 Atlantic Cable, Mr. Willoughby Smith, who was in charge of the electrical department, devised a method of testing, since well known to electricians, by means of which com-

over

Death has been busy of late among our railway telegraph superintendents. Mr. Edward Cripps, of the London, Brighton, and South Coast Railway, died on May 15th, and Mr. Henry Mesan, of the Lancashire and Yorkshire, died on the 20th ult.

POLAR AURORAS.

By M. J. PLANTÉ.

"Nothing should be neglected which can bring about a complete conviction of the theory of the forces of nature, and cause the uncertainty of investigation to give place to the security of known truth. Should we, for example, be so sure of the theory of the rainbow as we are reproduced that brilliant phenomenon with all its peculiarities, by means of a jet of watery spray thrown up in full sunshine? The experiments of the laboratory are, though on a small scale, useful, and therefore to be valued."

These words, spoken by an illustrious member of the Academy, M. Babinet, encourage me to pursue the examination of the analogies between the effects of electric currents of high tension and the great natural electric manifestations. The experiment of De la Rive has already demonstrated the connection of polar auroras with terrestrial magnetism; but it does not sufficiently explain all the circumstances which accompany them. In the experiments described in the present paper, the electric stream flows in connection with aqueous masses as in the atmosphere, and a series of phenomena, completely analogous to the various phases of polar auroras, are observed.

1. If the positive electrode of the powerful secondary battery used in these experiments is brought into contact with the wet sides of a vessel containing a solution of salt and water, into which the negative electrode has been previously inserted, the following phenomena, varying as the distance from the liquid is increased or diminished, will be observed: either a crown formed of luminous particles making a circle around the electrode (fig. 1), or an arc bordered with a fringe of brilliant rays

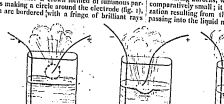

Fig. 1.

Fig. 2.

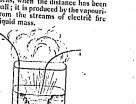

Fig. 3.

(fig. 2), or a wavy line which vibrates rapidly (fig. 3). This undulatory movement especially, offers a complete analogy with that which takes place in the aurora, been compared to the windings of a serpent, or to the motions of drapery shaken by the wind.

2. Although yellow light is predominant in these experiments, in consequence of the employment of salt and water, there have been observed, at these points where the water arising from the condensed vapour is less charged with salt, purple and violet tints similar to those of the aurora.

3. The rays of the luminous arc are produced by the flow of the electric stream into the liquid; the vacuum which results becomes again gradually filled up, new rays are formed, and an explanation is thus furnished of how the jets of light in the auroral *dark arc* appear to be thrown out and received every moment.

4. The circle or dark segment formed, in the auroras, by the mist or the nebulous veil which the electric stream meets with, corresponds to the humid circle or segment which, in the experiment, surrounds the electrode, and round which the vesicular current spreads itself.

5. The form of the arc in the voltameter is due to the fact that the liquid does not entirely surround the electrode; but, if the wire is more deeply immersed, waves and complete luminous circles are produced; just as in the auroras where the arc is often considered as the part, visible to the observer, of a complete luminous circle.

6. The liquid is violently agitated by the electric blast, eddies and luminous rings are formed by the shock of the electrified waves one against the other, and, if only a small quantity of liquid is used, a luminous cloud-like mist takes place, corresponding with that fluctuation of light which also characterizes the polar auroras.

7. The watery vapour is produced all the more quickly and in greater quantity, as the electrode sinks more deeply in the liquid. This phenomenon, which the strongest batteries of static electricity hardly give evidence of, is worthy of particular attention; for it explains, in a natural manner, the abundant falls of either rain or snow which have always been observed in connection with polar auroras.

8. The noise which accompanies these experiments corresponds with that which has often been heard during auroras, when the distance has been comparatively small; it is produced by the vaporization resulting from the streams of electric fire passing into the liquid mass.

9. The magnetic disturbances caused by auroras are reproduced in the experiments by placing a magnetized needle near the circuit. The deviation increases or diminishes as the luminous arc is more or less developed in the liquid.

10. The facts mentioned indicate that auroras must be produced by a flow of *positive* electricity; for the luminous phenomena are the same as those of the voltameter, and the negative electrode shows nothing like them.

11. But are polar auroras the result of a discharge between the positive electricity of the atmosphere and that of the earth assumed to be negative? If this were so, the fall of lightning gleams and luminous tufts be seen upon the prominent points of the surface of the ground, forming the counterpart of the phenomena which take place in the air. Observation, however, shows that such effects do not take place. I should be inclined therefore to think that it is the imperfect vacuum of the upper regions which, acting as an immense conducting envelope, plays the part of the negative electrode in the above described experiments; and that the positive electricity flows away towards the planetary spaces, and not towards the earth, through the fogs and frozen mists which float above the poles.

12. As for the origin of this polar electricity, it has been conceded that it comes from the equator and from the tropics. It may, however, be objected that the electrified clouds ought to discharge themselves in the course of so long a journey; and it is, in fact, known that storms become more and more rare as we approach the poles. By previous experiments, and others as yet unpublished, having led me to consider the celestial bodies as being charged with positive electricity (the only kind of electricity, perhaps, which exists), I should be inclined to regard the earth itself as charged with positive electricity, discharging itself, by means of simple emission, from both land and sea, which the strongest batteries of static electricity hardly give evidence of, is worthy of particular attention; for it explains, in a natural manner, the abundant falls of either rain or snow which have always been observed in connection with polar auroras.

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If this last hypothesis be admitted, it might be concluded that polar auroras result from the diffusion in the upper strata of the atmosphere around the magnetic pole, of the positive electricity arising from the polar regions themselves, either in obscure radiations when there is no interposed obstacle, or converted into heat and light through contact with watery masses either in a solid or liquid state, the latter being vaporized with noise, and precipitated afresh in the form of rain or snow upon the surface of the earth.—*Bulletin de l'Association Scientifique.*

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[1] *On Stratified Discharge.—III. On a Rapid Contact-Breaker, and the Phenomena of the Arc.* By WILLIAM SPOTTISWOODE, M.A., F.R.S. Received January 20.

In a paper published in the Proceedings of the Royal Society, vol. xxiii. p. 455, I have described a new contact-breaker designed for as rapid as possible action of mains. It consisted of a steel rod which vibrated under the action of an electromagnet. As regards sharpness of break and steadiness as of definition in the arc, this instrument left little or nothing to be desired. But, as explained in the paper above quoted, an alteration in the current not only affected the steadiness directly but also reacted on the bar itself. The effects due to an alteration of the current alone thereby became masked, and the study of the laws relating to such changes was rendered more difficult, or altogether impracticable. In order to obviate this inconvenience I devised another form of contact-breaker, in which the vibrating rod and electromagnet were replaced by an arrangement purely mechanical in its action, and therefore entirely under control.

This instrument consists essentially of a wheel platinoid at the edge, on which a platinum spring rests. As the circumference of the wheel a number (40 in the first instance) of discs were cut, and these filed with the same edge so as to intermit the current. The breadth of the disc was about ¼ inch, and that of the teeth about ⅛ inch. The wheel was connected with suitable driving gear, so as to give from 250 to 2,000 revolutions per minute in each direction over a wheel. A 4-inch drift was found sufficient for the purpose, but after a few 48-ft drift by Appunto, as mentioned in recent communications, was preferable. With the wheel at rest the platinum springs bore, with a slight weight of several ounces upon the edge; but, on the other hand, high tension in the primary was necessary. In many of the experiments, two effective breaks to 20 of the so-called Leclanché cells were by mode employed with the wheel at rest, and from 20 to 40 with the wheel cut. But these were afterwards replaced by a double fluid battery suggested by my assistant, Mr. F. Ward, as I described at the end of this communication.

For some time the results were not pushed until with the platinum spring resting on the wheel; and the effects were varied by altering either the pressure of the spring or the velocity of the wheel; but the gradual abrasion of the platinum threw it friction proved to be a fruitful source of irregular results. This irregularity of action, at all times difficult to compensate, and sometimes inexplicable, was fortunately removed by a simple although important improvement. It was, in fact, found that metallic contact between the spring and wheel was not necessary, but that a thin layer of water would enable a current to be established. Such a layer was secured by a thin film of liquid drawn out between the rubbing from a reservoir and feeding on the wheel. Various fluids were tried, but the simplest and on the whole the best proved to be to dilute oil of vitriol, in the proportion of about 1 part acid to 6 drachms of water. Gas fully speaking, the better conductor the fluid is, the easier are the results obtained; but owing to the insulating skin being very narrow in this instance, a comparatively weak mixture of acid and water was necessary. In one wheel, where the insulating skin was 1/10 inch, the mixture 50 times as strong as in another, more wide. The spring, which under these circumstances became unnecessary, was replaced by a point, the adjustment of whose distance from the wheel was similar to that of a governor. This arrangement gave excellent results, even when the number of contacts which the wheel was capable of was raised to 250; but it is with the unpleasant and disturbing noise of the friction spring I am dealt.

Wheels having different numbers of teeth were also constructed; and although the results were unsatisfactory, being teeth of different breadths, as compared with the same velocity of rotation contacts of different durations. The low-ith of the double plugs, or length of interruption of the current, was unaltered, so long as the current was efficiently broken. It did not appear, however, that with the same tube more could be obtained with wheels having different numbers of teeth, than with the same wheels at different speeds. But it was found that for different tubes different wheels occasionally gave better results.

With the contact-breaker here described effects similar to those produced by the rapidly vibrating break were obtained. The arcs were formed in a regular manner, and presented or resolved, as resolved it was, no column usually, unbroken so long as the velocity of the wheel was maintained with sufficient rapidity. Under these circumstances, and with a proper intermediate velocity, arcs resolved into and beautiful bands, both ends at both sides, and sometimes appeared compact and continuous. Many of the phenomena always exhibited their characteristic features.

The condition of the arcs here described, whether flowing, or stationary, may be recognized under the general term "steady;" and when there is no motion in either

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direction, they may be specifically denominated as "rectifiers."

The facts have now been cited that no 1 or 2 can, what are the conditions necessary for the production of single strike? Secondly, what are the conditions and circumstances of the advance and retreat—in other words, of the four-of-steady series?

With a view of one standing the nature of the distinction between the ordinary and the steady strike, careful observations were made with the revolving mirror. It having been noticed that when the strike-in and steady ordinary or irregular strike were produced, and that when it ceased rapidly steady strike re-struck, it as most probable that the latter effect might be due to the short time of contact, and to the consequent absence of many of the factors described in Part II. of these researches. This is in fact identical with the suggestion there made, that the flattening appearance was due to the superposition of the up-strike and down-strike, not to the simultaneous arrival of the points at which they were respectively to be struck. The experiments of Part II., which, in fact, proved to be the case; for on the upper of the wheel was increased the distance at the disc being diminished; the image as seen in the mirror became narrower and simpler in its configuration, until when the set-up off of the produced each discharge showed only a single column of strike of a width proportional to the aperture with of the slit. The experiment so done, in-deed by the multiplicity of the individual strike in the c ntact, was still perceptible, and was directed as usual towards the negative pole.

From a comparison of the number of strike as seen by the eye with the one seen in the revolving mirror, it was found that the strike so formed were of the kind called "rain-bow" by the experimentalists. And the phenomenon of the flow of strike from the negative pole to the disc was found as before to be due to the series in succession discharge. If in each discharge the strike occupy no more in advance of those occurred in a previous discharge, the column will appear to advance; if the reverse be the case, there will appear to recede. If the positions remain unchanged, the column will appear stationary.

The following re-arrangement of the theories of the flow will easily occur to the reader, viz. that the rapidity of the flow will increase with the extent of advance made by the strike in each successive discharge, until that advance amounts to half the distance between two contiguous strike. Beyond this it is that the flow will have the appearance rapid to be followed by the unaided eye, and can only be observed by the aid of the mirror. When the strike of each discharge have exceeded the flow will go or be reversed. If the rate of advance will continue to increase, the rapidity of the apparent direction will appear in the same sense as the advance—hence to the exact distance between two contiguous strike, when it will appear to be stationary. Experiments appear to confirm this view of the case.

Experiments were next instituted with a view of ascertaining the connection between the flow and resistance. Starting from a condition of current and break for which the strike were stationary, it was found that an increase of resistance, introduced generally in the primary circuit, produced a forward flow, i.e. from the positive towards the negative terminal, while under similar circumstances a diminution of resistance produced a backward flow. Furthermore, a change producing a forward flow the resistance be continually increased, the flow, after increasing in rapidity so as to become indistinguishable by the unaided eye, gradually appears to become slower, and ultimately to assume its old, or occasionally with the few suggested above.

Another fact worthy of note also subsequently used. The principle upon which it was based was the

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THE RADIOMETER AND ELECTRICITY.

The phenomena presented by this curious little instrument have awakened a lively interest on both sides of the channel, and though observations have been numerous, it can hardly be said that we have learned all from the radiometer that it is able to teach us. We recently referred to some interesting experiments by a Belgian observer, M. Dubaulx, who considered he had found in electricity the cause of the radiometer's motion, both direct and inverse. Prof. Stroumbo, of Athens (we learn from *Les Mondes*), has been experimenting in the same direction. Among other arrangements he constructed a radiometer having three platinum wires (which terminated in copper discs) soldered into the glass envelope of the instrument; two were on one side—viz., Disc A above the vanes and B below them; the other disc, C, on the other side, and below the vanes. A lighted candle being brought near, rotation occurred in the usual way from B to C. The candle was then put out, and when the radiometer had come to rest, a current of 3 or 4 elements was connected with a Ruhmkorff coil, and the extremities of the fine wire were connected, the positive pole with B and the negative with C. The radiometer then turned in the same direction as before. If, while it is turning under the influence of electricity, a lighted candle be brought near, the rotation is considerably increased. Thus the actions appear to be in the same direction.

While the radiometer was turning under the influence of a gas flame, the wires and discs B and C were connected with a galvanometer. The needle was deflected through an angle of 5°, and the effect would probably have been greater with a more delicate instrument. The radiometer had the same motion of rotation when the positive pole was connected with A, and the negative with C. On the other hand, if the poles be reversed, the positive being connected with C and the negative with B (or A), the radiometer at once not turn any more. If the positive pole was connected exteriorly with the top of the instrument, or its base, while the negative was connected with C, no motion occurred. Several other effects which M. Stroumbo obtained on applying his fingers to the glass support of a radiometer, whilst the envelope circularly-with silk cloth, pouring ether on it, &c., are connected by him with electrical influences.

In a recent paper to the Royal Society, Mr. Crookes called attention to some curious phenomena exhibited by a small piece of pith hanging down like a pendulum towards the rotating vanes of the radiometer, and about a millimetre distant from these. It was noticed that scarcely any movement of the pendulum occurred when the rotation was very rapid; but at one particular velocity the pendulum set up a considerable movement. At the suggestion of Prof. Stokes, the candle which produced the rotation was placed at the distance from the radiometer, for which a revolution of an rem of the fly synchronised with a vibration of the pendulum. In this way the pendulum was kept for some time swinging through a large arc.

Prof. Challis, in his study of the radiometer (*Philosophical Magazine*, November, 1876), has seen reasons to conclude that the light or heat in a radiant form, incident on the vanes, has the effect, after being transformed into heat of temperature, of so changing the relative positions of the atoms in a superficial stratum, as actually to incline the electric state. With this assumption, he proceeds to account for the phenomena described by Mr. Crookes. Since the radiant light or heat is converted into heat of temperature in a greater degree on the blackened surface of a vane than on the other, the two surfaces are electrified in different degrees, and relatively to a neutral state one is positively electrified, the other negatively. A face of the vane, whether positively or negatively electrified, will, on approaching the piece of pith, *attract it*; and the oppositely electrified face of the same vane, after passing the pith, will also attract it, supposing there is no contact between the vane and the pith. Thus the piece of pith is drawn in opposite directions in quick succession, if the rotation of the vanes be very rapid; and if impression of motion takes time, it might well happen that under these circumstances no perceptible motion takes place. If, however, the rotation is slow, the attraction of the vane in one direction may take effect before that in the opposite direction commences, in which case no oscillatory motion of the pithball will be produced. Clearly the oscillations will be most nearly when by reason of a synchronism of the time of oscillation of the pith with the time of revolution of the vane the attraction of a given vane acts like gravity on a pendulum. If the oscillations were due to action of the vanes on residual air, it seems hard to understand why there should be no perceptible effect when the rotation is very rapid.

No motion occurs in a radiometer before exhaustion of the globe, and the reason (according to Prof. Challis) is, that no electricity can pass, air of ordinary density being a non-conductor. On producing exhaustion, the rotation commences and increases up to a certain point, because rarefied air is a conductor of electricity. After a high degree of exhaustion is attained, the rate of rotation diminishes, because vacuum is a non-conductor of electricity. Such is the approach to that condition has a retarding effect. The vane continued to move after the degree of exhaustion was considerably greater than that at which the spark ceased to pass under the particular conditions arranged for the comparison.

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On the Role in Electric Phenomena of Insulating Substances in contact with Conducting Bodies.—M. Neyreneuf.—In this paper the author first investigates the action of the insulating film in ordinary phenomena of condensation, as in the Blackburn experiment. He shows that this film does not absorb the charge, as is supposed, but that it acts, like the glass plate of the Ramsden machine, by influence on the conductors. He thus explains various experiments, (several of which are his own device), and definitely assimilates the condenser to the electrophorus. The electromotive force of the insulating plate, in a condenser, is opposite to that of the electrical source of the charge, just as the polarization of the electrodes in dynamic electrolysis occasions the production of a secondary current opposite in direction to that of the principal. M. Neyreneuf studies the circumstances, conditions, and limits of the charge and phenomena of discharge. He further studies the influence of electricity on gases, and describes a number of experiments with the terrestrial and with flames.

Electl News July 22, 75

New Source of Electricity.—M. Donato Tomasi says:—When a current of steam is made to traverse, under a pressure of 2 to 6 atmospheres, a copper tube of 2 to 3 m.m. diameter wound spirally around an iron needle placed at some centimetres away from the magnetized during the whole period of the steam current through the tube. (Taken from *Comptes Rendus* of April 10, 1876.) In a subsequent communication of date M. Donato Tomasi quotes the following observations:—The important experiment of M. Donato Tomasi should, it seems to me, be interpreted by a very different consideration from that of the author. Heat does not act so as to produce "a new source of magnetism." It produces a thermo-electric current, generating the electro-magnetism, and is set up by the difference of temperature between the interior surfaces of the copper spiral traversed by the steam and the exterior surfaces exposed to the air. M. Tomasi ought to be able to reverse the current, and consequently the poles, by causing the heat to act so as to warm the exterior surfaces, at the same time maintaining the interior surfaces colder. (Taken from *Comptes Rendus* of May 3, 1875.)

Electl News July 8, 75

Aurorae and Terrestrial Magnetism between Novaya Zemlia and Franz Joseph Land.—M. Weyprecht. —The author thinks there are maximum regions of Aurora in the north, and that this is one. The wonderful brilliancy of the phenomena greatly impressed him. With clear sky, aurora would be always be seen. These forms were distinguishable. Flaming auroras are generally followed by storms. The needle was never at rest in this region; some magnetic storms were taken, and among the chief results are these:—Magnetic disturbances are unusually strong there; they are closely connected with auroras, and greater the more quickly rapid the movement of the auroras and the more intense its prismatic rays. In all disturbances, the declination-needle was deflected eastwards, the horizontal intensity decreased, the inclination increased. M. Weyprecht hoped to have brought the auroras into connection with disturbances of galvanic earth currents; but, being 24 miles from land, he could only bury the collecting plates in ice, which is not a good conductor: so that only a small influence on the galvanometer needle was observed.—(From *Petermann's Mittheilungen*).

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St. Elmo's Fire.—The rare phenomenon of St. Elmo's fire was observed at several localities in the Hare Mountains during the past month. At Blanksburg it occurred at a temperature of + 25° C. and pressure of 720.5 m.m., after a series of storms. The air was so laden with electricity, that cones held aloft emitted from their points light blue flames five inches in length and three in breadth. In Dibble the phenomenon occurred in the midst of a storm, half snow and half rain, when the ends of the branches in an entire grove were surmounted by flames from four to five inches in length.—*Nature*.

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ROYAL INSTITUTION.

On the Action of Light on Selenium.

Dr. Siemens gave a lecture on this subject before the Members of the Royal Institution, on the 18th February last.

He commenced by reference to both the transient and permanent effects of light, to its action as a moving force and as a chemical motor, and closed his introduction by a statement of the hypothesis that it is not heat but the ray of light that breaks up carbonic acid in the leaves of plants, thus separating the carbon. Thereafter followed a description of selenium, considered from a chemical and physical point of view.

The first observation of the effect of light on crystalline selenium, viz., its increasing the conductivity, was made by Mr. May, a telegraph clerk at Valentia, and was communicated to the Society of Telegraph Engineers on the 12th February, 1873, by Mr. Willoughby Smith, a member of that body; this observation was confirmed by subsequent experiments. Within the last year, Professor Adams, of King's College, and Dr. Werner Siemens, of Berlin, have made independent inquiries: those of the latter formed the principal subject of the address.

The experiments on selenium were made through the resistance of a sensitive element, composed of two spirals of platinum wire, running parallel without touching, placed between two thin plates of mica, the interstices between the coils and mica being filled with molten selenium. The two ends of the coil protruded and served to insert the element in a galvanic circuit. The experiments showed that amorphous selenium did not conduct electricity either in light or darkness; that selenium formed by heating to 100° C. for some time and then cooling, showed an appreciable conductivity in light, but a very slight one in the dark. This selenium has been called modification No. 1, or electrolytic; modification No. 2 being metallic, is formed by heating to about 210° C. and keeping several hours at this temperature before cooling. Its conducting power is very much greater than that of the other modification.

The effect of temperature was also the subject of experiment.

An amorphous preparation of selenium is placed in a galvanic circuit and heated in an air bath, kept constantly at a temperature of 160° C.: it is found that up to 80° C. no current passes; that from this temperature to that of 150° C. the conductivity rapidly increases, whilst it again diminishes up to 230° C, at which point it reaches a minimum; on cooling, the conductivity varies in the same manner, but in a different ratio. On comparing the effects which are actually produced in heating the selenium, with what would take place if the selenium simply increased in temperature, it is found that there is a spontaneous liberation of heat between 90° C and 210° C, whilst there is an absorption during melting.

From a considerable number of these experimental results, Dr. Werner Siemens has extended Helmholz's theory that the conductivity of metals varies inversely as their temperature from the absolute zero, in substituting the expression total heat for temperature, and considers the specific heat of selenium to be an extremely variable quantity. His explanation of the action of light in selenium is, that there is a change of its molecular condition from the first, or electrolytic into the second, or metallic modification, or that, in other words, there is a liberation of specific heat upon the illuminated surface of the crystalline selenium, which liberated heat is reabsorbed when the liberating cause has ceased to act. This hypothesis is favoured by the circumstance that time is necessary for the complete dispersion of the effects of light, and that the effect of light is greatly diminished by long exposure, causing a readjustment of the specific heat through the mass, the galvanometer needle tending to return towards its zero position; this fatigue of the sensitive plate wears off by hours of rest, but days are required to restore the previous degree of sensitiveness.

The effect of the different rays of the spectrum upon the sensitive plate was also shown, the actinic and dark heat rays having no appreciable influence upon it.

Dr. Werner Siemens' selenium photometer was exhibited, which consists of a selenium plate not affected by the changes to which the substance is liable, mounted upon a vertical axis, upon which it can be turned through a certain angular distance limited by stops. By this instrument the intensity of light can be measured in a manner which is absolute for white light.

The lecture concluded with some experiments on a selenium eye, which Dr. C. William Siemens had constructed, to illustrate the sensitiveness of the selenium preparations. It consisted of a hollow ball with two openings opposite each other, the one being furnished with a lens of 4 inches in diameter, and protected with slides, representing eyelids, and the other having an adjustable stopper, carrying a sensitive plate, connected up to a galvanometer and one Daniell's element.

On placing an illuminated white screen before the eye, there was a very considerable deflection of the galvanometer needle, a red screen produced a smaller deflection, a blue a still smaller, and a black hardly any appreciable motion. The eye was also extremely sensitive to the different light rays of the spectrum, but was unaffected by the heat rays. As explained, it would not be difficult to make the eyelids close automatically under the influence of a very bright light, by arranging a contact and electro-magnet in connection with the galvanometer; thus imitating the automatic action produced by light on the natural eye.

Tel Journ May 1. 78

An Electric Zoophyte.—A correspondent writes to a contemporary pointing out the fact that the ordinary *Zoophyton Flortiens* has a large natural store of electricity which it is capable of discharging into the water after the manner of the electric eel. Shocks have been felt from it by persons bathing. The writer charged a small Leyden jar with the discharge, the electricity being positive. After several experiments the Zoophyte became visibly weaker, and died in a few hours.

Tel Journ Apr 15. 74

A pamphlet has been issued, entitled "The action of Light on Selenium," by Willoughby Smith. It contains a copy of a letter from Mr. Smith to the Secretary of the Society of Telegraph Engineers, dated March 3rd, 1876, giving a history of the discovery. It appears that in 1866, having to fit up the apparatus for his well-known system of testing submarine cables during the paying-out operations, which requires a resistance of 100 megohms, while searching for a better substance than gelatine to form the resistance, the high resistance of selenium was brought to his notice. "I obtained," writes Mr. Smith, "several specimens of selenium, and instructed Mr. May, my chief assistant at our works at Greenwich, to fit up the system we adopt on shore during the laying of cables, using selenium as the high resistance, and employing the spare members of the staff as though they were on shore duty, and to report to me on the subject. It was whilst these experiments were going on that it was noticed that the deflections varied according to the intensity of light falling on the selenium." The pamphlet also contains a letter to Mr. L. Clark, dated 18th February, 1873, giving details of the experiments. This was read before the Society of Telegraph Engineers.

Tel Journ Apr 15. 75

Experiments on the Artificial Imitation of Magnetic Iron Ores.—Platinum.—Daubrée.—It is known that certain samples of native platinum not only act on the magnetised needle, but are even magnetic themselves, similar to true magnets. Berzelius, in a paper on the compositions of platinum minerals, noted this property in some nuggets from Nischne-Tagilsk (Ural), which he submitted to analysis. The antiferous sands of Oural, after repeated washings, leave a residuum in which the gold is mixed with a few platinum substances. To extract this substance a native magnetic oxide of iron and platinum is used, and after the action of a powerful magnet, the platinum ores that lie have a still further quantity of their particles. Such was the experiment undertaken by Daubrée, in 1866, from which he concluded that natural platinum nuggets are much stronger than natural crude iron magnets. Stanley analyses have shown that grains of platinum endowed with magnetism are always alloyed with a certain inconsiderable quantity of iron. Under or over a particular quantity the platinum becomes not magnetic, *i.e.*, capable of being attracted by the action of a magnet, is not itself magnetopolar. Now we know that magnetic mineral substances may, as a result of different operations, become magnetopolar; and Edmund Becquerel has shown that platinum, with traces of iron, under the action of energetic poles, may acquire likewise the magnetic property. The examples in which magnetopolar platinum nuggets (containing some traces of iron) were successful, is attributed by the author to the influence of the terrestrial globe. To ascertain whether such was the case, some platinum was melted with a small quantity of iron into the form of a bar, the mould, being carefully laid in the direction of the magnetic meridian. The melting was a small quite cold. Two very energetic magnetic poles found at its extremities, placed exactly like those of an ordinary magnetised needle; this was not a chance result. This goes to confirm the importance the globe's general action may have had in the distribution of the different poles of various magnetic minerals and rocks, at the moment when those minerals and rocks were first formed.

Tel Journ Dec 15. 73.

Tribution between Capillary and Electric Phenomena. —M. G. Lippmann.—The author sets out from an experiment by Kühne, which is thus:—A drop of mercury in pure or dilute sulphuric acid containing a little bichromate of potash. A polished iron wire is fixed in the neighbourhood, so as to dip in the acid and touch the mercury surface. Whenever it has touched, the drop is thrown into regular oscillations, which may continue for hours. The author explains this by the fact that the polarisation of the iron (according with hydrogen (electrolytically produces contraction in it, and the electrical heat has depolarising effect. He brings a number of experiments to prove that the capillary constant (function of surface, coefficient of Laplace's formula) at the contact surface of mercury and dilute sulphuric acid is a constant function of the electromotive force of polarisation at the same surface. On this principle he constructs a very sensitive capillary electrometer, also an electro-capillary motor. The latter is, briefly, as follows:—A tube filled with dilute sulphuric acid has two cylindrical vessels, containing some mercury, placed in it. Into the mercury, dip platinum wires connected with a Daniell battery, and also two wires from the sulphuric acid by glass tubes. Two jets of coarse glass tubes (open at both ends), with a long glass tube fixed in the mercury so inside, fixed with their lower halves in the mercury at the two cylinders, the sulphuric acid filling their upper halves. As the alternate up-and-down motion of these handles is kept in since ed, and this is effected by means of the pulsator and valves, shown, passing through the platinum wires, alternately polarises the one mercury mass with hydrogen, the other with oxygen. In his one case, the capillary constant, the capillary depression in and between the tubes, is increased, and the handle rises; in the other, the reverse occurs. This up-and-down motion is converted into circular by a simple arrangement of levers, &c.; a crank on the shaft works a key which reverses the currents. One of these oscillators went five days and nights with the same Daniell at a rate of 216 revolutions per minute; the speed falls off somewhat as the battery becomes exhausted. M. Lippmann further shows that the converse phenomenon, change of mechanical work into electrical, may be shown in the following manner:—Mercury and acid are in the standard position, and the wire must be formed. The galvanometer shows a current going through the dilute sulphuric acid from the outgoing electrode to the other, and the quantity of electricity is proportional to the masses of metals, but independent of its form. The author mentions some other interesting experiments in reference to polarisation by capillary forces.

Tel Journ Dec 15. 73

In a supplementary number of the *Philosophical Magazine* for December, Mr. R. Sabine describes some curious observations on electricity disengaged between mercury surfaces; and on the motions produced in mercury by oxidation. He concludes from his experiments (1), that the electricity disengaged between pure mercury surfaces (when not hydrogenised) is due to different states of oxidation; (2) that the motions observed to take place in mercury electrodes under water (or dilute sulphuric acid), are due to the displacement of the surface corresponding to the different atomic volumes of the metal and its suboxide (or subsalts and sulphate); (3) that the pumping action of a column of mercury in a tube or narrow channel is due to rapid circulations caused by such displacement; (4) that these motions are not due to change of either constant of capillarity or adhesion; and, finally, (5) that we may give a negative answer to Draper's question—viz., Is capillary attraction an electrical phenomenon? (In the same number will be found a paper by Mr. Lodge, "On a Mechanical Illustration of Thermo-Electric Phenomena.")

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In an interesting communication to Nature, Mr. Robert Sabine states that the effect of surface tension upon mercury, on action of light or even slight solution, are strikingly shown when the mercurial forms one of the metals in a small voltaic cell. On constructing such a cell, by immersing a plate of amalgam covered with dilute sulphuric acid in a cell of water, in which a piece of platinum foil was likewise immersed, the current was first found to be electropositive to the platinum, but the difference of potentials between these metals soon fell to zero. On allowing a jet of air to impinge on the amalgam, a current was set up in the platinum in a direction opposite to that of the original current, and a steady deflection of 30° was obtained. This difference gradually lessened however as the spot was wiped so that the electrical equilibrium was restored, at which the difference of potentials, being equal and opposite in favour of the platinum, was then that which would have been were it the zinc. Mr Sabine found that the slightest shaking of the cell disturbed the electromotive force of the couple, and no sooner is motion the latter by means of a stirrer, the galvanometer needle immediately began as a steady deflection in the direction of daylight.

ELECTRIC RESISTANCE IN SELENIUM.—M. Fromme experimented with bars of selenium, 25 centimetres long and two millimetres in diameter, enclosed in a small tube with air expelling it in vain to allow a mass of fused sulphur to enter them. Such that the deflection of a galvanometer was due to light impulses is proportional to the number of elements in the last-mentioned, daylight produces the maximum effect, a ray only three millimetres but a small deflection. It should be stated, yellow gives the maximum and green the minimum effect. The rays of a lamp illuminated by yellow and red glass give a more powerful effect than when allowed to fall direct upon the mass. Certain solutions such as chloride of copper and nickel solutions intercept the active rays completely; whilst others, such as chloride of chromium, and above all the solution of selenium in very opaque sulphate of carbon, give a greater effect than direct radiation.

Telegraph Journ July 1, 75

ON PHENOMENA PRODUCED IN LIQUIDS BY ELECTRIC CURRENTS OF HIGH POTENTIAL.*

By M. GASTON PLANTÉ.

The author studied, with facility, the phenomena he now explains, by means of his secondary battery; whereas various observers (among whom were Davy, Grove, De la Rive, &c.), by using ordinary batteries, instead of a very high potential one, gave no satisfactory analysis to their investigations. If, for example, by allowing the passage of currents of variable intensity into liquids, we assist, so to speak, in the struggle between the electric flow and the two forces (molecular and chemical) which tend to maintain entire the metallic molecules of the electrodes, or the elements of the liquid decomposed at the voltameter. If the electric flow possess a high potential, the mechanical and calorific effects dominate, the molecular attraction is overcome first, the electrodes are disintegrated, fused, or volatilised. If the potential is somewhat less, the electrodes form the seat of luminous phenomena produced in the space and the resulted vapours surrounding them; the liquid, scarcely wetting the electrodes, is not decomposed without difficulty. Let the potential still further decrease, as also the principal calorific and luminous phenomena disappear, whilst chemical decomposition becomes manifested; and so, on the other hand, the current then traverses the liquid in a more complete manner, its strength will seem to be greater." Experiments were carried on with discharges from two secondary batteries—each composed of twenty lead plate couples—within a voltameter, containing a solution of diluted sulphuric acid. Various effects were produced, according to which pole was first plunged into the liquid, thus:

1. Plunge the positive platinum electrode into the voltameter. Let a piece of exposed platinum wire also form part of the external circuit, to show, by its appearance, the varying resistance of the circuit. If you plunge into the liquid the negative pole of the battery, covered in a shield of light vapour, without sensible disengagement of gas. The platinum wire in the air does not become red but in two or three minutes it becomes incandescent, the luminous sheath disappears, and an abundant release of gas takes place at both poles.

2. With a series of ten secondary batteries, whose discharge was equal to that from ten Bunsen's elements, in potential series, the same experiments was performed. On immersion of the negative pole, its fusion or volatilisation took place with a kind of explosion, and a flame diversely coloured, according to the metal employed. If the liquid contained but small traces of acid, so as to prevent the complete fusion of the metals, a continued series of sparks, accompanied with a crackling noise (analogous to that from induction instruments) was produced, and these sparks were lengthened for several minutes, by gradually decreasing the current's strength.

3. The most important phenomena arose from using a solution of chloride of sodium. On immersing the negative pole first, to a depth of 1 millimetre, and on bringing the positive pole into contact with the liquid, a small luminous globule, of perfect sphericity, was observed around the positive wire, with a noise. On lifting the wire, the globule increased to nearly 1 centimetre in diameter; by deeper immersion, a rapid gyratory movement ensued, and when it had acquired a certain speed, it detached itself, as though attached by the other electrode, its disappearance being accompanied with an explosion and a flame at the negative pole. The author, however, considers not to be gaseous, because the conditions of the experiment were not favourable to the decomposition of water. He considers it to be a liquid globule, in a particular spheroidal state, illuminated by the electricity it encloses.

4. Instead of plunging the wire into the middle of the liquid, let it approach the glass sides of the voltameter. A luminous eddy is produced, and a brilliant fumerous ensues, and when it has acquired a certain volume and detached the electrode, to a distance of 3 or 4 centimetres. Should it reach the neighbourhood of the negative electrode it occasions an explosion, or a noisy spark with flame, therefrom. The lesson sought to be taught from these phenomena is that these luminous globules, charged with electricity, animated by a revolving movement, producing a rippling furrow, and dispersing themselves with an explosion or noisy spark, present a reduced image of globular lightning, or thunderbolts.

Le Jour Oct 1, 75

DILATATION OF MAGNETISED CORES.—Messrs. Andrew and David Gray, of the Physical Laboratory, Glasgow University, have applied Edison's micro-tasimeter to the measurement of the lengthening and thickening of a bar of iron produced by magnetization and demagnetization. The magnetic effect was produced by the current from three of Thomson's Daniell cells, sent through a rough electro-magnet formed of four layers of six brass rods of bundled wire surrounded by a tube containing the iron wire to be magnetised. A deflection of fifty divisions on the sensitive scale of a reflecting galvanometer in the Wheatstone Bridge circuit indicated the elongation on magnetization. Further results of a quantitive kind are promised.

THE ELECTRICAL NEWS.

VOL. I. NO. 6.

ON THE CHANGES OF TEMPERATURE WHICH OCCUR IN PASSAGE OF AN ELECTRIC CURRENT FROM ONE METAL TO ANOTHER.

THE temperature-effect here denoted differs from that in passage of a current through a homogeneous conductor, inasmuch as it may be a cooling as well as a heating. The phenomenon was first observed by Peltier, in 1834.

Purgendorff showed that it must be closely connected with thermo-electricity, for heating took place at the junction point of the two metals, if the galvanic current flowed from the positive to the negative metal (according to the thermo-electric series), *e.g.*, from antimony to bismuth; and cooling, if it flowed in the opposite direction. It was discovered that in the circuit wire there was a thermo-electric excitation, the direction of which was opposite to that of the thermo-electric current.

The experiments of Quintus Icilius on this subject in 1853, and those of Fechner in 1854, shortly after, have been revised and criticised by Dr. Buff, in a recent instructive paper to *Poggendorff's Annalen*.

Quintus Icilius made a galvanic current of known strength pass, for thirty seconds, through a thin cylindric battery of antimony and bismuth bars. Then opposite changes of temperature were produced at the odd and the even solderings, and the effect of these was measured galvanometrically. From the observations it was inferred that the difference of temperature of the odd and even soldderings remained independent of the absolute heating of the metals, and was in direct proportion to the strength of the producing current.

There was, however, a slight but distinct increase of the quotient of thermal effect by strength of current, as the latter was increased. This curious fact was recognised, but did not explain.

Dr. Buff repeated this experiment thus:—Using a very sensitive metallic galvanometer, he did not require more than a single pair of cylindrical bars (4 mm. thick). These were plained and bound together with the fine surfaces opposed. To the outer ends of the bars copper wires were soldered, through which the principal current was passed (thirty seconds), then, by a quick transformer, the wires were connected with the metallic galvanometer. The thermo-electric couple was placed under a metallic vessel, to cut off the influence of air. A useful improvement was previously made of the indications of the metallic galvanometer with those of the current compass in the primary circuit. A deflection of 1° in the former being regarded as proportional to a deflecting force = 1, it appeared that up to 21° the deflecting force might be measured by the amount of the deflection. For greater deflections a necessary correction was made.

The first result was a gradual increase of the proportional thermal effect to the strength of the principal current; then it was observed that the temperature changes at the transition and even into metals in contact were approximately, but not exactly, proportional to the strength of the producing current. Dr. Buff discovered the reason of this. "The thermal effects," he says, "at the different points of junction of a thermo-electric battery, which take the form now of heating, now of cooling, and which we may denote by π, are always accompanied by heat actions, which are dependent on resistance to conduction, and, it is known, are proportional to the square of the strength of current. This second kind of actions, which we may call σ, are of constant influence on the galvanometer, when they are of equal strength at all the points of junction; on the other hand, when the places of contact are of unequal nature, they must become more and more perceptible with increasing strength of current, for their unequally active influences do not vary with the square of the strength of current, while that of π increases only in direct proportion to it. Now such inequalities are undoubtedly present in the thermo-electric pair described; for at the two ends copper wires were soldered, which, with the middle antimony and bismuth were only touching each other with plane surfaces, though of course pressed together. To remove any such disturbing influence, as much as possible, two bars were now soldered together with easily-fused metal, and the experiment repeated as above."

From the numbers given in a table it is shown, that through this intimate connection of the two bars, and the increase of points of contact at the bounding surface, the irregularities referred to as completely removed (at least within the limits of current strength selected). Hence the author considers it demonstrated that "the change of temperature in passage of the electric current from one metal to another exists in a law of proportionality to the strength of current more exactly, the more completely other causes of excitation of heat in the place of contact are excluded."

Fraulenhaim (as above stated) also studied this subject. After trying various modes of experiment, he finally decided to use Peltier's cross; which consists of two bars, bismuth and antimony (or the like), laid crosswise one on the other, and soldered together. Two neighbouring ends are connected with a galvanic battery and tangent compass, the two others with an astatic galvanometer.

Fraulenhaim considered that at the crossing point there were two heat effects: that due to ordinary resistance, and that dependent on passage from one metal to the other. If the former (σ) was independent of direction of the principal current; the latter (π) changed after the direction of current were reversed. Hence two equations $\pi + \sigma = a$, and $\pi - \sigma = b$, were found, which both π and σ could be deduced from proper experiments.

Dr. Buff considers that Fraulenhaim's experiments are invalid, because he sought to measure the temperature of the crossing point while the principal current was passing. (He had the other method failed to mistakes which did not allow of being calculated. The errors of these mistakes he did not explain).

Fraulenhaim, again, thought the current measured by his astatic galvanometer was the effect of thermo-electric action. But (Dr. Buff says) it is really in great part a branching of the principal current. To avoid this the experiment it will be found that the action on the double needle occurs with the greatest part of its strength immediately after closure of the principal circuit. If we suppose the strength of the first deflection, first observed, = α, the secondary circuit, and renew the experiment after the needle has come to rest, we generally observe only a slight change in the amount of the deflection from that first noted. A thermo-electric excitation must, however, unavoidably occur; but it can only be made distinctly perceptible after exclusion of the principal current, and by shortening the circuit of the thermo pile. Hence a more momentary action of the principal current must, in great part be produced, afterwards, a diminished deflection of the double needle; whereas, the galvanic circuit being kept closed for some time, there is a gradually increasing deflection of the double needle. (Dr. Buff mentions other facts as indicating that in the secondary circuit of the Peltier cross a branch of the principal current is present in considerable quantity).

If, now, in an antimony-bismuth cross, the principal current flows from antimony to bismuth, its branch x current flows in course through the antimony bar forwards; and the branch current y is taken by the thermo current depending on π and σ, since the place of contact is heated by both influences. Hence the action on the galvanometer is expressed by the equation $\alpha = x + y + \sigma$. If the principal current is sent in the direction bismuth to

Intent stimulation of the muscle and the electrotonus of the nerve.

The subject has since been studied by others, and recently, as we learn from *Naturforscher*, by M. Hermann Munk. Dr. Sanderson's observations were made on the leaves cut off;* M. Munk, on the other hand, has applied the unpolarizable electrodes to the uninjured leaves, and studied the distribution of tension. The phenomena which occur in this case we shall now shortly recount.

If the under surface of the leaf be first stabbed (that is, a current appears in part) *up* and direction, *i.e.*, flowing in the leaf from the end of the petiole or leaf-stalk (call it the *fore end* of the leaf), to the free end or point of the leaf (which may be called the *hinder end*). Points situated similarly on the two halves of the leaf are homogeneous, hence on the two sides of the midrib all is symmetrical.

Conceive the midrib divided into two unequal parts, a shorter hinder part and a longer fore part; then in each of these parts every point nearer the inner end is positive to every more distant point. The most positive point of the midrib lies about the fore end of its hindermost third, and with increasing distance from this point the positivity decreases towards both ends.

Suppose lines drawn on the surface of a half-leaf at right angles to the midrib; and call these, *cross lines* of the leaf. Every point of each a cross line proves negative to the corresponding point of the midrib; and regularly the negativity of these points increases first to a maximum, and then, on to the outer leaf-border, decreases. The most negative point of the cross line never coincides with the middle of the line, but is always nearer the leaf-border than the midrib.

By connecting the most negative points of all the sections, we have a principal line of length (*Hauptlängslinie*) nearly parallel to that of the midrib. All points in this line are homogeneous. So also are related points of other lines of length running parallel to the midrib, and lying inwards from the principal length-line. Of the middle parts of two cross lines, which are both in the fore or both in the hinder halves of the leaf-halves, the middle nearer to the fore or to the hinder leaf-border respectively, is always positive to the more distant middle, and the force, downward in the former case, upward in the latter, increases with the width of the leaf at this arch. The principal length-line, then, is the system of the most negative points of each leaf-half, while, in opposition, is of the hindermost third of the midrib. And, as side of the midrib so it each leaf-half all is symmetrical on the two sides of the midrib cross-to be disturbed only in that the most positive point in the midrib is displaced both from the middle.

The extirpation of the upper surface of the leaf offers great difficulties, owing to its sensitiveness. These having been overcome, it is found that the same distribution of tensions prevails as on the under surface. Indeed, between two similarly situated points on the two surfaces there is no difference of tension, so that it may be assumed that the absolute amount of tension on the two surfaces is the same. All these electromotive actions of the leaf of *Dionæa* are a lifeproperty of it, and gradually decrease as it gradually dies. They are further dependent on the state of nutrition of its leaf, and its fulness and vigour of life.

The absolute amount of the force is considerable. The difference of tension between a point in the region of the principal line of length, and a point in the hinder half of the midrib, is about one-tenth of a Daniell, and may even rise to one-fifth. Between other points of the leaf smaller values are had.

M. Munk proceeds to inquire as to the source of the electromotive actions. He concludes the forces must reside in the interior of the leaf, and cannot arise from heterogeneity of surfaces. By way of preliminary experiment, he had combinations of zinc-copper plates prepared, which, immersed in a conducting liquid, gave tensions on their surface similar to those found on the surface of the leaf. Thus a representation may be given of the electro-motive force probably operating within the leaf. The combination of two flat zinc cylinders, with copper-net interior, their bases turned toward each other, and the outer parts obliquely cut away, so that in the middle an obtuse angle is formed, and the whole immersed in a conducting liquid, represents approximately the electro-motive forces in question. In place of these two flat cylinders, conceive many small narrow cylinders of the same kind, placed much the same electro-motive force. Guided by these preliminary observations, M. Munk successively excludes, as possible seat of the electric forces, the disc-plasma, the sun-like hairs, the fibre-vascular canals, and the epidermis, so that there remains only the parenchyma; with regard to which he concludes that the roughly cylindrical cells of the parenchyma in the halves of the leaf, and that of the midrib, are endowed with forces of such a kind, that the positive electricity is driven from the middle of the cell to each of the two poles, which are positive to those in the middle.

The mechanical movements of the plant are of two kinds: stimulation movements, and resorption movements. In the former, the leaf closes very quickly after stimulation, within a minute or so, all parts moving simultaneously. In a few hours it begins to open again, and is quite open after 24–36 hours. It is then susceptible of further stimulation. The resorption movement, on the other hand, is more rare, and occurs when a small piece of flesh, albumen, or the like, is carefully laid on the leaf-surface, avoiding the sensitive hairs. The closure which follows is very slow, not beginning for some hours, and being completed only in 1–1½ days. The movements of the two halves are irregular and unsimultaneous, and depend on the piece of contact; from which they spread outwards. The re-opening begins after several days, and takes several days to be completed; and during this time the leaf is not, or is very little, susceptible of either stimulation or resorption movements. The leaf may die after one such resorption movement, and two or three always prove fatal to it; it opens no more.

M. Munk has occupied himself with the stimulation movement. It appears that the upper parts of the parenchyma of the leaf-halves and the upper midrib parenchyma, or at least its upper portion, are the stimulable parts: they may be stimulated by mechanical seizure, or removal of water in certain amount or with certain rapidity. M. Munk says the stimulation is propagated immediately over the whole parenchyma, and it relaxes. The relaxation occurs, as in *Mimosa*, through a flow of water from the interior of the stimulable parenchyma-cells, whereby the stiffness of the cells is diminished, and a good part of the escaping liquid goes into the parenchyma of the unstimulable parts. This is necessarily followed by movement, as the author explains.

We now come to the electrical phenomena in stimulation, of which Dr. Sanderson said that they presented a negative variation similar to that of the muscle-current. The electrodes were placed on the under surface of the midrib, as being the only part of the leaf which, during movement of the latter, does not alter in position. On stimulation through movement of the sensitive hair, there occurs, not a simple negative variation, but, as the author expresses it, a positive variation with negative after-many impulse (*Nachschlag*), which he calls double variation. This electrical phenomenon occurs even when, notwithstanding stimulation, there is no movement of the leaf. The latter circumstance renders possible an examination also of the leaf parenchyma; and the same double variation is here observed.

As to the explanation of this double variation, the supposition, that all the cells pass first through a negative then through a positive variation, is to be rejected as the process is rather this author thinks that through stimulation the cells of the upper halves of the half-leaf parenchyma and of the upper midrib parenchyma experience a negative variation, those of the under halves of the half-leaf parenchyma and of the under midrib parenchyma a positive, that is, the negativity of the middle of the cells to their poles increases in the former cells, on stimulation, and decreases in the latter.

As regards time-relations, the phenomena of variation and after-through, when the stimulation-movement begins.

ELECTRICAL APPARATUS FOR EXHIBITING THE ROTATION OF THE EARTH.—Mr. Geo. M. Hopkins, whose electrical gyroscope we illustrated in our number for August 15th, has applied the latter to demonstrate the earth's rotation. For this purpose the gyrating wheel with its electro-magnets is suspended by silk threads in the plane of the meridian, that is at right angles to the plane of the equator and parallel to the polar axis of the earth. The electrical contacts are made by metal discs carried by the wheel dipping into capacious mercury cups carried by the fixed support of the apparatus. A pointer attached to the wheel and a beam of light reflected from a mirror both serve to indicate on a scale the earth's angular velocity.

VARIATIONS OF CURRENT STRENGTH BY PRESSURE OR CONTACT.—As was found by De la Rive that when the circuit of a Daniell or Decretet electro-magnet is closed between the two poles no spark or sound is observed, but, on the contrary, when the circuit is opened a crack like a pistol-shot is heard. In 1834 it was shown by M. Trève that the same phenomenon, though in a less degree, took place in opening the circuit near a single pole of the electro-magnet, and, further, that the influence of that single pole equally determined the instantaneous stoppage of the little coils of copper originally united between the poles. In a recent communication to the French Academy of Sciences, M. Tobie points out that this experiment of De la Rive is an excellent means of showing that a large surface the influence of the pressure existing between two contacts on the intensity of the current traversing them. The ends of the wires of the electromagnet are held in the hands between its poles, and the noise attending the opening of the circuit can be varied considerably by leaving more or less strongly on one thread or the other. This noise, which is hardly perceptible when the two wires touch each other lightly, becomes like the report of a pistol when they are forcibly pressed together. Equally curious effects are to be noticed on making contact with pointed wires.

INFLUENCE OF ELECTRICITY ON VEGETATION.—M. Celi is conducting experiments on this interesting subject similar to those of M. Cornalia to which we recently alluded. This mode of operation consists in growing two similar seedlings in equal quantities of the same soil, water and air; the only difference between their conditions of growth being that one of them is grown in a specially electrified atmosphere. The apparatus consists of a water-dropping collector, that is, an insulated metal basin of water from which a fine jet is constantly flowing and breaking in spray. This basin consequently takes the potential of the surrounding atmosphere, positive ordinarily, but sometimes negative in broken weather. The plant to be electrified is enclosed in a bell jar, and a wire runs from the basin to a set of metal points within the bell jar which give off electricity to or take it from the jar. The non-electrified plant is also enclosed in a similar bell jar and in the same soil and water, but has no wire connecting it with any source of electrification. On July 12 last, three grains of maize of equal weight were sown under each of these bell jars. On August 1 they sprouted, and for two days kept pace with each other in their growth; but on the third day the electrified plants began to develope more rapidly than the others, and on August 10 the relative heights of the plants were 17 and 8 centimetres.

REMARKABLE ELECTRICAL PROPERTY OF GLYCERINE.—Professor Wullenhofen finds that when a cord is coated with glycerine on one side, and paint connected with conductors leading to the coatings of a Leyden jar, or the terminals of a Ruhmkorff coil, are placed in contact with opposite sides, but not exactly opposite each other, the positive is in contact with the coated side, the perforation by the discharge will invariably be opposite to the positive point instead of the negative, as in Zollin's experiment.

Tel Jour July 15. '73

Relation between Electric and Capillary Phenomena.—By M. G. Lippmann.—(1). The surface of a drop of mercury placed in a glass vessel and surrounded with dilated sulphuric acid, quickly contracts, becoming more convex when placed in metallic communication with the zinc, but it re-expands when placed in contact with acid liquids. It may produce electric current which polarises the surface of the mercury. The experiment shows, first, that the contraction of the surface is due to a change in the capillary constant, this constant and the electromotive force of polarisation being continuous functions of one another; second, that, reciprocally, an extension of the surface produced by a purely mechanical action polarises it in the same manner as an electric current. (2) Variation of the capillary constant of a surface of mercury ascertained by hydrogen. The method employed consisted in polarising the top of a column of mercury contained in a glass tube by the current of a Daniell's element. The value of the capillary constant was taken by measuring the depression produced by the maximum. The same arrangement which furnished the capillary curves also measured the electromotive force of the polarised cell, and the initial deposition. The results have been confirmed and extended. The capillary constant varies from 361 to 423 millimetres, when the electromotive force of the polarisation varies from 0 to 1st Daniell. In employing a glass tube drawn to a slender point, of a diameter of about one m. m., altered under the objective of a microscope, we obtain a *capillary electrometer* of great sensibility, well adapted to measure electromotive forces. The free tension at the point of a Daniell element is measured by a pressure of more than one-third of an atmosphere. The approach of a freely-charged proof plane produces, by influence, a current which repels the mercury. (3). Polarisation produced by a variation of the surface.—By replacing the glass tube by a Thomson electrometer as modified by M. Kirchhoff, or by a quadrant electrometer, constructed by the author, of mercury, we find that the capillary constant of the surface and its electromotive force vary continuously whilst the surface is developing. The quantity of electricity produced may be measured in absolute units; it is independent of the form of the surface, and is simply proportional to the increase of area. These quantities change their sign when the surface diminishes instead of increases. (4.) Electrocapillary motors.—We are able to construct, by the principles given above, a motor which transforms indefinitely the current of the battery to mechanical work. Two masses of mercury, surrounded by sulphuric acid, may serve alternately for negative electrodes to the current of a Daniell's element. In each mass is partially immersed a bundle of glass tubes, open at both ends. At each inversion of the current one of the bundles ascends, the other descends. A system of levers transforms this alternate motion into rotary movement. The machine itself works by commutator. When we replace the battery by a galvanometer, and then work the system of the machine by hand, the needle is deflected during the rotation and in a direction which changes with that of the rotation.

Tel Jour Sept 1. '73

Curious Electrical Experiment.—By M. Broche, of Toulouse.—I here a description of the following apparatus will be interesting. I do not know if it is new, but I have never seen it in any physical works. Two bands of paper are arranged as an armillary sphere, that is, the two circular bands of paper are placed at right angles. The bands at summit and base are pierced with two holes, in which passes a vertical axis terminated by two metallic cups or small plates of cork. This little apparatus is first upon an electrical machine, and the following are the phenomena observed:—If the finger be placed to the left or to the right of the apparatus, it turns from the right to the left or from left to right, according to the position of the finger. If the change in the position of the finger be made quickly, the change of movement is also instantaneous. If the finger be raised or lowered while the apparatus is revolving, it mounts or descends the length of wire. The pulse of the hand presented stops the movement. A metallic point produces the same result. During the rotation, a beautiful star appears at the end of the finger. A button of copper may replace the finger, but the movement is slower. M. Bahnsdorff has successfully repeated these experiments.

Researches on the Phenomena Produced in Liquids by Electric Currents of High Tension.—M. G. Planté.—The author employed secondary coils which use the largest inner (?) coil (?) giving 20 sign to the liquid of the voltameter. The two strongest results which seem to throw light on the origin of the fire-ball, or globular lightning, sometimes observed towards the end of an electric storm.

Animal Electricity.—An important paper on the electrical currents produced in animal electricity is published in the *Philosophical Transactions* for the present year. The author, Dr. Augustus D. Waller, finds that the phenomena of the electrical phenomena of muscle and nerve may be readily deduced from a few very simple propositions. Artificial muscle-column responds both to electrotonic and to excitative influences by an electric wave. The slight disturbance of the muscle-negative potential with respect to the unaltered. This, together with the doctrines of internal transverse currents in nerve and of the spatial-internal inverse nerve-excitation, appears fully competent to explain all the facts hitherto observed.

communication to the Royal Society.

Electric Fluorescence.—It has been found by M. Wiedemann that nearly all platino-cyanide double salts also fluorescence under the electric discharge; but so long as the are undecomposed no double fluorescence is observed. When platino-barium cyanide had been traversed by a single discharge, the strong fluorescent light showed no dichroism, but after a series of discharges it appeared. It also occurres when crystals of platino-various cyanide or other platino cyanide double salts were left a long time in vacuo (without electric discharge), whereby they lost water; and the more rapid appearance or dichroism under the electric discharge is attributed by him to the heating of the crystals.

Beethoven Feb 28 1880

the very opposite principle. Safety must be conveyed by a decided and unmistakable signal, the absence of which shall, in itself, be an indication of danger.

THE "ETHERIC" FORCE.

We often hear that "there is nothing new under the sun" and a fresh confirmation of the fact will be found in a paper on the "Phenomena of Induction," by Professor Edwin J. Houston, which appears in *The Journal of the Franklin Institute* for last month. The author it appears had, as far back as the commencement of the year 1871, published an account of some experiments made by him which, both in their method and results, bear a resemblance to those recently made by Mr. Edison; and they further seem to indicate that the action of the so-called "Etheric" force, of which so much has been heard of late, was observed then, and was settled as being nothing more nor less than the effects of Electrical Induction. Professor Houston says:—

The experiments alluded to were made with a Ruhmkorff induction coil, capable of throwing the sparks about six inches in free air. I found that by connecting one of the poles of the secondary coil with a gas pipe by means of a good conducting wire, and the other pole by similar means, either with a large insulated conductor or with a semi-insulated conductor, as for example, by allowing the wire to rest on a dry lecture table, that the volume or quantity of the spark was greatly increased, and at the same time the characteristic whitening of the condensed spark produced. These results I attributed entirely to a condensation of the spark by connection with extended surfaces, similar to the condensation produced by the introduction of a Leyden battery into the circuit.

During the progress of the experiments the following facts were noted, which bear upon the observations of Mr. Edison. While the interrupter of the coil was in operation, making and breaking contact with the battery, sparks could be drawn from any metallic objects in the neighbourhood of the coil, and, indeed, in adjoining rooms. For example, by holding a small metallic object in the hands, sparks were drawn, in an adjoining room, from a large pneumatic gas meter, from the well soldered joints with the water-pipes of the building. Similar sparks were drawn from a half-horse power engine, also in metallic connection with the water-pipes, and from the steam boiler in the chemical laboratory on the floor below. A person standing on the floor could draw sparks from any of the gas pipes in the adjoining rooms by holding a knife blade to the pipes or burners. These results I of course attributed to the action of the induced electricity from the coil, and published a note of them merely as a new experiment with the induction coil. On first hearing of the alleged discovery of the "Etheric Force" by Mr. Edison, I was led to think it probable that the phenomena observed by him were similar to those noticed by me in 1871, but from the brief descriptions published in the newspapers, was unwilling to make a public note of my belief. In the *N.Y. Tribune*, of December 9, however, Dr. Beard, of New York, has published a fuller account of the manner in which the experiments were conducted, and as far as I can gather they are of a similar nature to mine, and I feel warranted in believing that they can all find a satisfactory explanation by the presence of *induced electrical currents*, without the intervention of any new force whatever.

Immediately on reading the first published account of Mr. Edison's experiments, I repeated my original experiments in connection with my friend, Professor Elihu Thomson, of Philadelphia.

I append a brief description of our experiments. The induction coil already mentioned was worked by means of an electro-poin battery of ten cells coupled for an intensity of ten. The elements of each cell consist of a single plate of zinc placed between two plates of carbon. The available surface in each cell is about three by six inches. One pole of the battery was placed in metallic connection with a gas pipe and the other in similar connection with a large insulated conductor. On working the interrupting breakpiece, a torrent of characteristic white sparks of condensed electricity passed between the platinum points of the coil. Under these circumstances, that is, while the discharges were occurring between the points, sparks could be drawn from all metallic objects in the same room with the coil, or in adjoining rooms. The sparks were especially noticeable when metallic objects were approached to the gas or water pipes of the building, or to metallic surfaces in connection therewith, as in the case of the pneumatic trough, steam engines, and boiler before mentioned. As already implied, actual contact between the gas or water pipes and one of the wires leading from the coil, was unnecessary, as distinct sparks were afforded by a stove in the same room, and from another in an adjoining room.

In order to test the suspected similarity between these sparks and those described by Mr. Edison, we submitted them to the tests proposed by him. We made a number of experiments, and obtained the following general results, viz.:

First, The gold leaves of a delicate electroscope did not diverge on being brought into contact with the metallic objects yielding the sparks, although in every case the sparks could be seen at the point of contact.

Second. The needle of a delicate astatic galvanometer was not sensibly deflected by the sparks, on an apparent current being caused to traverse the coils of the instrument.

Third. A small shred of cotton wool was not sensibly attracted or repelled by pieces to which the spark might be obtained.

Fourth. The so-called retro-action of the spark was distinctly observed. On looping a wire back on itself, a decided spark was seen at the point of contact made by the end of the wire with any portion of the wire itself.

All the above results are in strict accordance with the known laws of electricity, as will appear hereafter.

To still further compare these results with those obtained by Mr. Edison, we dispensed with the use of the induction coil, and employed an apparatus similar to that described by him, viz.: An electro-magnet in connection with the battery already mentioned, the current of which was rendered intermittent by means of an ordinary

interrupter. With this arrangement, a wire in contact with the core of the magnet yielded sparks having all the properties described by Mr. Edison.

From a careful reading of the published accounts of Mr. Edison and Dr. Beard, it appears that the alleged discovery of a new force is based on their failure to obtain from the sparks, indications of electrical charges or currents; or in other words, in the apparent absence of electric polarity. All the effects noticed, however, are readily explainable by reference to the presence of an instantaneous outgoing current, immediately followed by an incoming one, with the complete re-establishment of electrical equilibrium. When we bear in mind the enormous velocity of electrical currents of this character, probably some hundred thousand miles per second, we can readily understand that the flow and reversion of the current would take place in an exceedingly small fraction of a second; a space of time insufficient, were the current merely direct, to produce any decided divergence of the leaves of the electroscope or the needle of the galvanometer. *The presence of the inverse current, immediately following the direct current, would absolutely and necessarily prevent the exhibition of electrical polarity as exhibited in the motion of the electroscope, galvanometer, and of similar instruments.*

It is doubtless due to the fact that the direct and inverse currents are opposite in their effects, and therefore produce instantaneous electrical equilibrium, that Mr. Edison failed to obtain the characteristic twitching of frogs' legs, or the discoloration of iodized paper; for, although these results would unquestionably follow an electric current in one direction, their presence would be masked by the opposite effects produced by the instantaneously following inverse current.

The possibility of the existence of the direct and inverse currents as above described, may be questioned; but when we bear in mind that the sparks can only be obtained by the interruption of the battery current, and that it is necessary to pass the battery current through a long coil of wire, conditions in every way favorable to the productions of instantaneous induced or extra currents; the direct and inverse currents follow as a matter of necessity; for the induced or extra currents in the coil of wire necessarily produce, in the core of the magnet and the metallic wire in connection therewith, an electrical current in one direction, instantaneously followed on the cessation of the induced or extra current; by a current in the opposite direction for the re-establishment of the electric equilibrium in the cores of the magnet.

It is a fact well known to all versed in electrical science that the induced current produced at the moment of making contact with the interrupter flows in the opposite direction to that produced on breaking the contact. This fact would in itself, exclusive of the above explanation, be sufficient to account for the production of inverse currents in the core of the magnet, when the interruption of the battery current was sufficiently rapid. Dr. Beard admits that the phenomena may be referred to a somewhat similar explanation, but the value from his subsequent adoption of the term "spalic force" as a preferable term to "etheric force."

It is matter of surprise to us that both Mr. Edison and Dr. Beard endeavored by careful insulation to eliminate in the apparatus employed by them the effects of induced electricity or science that the more perfect the insulation the more decided the effects of induction; of which perhaps, no better instance could be found than the care taken to thoroughly insulate the secondary coils in the induction or Ruhmkorff apparatus. In view of the above considerations, we feel warranted in the belief that all the phenomena noticed by Mr. Edison and Dr. Beard are explainable by the presence of inverse electrical currents of considerable quantity, but comparatively small intensity, instantaneously produced at the making or breaking of the battery circuit.

There was noticed during the progress of our experiments with the induction coil, the following curious phenomenon, which appears to us favorable to the explanations we have adduced. One of the poles of the coil was connected with a gas pipe and the other with an insulated conductor of considerable surface in the room containing the Ruhmkorff coil. This room is in connection by a telegraph wire with the chemical laboratory on the floor below, and with an earth circuit station, D, in another building, about five hundred feet distant in a direct line. On the interrupter of the coil being worked a peculiar clicking sound was heard by both of us in the line wire in the chemical laboratory. The operator at D was requested to observe whether any unusual phenomena were noticed at his instrument. He at once telegraphed to us that a distinct "tinkling sound" was heard, which did not vary whether the ordinary battery current of the line was opened or closed. Since he did not know what to expect, his confirmation of our observation was very satisfactory. The production of the sound is probably referable to a rapid succession of molecular changes produced in the wire by the sudden reversion of its electrical states.

Proceedings of Societies.

THE CHRISTMAS LECTURES AT THE ROYAL INSTITUTION.

By PROFESSOR TYNDALL.

(Continued from page 61.)

THE LEYDEN JAR AND THE ELECTRIC DISCHARGE.

Professor Tyndall's fifth lecture on Experimental Electricity, was devoted to the Leyden jar. He began by exhibiting the first form of this apparatus, as invented by Kleist, in 1745, and Cunæus, of Leyden, in 1746—1745. A phial three parts filled with water, with a nail fixed in the cork and plunged in the water. The nail was electrified, and the charge gave a smart shock when the phial was held in one hand and the nail touched with the other. The effect was increased by Wilson in 1746, who placed the phial containing water in a vessel so filled with water as to bring the surfaces of the liquid to the same level; and by Drs. Watson and Bevis, who substituted shot for the water inside the phial. Dr. Bevis coated a plate of glass with silver-foil on both sides, within about an inch of the edge; and Dr. Watson coated a phial inside and out with silver

no doubt, inventors and other students in telephony will take up the work and experimentally develope it further. So far, I feel satisfied in having discovered the principle and experimentally established the possibility of reproducing sounds by thermo-actions, through conversion of forces. A new route is thus opened to scientific research, and to progress in telephony.

THE ELECTRICAL PROPERTIES OF BEES WAX AND LEAD CHLORIDE.

By Professors J. PERRY and W. E. AYRTON.
Abstract of Paper read before Section A of the British Association, August, 1878.

PROFESSOR AYRTON commenced by noting the close way in which investigations in the various branches of physical science were linked one with another, and by remarking that experiments on electric absorption ought to have no less interest for the scientific engineer than those on the increasing strain of materials under constant mechanical stress had for the electrician. He then described how, in consequence of the absorbed charge in water being immeasurably greater than the surface charge, no direct method of determining experimentally the specific inductive capacity employed by Mr. Perry and himself, in their experiments on "Ice as an Electrolyte," failed to give the result equal to the square of the index of refraction for light of infinitely long waves, and he suggested that the method recently employed by Mr. Gordon for measuring the specific inductive capacity of rubble with very rapidly reversed charges might possibly, if applied to water, give an answer approximately more equal to the square of the index of refraction; however, he was inclined to think that, since Mr. Gordon's method for solids gave rather the application of the proper correcting factor for the thickness of the dielectric numbers closely agreeing with the received specific inductive capacities, there existed no known method for correctly ascertaining the electric capacity of a fluid.

For although a condenser might be made of opposed metallic plates separated by a space almost entirely filled with a liquid dielectric, which did not, however, touch either plate, and although, according to the arrangement would be solid to be insulated from the water, and the other, to be insulated from the paper on both sides—"Viscosity of Dielectrics," a succession of rapidly reversed charges would be accompanied by *true electric retardation* in fact that it would be worthy of consideration whether the experiments of the result which Mr. Gordon had brought to their notice at this meeting, viz., that his new method of measuring specific inductive capacity of solid dielectrics had given the old results might not be found to operate in this *conduction*—this viscous conduction he might term it, although in reality there was but one kind of conduction, the conversion of electric energy into heat—for this conduction would occur unequally in the two apparently balanced condensers, since the two dielectrics varied in viscosity, consequently the balance of capacities was not a real one.

Nevertheless Professor Ayrton thought it highly important that careful experiments should be made, both with constant and with rapidly reversed charges, on the inductive phenomena observed in such a water condenser as he had described.

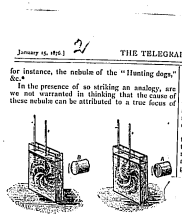
The abnormal rise in the specific inductive capacity of bees' wax, on solidifying, which the experiments of Professor Perry and himself had shown, coincided with an increase in the index of refraction; he regarded this as furnishing an important addition to the experimental proof of Professor Clerk-Maxwell's electro-magnetic theory of light, and he hoped that some of those philosophers of Trinity College, Dublin, who had so successfully turned their attention to the elucidation of the molecular vibrations causing Crookes' force, would give their views on the molecular vibrations accompanying wave motion and electric induction.

He thought that the experiments described in the paper on bees' wax and lead chloride showed, in a sufficiently satisfactory way, that, where the resistance of an electrolyte diminished by electrification, it was due to the electrometric force employed being sufficiently great to decompose the clamp in the pores of the electrolyte; but, in view of the fact that the resistance of water itself increased by electrification, it seemed to follow that the products of the decomposition of the clamp must act chemically on the solid electrolyte and cause deterioration, and hence a smaller specific resistance. But if there were deterioration we should expect that the specific resistance of the material would actually diminish day by day, a result that was not observed in the experiments of Professor Perry and himself, on bees' wax at any rate, as will be seen on examining the table given in the paper in the *Philosophical Magazine* for August. He therefore concluded that further experiments on electrolytes, in which resistance diminishes by electrification, were necessary to make the explanation quite complete.

ELECTRICITY IN FLOWERS.—Last evening a gentleman of this city accidentally made a most singular discovery, which has since been fully confirmed. He was passing through the store of Avery Sentell near the Music Hall, over which the vine was trained, and observed a flower attached to a single green thread upon the vine, which was fully extended straight out from the wall, and perceiving some of himself would do the same with which the stem was closed, there not placed there for the purpose of conducting the electric fluid of the atmosphere to the plant. In order to confirm this investigation he approached his finger within a half inch of it, and was startled to observe a slight electric impression—a just unmistakable motion of the stem. He then placed his finger a little nearer the stem; trembled violently and was seemingly attracted and repelled from him. The hairs which he noticed before did not do more, but remained erect. There was no wind at the time and the motion was purely an individual one. After this interesting experiment he touched the end of his finger within a short distance of the growing bud and slowly moved in a circular direction. The stem followed the motion until it was bent in the shape of a letter C, and when the finger was withdrawn instantly resumed the former straight position. This last experiment was witnessed by several persons, all of whom tried it with varying success.—*Lafayette (Ind.) Courier.*

for instance, the nebulæ of the "Hunting dogs," &c.*

In the presence of so striking an analogy, are we not warranted in thinking that the cause of these nebulæ can be attributed to a true focus of



electricity? whilst their special form may probably be owing to the presence of a strongly magnetic celestial body in the neighbourhood, and that the direction of the curvature of the rays may depend upon the nature of the magnetic pole turned towards the nebulæ.

We must then seek amidst the stars already known around these nebulæ for those which by their position may exercise magnetic influence, and explore the celestial vault upon the axis around which the spirals seem to turn in this or that direction, in a systematic manner, in order to discover the celestial bodies capable of influencing their forms or their gyratory movements. Further, if a star was found which satisfied these conditions, we should examine it upon the line passing through the centre of the nebulæ, and through the star itself, to see if there is not a point corresponding to the other pole of this star, and a second nebulous spiral having its rays turned in the reverse direction to the magnetic currents of the pole, but nevertheless appearing to the observer, turned in the same direction to those of the first; then the whole of these three bodies thus constitute a symmetrical stellar system. The cosmic matter is spread with such great profusion in space that this hypothesis is quite admissible.

Such researches require the employment of most powerful telescopes. I have suggested these theories to astronomers who have the reserve which should accompany inductions based upon simple analogy; but if observation justifies the assumption, it will afford a decided proof in favour of the electrical origin of spherical bodies. One might object that it would be impossible for a current of electricity to be conducted in space from the exterior to the centre of the nebulæ; in reply to this objection, I may remark that in other experiments with a source of electricity much more intense, I have observed little luminous rings formed by incandescent particles wholly detached from the electrode; these rings, the middle of which was agitated by a liquid vortex, move in the interval between the electrode and a larger luminous ring, formed by matter disturbed by the impulse of an electric wave against the partitions of the voltameter. These have the electrical fact separated from the principal ray to which they have given birth, and analogous, although infinitely small, to the origin of the isolated stars, or to those stellar agglomerations, for instance, which constitute the ring-shaped nebulæ of the "Harp," the "Swan," or the "Milky Way."

The last luminous ring which forms the limit of the development of the electric wave in the voltameter can even show the existence of immense nebulous rings hitherto invisible, which envelope all the others, and which is the last wave of the general electric movement of the universe.

ON NEBULOUS SPIRALS.

By M. F. PLANTÉ.

IF spectrum analysis has in later times allowed us to study the chemical constitution of celestial bodies, it is not rash at the present day to seek to give a reason for their physical constitution by the observation of electrical phenomena, and by the inferences that may be drawn from them.

The gyratory movements, accompanied by luminous effects, which I have observed with a powerful flow of electricity, the spherical and annular forms manifested by bodies under this influence, have already led me to surmise the probability of the electrical origin of celestial bodies.

I am able now to attribute the same origin to these worlds by a process of aggregation and disaggregation, which constitute the non-resolvable nebulæ, and particularly those which take the remarkable spiral forms.

I have some time since drawn attention to an experiment in which a cloud of metallic matter, attracted to an electrode by a current of electricity in the midst of a liquid, assumes a gyratory movement in the form of a spiral. It will suffice to look at Figs. 1 and 2, which represent this experiment, in order to recognise the exact form of the spiral nebulæ described by Lord Ross, the form of which have the curvature of their rays directed in the reverse direction to which the hands of a watch turn, like the rays in Fig. 1—such, for instance, as the nebulæ of the "Hair of Berenice," &c. Others have their rays directed in the same direction as the hands of a watch use, as those in Fig. 2, as

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Selenium Experiments.

H. J. Moss has discovered that, when a bar of selenium is placed in the exhaust tube of a Sprengel pump and the air exhausted, the selenium becomes electrically conductive in the course of ninety hours. The selenium is then found to be covered with a delicate film of mercury, from the globules contained in the pump; and the conductivity is ascribed to this film.

* If we consider the moment when the metallic powder is in a state of rotation in the liquid, the resemblance to the rays of this latter nebula* in particular, is still more marked than in the figure referred to.

It is a well-known fact that muscles contract under the influence of electricity, and it is long since experiments were first made in the stimulation of dead bodies by this means. Some curious phenomena have been obtained in this way. Recently, Dr. Keppeler, of the hospital of Mannheimgen, has added some new observations on the subject. He subjected twenty corpses to the action of various electric currents, and noted the rate of disappearance of the electri g-muscular contractility. In persons emaciated by long chronic maladies, this disappeared much more rapidly than in robust individuals, or those who had had acute maladies. It disappeared five quarters of an hour after death, at the quickest, and six-and-a-half hours at the slowest. It is in cases where a rise of temperature is observed after death (which are not extremely rare), that the electric contractility persists longest. The importance of this sign of death is evident if we reflect that the contractions under electricity continue intact so long as there remains the least life. In the most prolonged faints, in the deepest lethargies, in all the varieties of apparent death, poisonings by carbonic oxide, chloroform, or narcotic substances, this valuable sign can be had at will, so long as real death is not a *fait accomplit*. The fact of death, too, can be thus ascertained without the necessity of awaiting other certain signs of death. Some interesting cases in this connection are related by Dr. Keppeler in his paper, which appears in the *Bibliothèque Universelle* for November.

between this interval and the extent of the barometric variation, judging by the frequency with which the thermometric change followed at a short interval after an extensive change in the barometer, the consequent variation in pressure affecting the more or less rapid development of heat. Frequently when the extension of the magnet was extensive, the change in the barometer and thermometer are less active, exhibiting a tremulous or perturbed result. Sometimes the contrary only behaves in this way. The variations of the thermometer descends in winter, but it still retains the variations in rapport with those of the results of the barometer.

The following table would also show that a relation exists between the direction of the magnetic variation and the rise or fall in the barometer and thermometer. The years 1848 and 1851 are selected at random, and the maxima and minima are those of the maximum wave-line on each date.

Mr. Broun. Observ.'s Assist.'s	Chiswick: September.						
	Magnetic Variation Sept. 1851	Barometer 1848.		Thermometer 1848.	Barometer 1851.	Thermometer 1851.	
E.	W.	Max	Min	Max	Min.	Max	Min.
—	8 2	—	—	4	—	3	—
4	4	8	3	13	7	4	4
7	7	9	3	13	7	7	7
11	11	10	10	17	11	11	11
13	12	16	10	17	13	13	13
16	17	15	11	20	19	20	16-19
—	—	21	21	22	21	20	21
—	21-23	Gradual rise from 21 to 23		23	—	22	22
24	27	27	—	23	24	18	24
28-30	—	—	26	16	29-30	13	—

This table shows that an E. magnetic variation is attended by a maximum barometer and thermometer, and the W. variation by these at a minimum.

The following extract is from a paper by Mr. T. Hopkins on the Meteorology of January:—"At about 10 a.m. the barometer ceases to rise, and shortly afterwards begins to fall, and it continues falling until 4 p.m., although the cooling of the wet-bulb thermometer has by that time ceased. From 10 until 1 or 2 o'clock, the time of the highest temperature, vapour must be rapidly mixed into the atmosphere in increasing quantities; and the vapour must be presumed to accumulate in the atmosphere until 4 o'clock, as the evaporation generally continues active up to that hour, and no decline of the dew-point indicates the condensation of any portion of the vapour thus produced. Now, if increase of vapour had raised the barometer up to 10 o'clock, why should not a further accumulation of vapour after that hour raise the barometer still higher? The fall of the barometer after 10 o'clock, in fine weather, must be accounted for from the operation of the causes named."

The force of this is evident in connection with the theories advanced in these papers. The part of the surface of the earth turning towards the sun, and receiving from the great source of atmospheric agitation, the pressure from without our system. The consequent increasing evaporation together until about 10 o'clock, when the force *ab extra* diminishes, and the balance of vapour alone cannot maintain the increased column at its previous altitude. When, by the rotation of the earth on its axis, that part of the earth's surface under observation approaches the force *ab extra* about 4 o'clock, the effect of its power is observed in the increased altitude of the mercury. No previous theory could explain this, and the same as regards the following:—

Mr. Broun found that the semi-diurnal variation of the barometer was greater in winter than in summer.§ He also notes in the same memoir that the barometric variation during the day in

* Transact. Roy. Soc. Edinburgh, Vol. xviii., plate 21.
† *Phil. Mag.*, 3rd Ser., Vol. xxxiii.; also Vol. xxxiv.
‡ *Philosophical Magazine*, 3rd ser., Vol. xxxix., p. 466.
§ *Complet. Results*, T. Series, p. 124.

OCTOBER 30, 1874. ENGLISH

NOTES ON SOME ELECTRICAL PHENOMENA.

No. VIII.

(Continued from Vol. XIX., p. 476.)

WHILST computing a mass of meteorological observations in reference to electro-magnetic theories advanced in three papers, the writer has met with some results that may, perhaps, interest those of our readers who study these theories.

The rapport between the magnetic and barometric variation was has already been detailed and illustrated by Mr. Broun. The pressure developed by the electric disturbances in the stars, more particularly from their enormous ovenidences, is disclosed by the varying height of the barometer, and, on occasions, especially when sudden, generates heat, it might reasonably be supposed that a variation in the thermometer would also occur in rapport with the magnetic and barometric variations. As far as the writer's investigations have extended he finds such to be actually the case, that there is a decided relation between the thermometric and the barometric fluctuations, the former following the latter generally after an interval of from two to four days, which lapse of time is the action on our system *ab extra* is like that of our star whilst it, seeing that the greatest heat of the day does not occur at noon, but some time after. There also appears to be a relation

Journal de Physique, III., No. 34, Oct. 1874.—This number commences with the first portion of a paper by M. J. Bertrand, entitled "Demonstration of Thomson's rule relative to Electro-dynamic Actions." The object of this paper is to simplify Ampère's demonstration of the theorem of electrodynamics.—Arrangement for obtaining projections of the metallic rays and amphyglogen fluxe, the latter employs a mixture of the chloride of the metal with one-sixth of its weight of powdered gum-lac, provided with a vertical slit. Reversals of the metallic lines are effected by allowing a beam of white light (transmitted or sun-light) to pass through the disfigurating mixture and, analyzing the resulting ray by prisms. By allowing the sun-light to fall only on one-half of the slit, the coincidence of bright with dark lines can be shown.—M. Mercet contributes a paper describing two pieces of apparatus for obtaining the placement of isoclinic lines.—On the magnetisation of steel, by M. E. Bourg.—This number contains a translation of Lord Rayleigh's paper on the manometer and theory of diffraction gratings from the *Philosophical Magazine* for February and March.—Sensibility of silver iodide to rays supposed to be chemically inactive, by H. Vogel, from *Pogg. Ann. of Chemistry*.—From the same journal there is a paper by H. Seeliger, on changes in the length and elasticity of a wire under the influence of an electric current.—From the Proc. Roy. Soc. there are translations of Prof. Tyndall's paper on the transmission of sound, and Mr. Norman Lockyer's note on a new law of absorption phenomena.

EARTH CURRENTS.—Cappanera notices that earth currents are strongest in certain volcanic districts. At Potenza they are strongest in the neighbourhood of the Monte Vulture (mount of Vultures, and are most noticeable in October, November, December, March, and April, especially during heavy falls of snow.

Mr. Preece's Speaking Telegraph.

We have had a sealed account of an invention of speaking by telegraphy have been shown to us, but we are still quite in ignorance of the nature of this invention, it would be well to have the complete secret before we occupy ourselves much on the matter for some time to scientific men. The following plan has been described to us, and our friends, and, no doubt, has suggested itself to many acquainted with the physical discoveries of the last four years. It is simply carried out between the elaborate nature, and on account of its expensive character, we should we recommend its being carried out in this form. But if the new American invention, to which reference has been made, should turn out to be some plan of this kind, then this letter may be good in preventing monopoly in an invention which really is the joint property of Willoughby Smith, Siemens, and other scientific men, rather than of a particular man who has had sufficient money and leisure to carry out the idea. The plan, which was suggested to us some three years ago more immediately by a picture in *Punch*, and governed by Willoughby Smith's experiments, is simply—Let the transmitter at a station of a large surface made up of very small square squares of selenium. One end of every piece was connected by an insulated wire with the distant place, i, and the other end of each piece connected by a wire to the earth. With the plan commonly employed with telegraph instruments. The object whose image was to be sent by telegraph was illuminated very strongly, and, by means of a lens, a very large image thrown on the surface of the transmitter. Now it is well known that if each little piece of selenium forms part of a circuit in which there is a constant electromotive force, say of a Voltaic battery, the current passing through each piece will depend on the illumination. Hence the whole Voltaic current in each telegraph wire would depend on the illumination of its extremity. Suppose, then, that each piece, 1, was, in our original plan, a collection of opposite cells, the position of each of which (as in the ordinary needle telegraph) was controlled by the electric current passing through the particular telegraph wire with which it was connected. Each magnet, by its movement, closed or opened an aperture through which light reached to illuminate the back of a small square of frosted glass. There were, of course, as many of these illuminated squares at 2 as of selenium squares at A, and it is quite evident that since the illumination of each square depends on the strength of the current in its circuit, and this current depends on the illumination of the selenium at the other end of the wire, the image of a distant object would in this way be transmitted as a mosaic by electricity.

A more promising arrangement, suggested by Prof. Kerr's experiments, consisted in having each little square at a route of silvered soft iron, and forming the end of the core round which

NOTE.—All degrees of temperature are Centigrade, unless otherwise mentioned.

Comptes Rendus Hebdomadaires des Seances, de l'Academie des Sciences. No. 1, January 12, 1875.

Memoir on Electro-Capillary Actions, Treating of (a) the Depolarization of the Electrodes, as well as of the Electric Effects Produced at the Point of Contact of the Membrane and of Various Liquids; (2) the Relations between the Electromotive Forces, the Quantities of Heat Liberated during their Production, and the Diffusive Powers.—M. Becquerel.—The names of this paper appears sufficiently from the title. The author considers that he has arrived at a more exact determination of the electro-motive forces, and more complete study of the intervention of electro-capillary actions in the phenomena of life.

Mr. P. Bonham made some remarks on some further experiments on *Crystallisation of Metals by Electricity*, in which he stated that he had placed the positive and negative electrodes of a battery in a vessel containing a mixed solution of copper and zinc, and that with terminals of copper he obtained a good crystallisation proceeding from the negative pole of mixed crystals of copper and zinc, and beyond this, crystals of copper alone. With terminals of zinc he got a mixture of crystals as before, and beyond of zinc, crystals of zinc alone. But if terminals of brass (a compound of zinc and copper) are used, there is a dull crystallisation of zinc across the field. He also observed that with zinc terminals, by increasing the battery power, the crystallisation is broken up; but not so when the terminals are copper or brass, but then the crystallisation extends closer and beyond the positive pole.

Mr. Gladstone read a paper *On Silver Nitrate*, giving the

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the corresponding current passed. The spokes formed by these squares at 2 were to be illuminated by a great beam of light polarized by reflection from glass, and received again by an analyzer. It is evident that, since the intensity of the analyzed light depends on the position of the plane of polarization by each little square of iron, and since this depends on the strength of the current, and that again on the illumination of the selenium, we have another method of receiving at 1 the illumination of the same square at A. It is probable that Prof. Graham Bell's microphone may admit to some plan of a much simpler kind than either of ours; but in any case it is well to show that the discovery of the light effect on selenium carries with it the principle of a plan for seeing by electricity. JOHN PERRY

Scientific Club, April 21 W. E. AYRTON

Remarkable Electrical Phenomena.

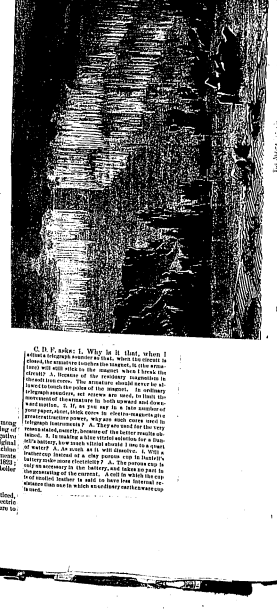
The night of July 7-8, 1835, will be long remembered in Switzerland for thunderstorms, several of them of almost unexampled severity. Of these, one that broke over Geneva was unprecedentedly severe and disastrous. It appears to have originated in no violent, in the department of Ain, and took an easterly course up the valley of the Rhone, over the lake, and through the city of Geneva, without rain, and hence did not elicit the course over Savoy. An oblique course on, though the heat was suffocating and not a breath of wind stirred below on the streets, light objects on the roofs of the houses began to be whirled about and carried off at by a tempest of wind. At the same time a dull, rumbling sound, resembling neither that of wind nor that of thunder, announced the approach of the thunderstorm, and at 11 minutes exactly it burst over Geneva in all its fury. An avalanche of enormous hail stones, with no trace of rain, was precipitated from the sky, and shot against opposite objects by a tempest of wind from the southwest. In a moment the street lamps were extinguished, and in a brief interval incredible damage was inflicted, the glass and tiles of houses smashed to powder, trees stripped of their bark and the side facing the west, and even of every sort were, in many instances, driven into the ground. The smallest of the hailstones were the size of a hard nuts, many were as large as walnuts and chestnuts, and some even as large as a hen's egg. Some of the hailstones measured four inches in diameter, and six hours after they fell weighed upwards of ten ounces. For the most part the hailstones were of a flattish or lenticular form, with a central nucleus of 9 to 12 lines diameter, developed in several concentric layers of ice, generally from 6 to 8 alternately transparent and opaque. A map has been printed in the *Journal de Genève*, showing the districts where the storm was felt, as well as the degree of its intensity in each locality. The electrical phenomena were very remarkable; the flashes of lightning succeeded each other with such rapidity, from midnight till a few minutes after 1 o'clock in the morning, that a mean of from 2 to 3 were counted per second, or from 9,000 to 10,000 per hour. Electrical phenomena were remarkably developed before and during the hail. The ground, almost in prominent objects, as well as the hailstones, were strongly electrified. Immediately after the hail, some was greatly developed, the smell being so pronounced as to be compared, by nearly all observers, to sulfur. The intensity of the electric charges passed from cloud to cloud over a central point from which the hail fell, but thunder was very rarely heard.—*Nature.*

ELECTRICITY.

The old electrical machines are very interesting. Among them will be seen Priestley's electrical machine, consisting of a glass globe which can be rotated on a fixed rod, whose negative electricity being obtained from the rubber; Nairne's original globe and cylinder machine from King's College; a variation of the same by Singer and used by Beccaria in his early experiments in connection with the electric telegraph, described in 1672; and Armstrong's Hydro-electric machine—an old iron boiler standing on glass legs.

THE AURORA.

Prof. Lemström's polar light apparatus should be noticed, intended for showing that the Aurora Borealis is an electric current flowing from the higher regions of the atmosphere to the earth.



Annales de Chimie et de Physique,
August, 1875.

Relations Between Electric and Capillary Phenomena.—M. Gabriel Lippmann.—The following is a resumé (by the author) of this valuable memoir. Two distinct laws have been demonstrated by experiment; the first (chap. i.) connects the capillary constant with the electric difference; the second (chap. ii.) connects the variation of the electric difference with variations of area of the surface. These two laws, established separately by experiment, are connected together by a tie essentially necessary, if we admit the principle of energy and without hypothesis, that is to say, if the two laws formed (three decrits), which is to say, if the second law were assumed, work would be created, if the first law were not assumed. In the mathematical theory of chap. iii. this relation has been established anew, in analytic form; the analysis rests on two principles:—(1), conservation of energy; (2), conservation of quantities of electricity. No hypothesis has been called in, either in this or in the rest of the work; it is to avoid doing so, that I have abstained from giving a physical theory, an explanation of the properties observed. The electro-capillary meter described (chap. iv.) shows directly—(1), that an indefinite quantity of electrical work can be converted into mechanical work by means of capillarity; (2), that the phenomena described above are reversible. If we compare the phenomena with those of thermo-dynamics, we find that the first law answers to the law of dilatation of bodies by heat, and the second to that of cooling during expansion. The first law has also a second consequence, (3), which consists of the identity connecting the measurements of electrical tension (theory, chap. ii.), and measurements of electrical attractive forces. The electrometer described in chap. vi. is much the most precise of the electrometers now known. Chap. vii. contains the explanation of the whirlwinds described by Gerbois. The principle explaining them seems susceptible of some further applications.

SCIENCE IN GERMANY
(From a German Correspondent)

HERR W. SIEMENS has recently made the following communication to the Academy of Sciences of Berlin:—

It has been shown by Willoughby Smith and by Siale that crystalline selenium conducts electricity better when illuminated than when in darkness. The specific conductivity, when platinum and selenium rendered crystalline by heating from 100° to 150° C. is very small and extremely variable; and also the increase of the conductivity through illumination is very inconstant, so that it is impossible to establish a more dependence of the conductivity on the illumination.

I have discovered, however, by continuous heating of amorphous selenium to a temperature of 210°, as also by long continued heating at 180°, and by very long continued heating enclosed, the selenium passes into a coarse-grained crystalline state, in producing another modification of the crystalline selenium, which has considerably greater conductivity, and retains it, and conducts in this state electrically, so that with increase of temperature the conductivity decreases. The action of light on this modification of crystalline selenium is much greater, and apparently quite constant. Bring in two fine spirals of wire, about 1 millimetre apart, between two leaves of mica in coarsely crystalline selenium, he has obtained an exceedingly sensitive measure of light. Dark heat rays are *absolutely without influence* on the conductivity, and heating of the selenium, as already mentioned, *diminishes* the same. Diffuse daylight even doubles the conductivity of this light-measure, and direct sunlight increases it sometimes *more than eightfold*. The increase of conductivity of the coarse-grained selenium through illumination takes place very quickly. And similarly, the diminution of it, on shutting off the light, occurs, as a rule, in a very short, a longer time is required before the state corresponding to darkness is again fully established. The increase of the conductivity is not proportional to the light intensity, but a function of it, which comes near the proportion of the square root of the light intensities.

Herr Siemens hopes this interesting property of selenium may be utilised for construction of a reliable photometer.

W.

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* See ELECTRICAL NEWS, vol. i. p. 7.

...was scarcely will be without its wire.

CAVENDISH showed that nitrogen and oxygen in air formed a mixture only, but that the passage of electric sparks produced their chemical combination—nitric acid being the result.

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that the tube is open at both ends. We have, however, common experience—such as a thunder-clap, noises caused by the expansion or displacement of free air; and it may be conjectured that when the empty space is made by so rapid a motion as that of sounding, this sort of *electric click* will be produced. If the capillary be enclosed at one end, the phenomenon is reproduced with great facility.

When the platinum wire is restored to the open tube the vapour bubbles formed as in cautiously break the corner; as they condense the liquid is drawn up into the tube to re-fill the empty space thus formed, and rises to the upper portion, whence it falls back again in sparkling flets. Fresh bulbs of vapour re-form and condense, the liquid remounts, and the phenomenon reproduces itself in an intermittent manner.

In the previous experiments the positive wire was in contact with the liquid tube; if this wire be plunged into the liquid without touching the glass, luminous globules (already described) will be animated by a gyratory movement and will be produced. The length of the liquid column is not an obstacle to the production of the globules, as we have seen in the insulating tube of a condenser. When the negative wire is deeply immersed, and the liquid column is also kept strongly negative, the luminous globules formed at the positive pole disappear without sparks as the negative pole, and allow the electricity they enclose to flow into the air or to the surface of the liquid. But, when the negative wire is only slightly immersed, if the positive wire be also immersed its immersed surface is soon found to be greater than that of the negative wire, by the spherical agglomeration of the liquid in its neighbourhood. The current then traverses the voltameter, instead of remaining accumulated at the surface, and the properly called discharge is then produced with a noisy spark, fusion, or volatilisation, of the electrode at the negative pole.

Several conclusions may be drawn from these phenomena, in explanation of the effects of atmospheric electricity.

First of all we meet with representation of various kinds of lightning flashes. The electrified globules formed by the aqueous vesicles of the clouds may be produced or disappear without any explosion, and so give rise to those glimmerings (or flashes without thunder, as are sometimes seen in the still evening sky). Sometimes, We can also understand how electrified globes, observed near the ground, may be luminous without certain explosion, and how, near observers without striking them, may locate themselves on telegraph wires without melting or volatilising them. The phenomenon just described under the name of electric thunder-clap may likewise give the idea of thunder—not that there is in this case a discharge as at the time of the thunder-stroke; but the experiment offers an analysis of the noise which is produced at the time of the cessation of an electrical current moved enough to have previously surfused or volatilised the material opposed to its passage.

The same series of experiments explains the crackling noise of waterspouts; the mist which is formed around them, formed as that which leaves a steam-boiler; the silent flashes which rend them; the fire-balls at their extremity; and the bubbling agitation of the waters when they touch the surface of the sea. These meteors may be compared to positive liquid or vapour electrodes from which the powerful electric currents of storm-clouds escape towards the land or sea; and, if they are not accompanied with fulminating effects, it is because the conducting cloud accompanies them to the earth, and because there is not in that case a properly called electric discharge, any more than in our experiments. The conical form of waterspouts can be explained by the tendency of positive electricity to form cones in the air, under certain conditions, as to their gyratory motion, though the electric flow seems to produce by itself whirling effects, mechanical actions may also account for them; and we can only affirm

M. Plantè is at present engaged in researches on the phenomena produced by currents of high tension by means of his secondary battery, and the results seem likely to throw some light on a number of natural phenomena (those of thunderstorms, terrestrial polar auroræ, &c.) In one experiment described, having inserted the positive platinum wire in a capillary tube and this in a liquid, a stream of mist occurred; and on taking the arrangement out of the liquid there was a detonation like that of a fulminating capsule. The tube was neither broken nor heated, but the lower extremity had become conical like the top of a funnel. The phenomenon is purely mechanical—due to sudden entrance of air into the tube. The intensity of the sound, M. Plantè says, is remarkable, considering the narrowness of the annular space between the wire and the sides of the tube, and that the tube was open at both ends. But, he adds, there are other examples, such as the crack of a whip, of sound imposed by sudden displacement of free air, and we may suppose that, a vacuum having been produced by the rapid passage of electricity, such air rushed to fill the tract occurred. Something similar may take place in the case of thunder—in the sudden creation of the electric effect.

Effect of Magnetism on Watches.

To the Editor of the Scientific American: Oct. 7 5

A few weeks ago my watch, for the first time in ten years, refused to go. Up to then, it had kept correct time, and was then in good repair, having been recently cleaned. When it first began to stop I would start it by the key, and it would sometimes run a day; but finally it stopped entirely. I had it carefully examined by an expert, who, although he could find no cause, failed to make it run even for an hour.

I was running at my works a powerful magneto-electric machine for depositing copper; and having noticed that I could magnetize a piece of soft iron at a distance of at least six feet from the machine, so that it would lift and support the weight of a large nail, I became impressed with the idea that some of the steel parts of my watch had become permanently magnetized; so I made a watch repairer take it apart. Having some fine soft iron filings, I dipped the balance wheel, escapement wheel, lever, and hair spring into the filings; and each piece raised up at least one half inch with weight of the filings, through the polar magnetism of the particles.

I have read of watches being spoiled by magnets, but had no idea that it was unsafe to go into a room containing a magnet.

The watchmaker thought he might "break it off" for about a dollar: I let him break on it three days as a lesson in magnetism, and then told him that nothing short of heat, like it red hot would demagnetize it. He put in new parts, including a new mainspring, which was also infected, and the watch now runs as well as ever.

406 Cherry street, New York city. I. R. FELLER.

Remarkable Electrical Phenomenon.

The night of July 7-8, 1875, will be long remembered in Switzerland for thunderstorms, several of them of almost unexampled severity. Of these, one that broke over Geneva was unprecedentedly severe and illustrious. It appears to have originated to westward, in the department of Ain, and took an easterly course up the valley of the Rhone to Geneva, on reaching which it spread over a wider area, and thence directed its course over Savoy. As midnight came on, though the heat was suffocating and not a breath of wind stirred below on the streets, light objects on the roofs of the houses began to be whirled about and carried off as by a tempest of wind. At the same time a dull rumbling sound, resembling neither that of wind nor that of thunder, announced the approach of the thunderstorm, and at 12 midnight exactly it burst over Geneva in all its fury. An avalanche of enormous volumes, with an mass of rain, was pre-eminent from the sky, and shot against opposing objects by a tempest of wind from the southwest. In a moment the street lamps were extinguished, and in a brief interval incredible damage was inflicted, the glass and tiles of houses smashed to powder, trees stripped of their bark on the side facing the west, and crops of every sort were, in many places, all but totally destroyed. The smallest of the hailstones were the size of hazel nuts, many were as large as walnuts and chestnuts, and some even as large as a hen's egg. Some of the hailstones measured four inches in diameter, and six hours after they fell weighed upwards of 10 ozs. For the most part the hail stones were of a flinty or lenticular form, with a central nucleus of 9-16 to 9-10 inch diameter, developed in several concentric layers of ice, generally from 8 to 8 alternately transparent and opaque. A map has been printed in the *Journal de Genève*, showing the districts where the storm was felt as well as the degree of its intensity in each locality. The electrical phenomena were very remarkable; the flashes of lightning succeeded each other with such rapidity, from midnight till a few minutes after 1 o'clock in the morning, that a mean of from 2 to 3 were counted each second, or from 6,000 to 10,000 per hour. Electrical phosphorescence was remarkably intense before and during the hail. The ground, animals, prominent objects, as well as the hail stones, were strongly phosphorescent. Immediately after the hail, stones was greatly developed, the hail being so pronounced as to be recognized, by nearly all observers, to garlic. The incessant electrical discharges passed from cloud to cloud over a central point from which the hail fell, but thunder was very rarely heard.—*Nature.*

The Remarkable Electric Phenomenon.

To the Editor of the Scientific American: Sept 25

Regarding the statements relating- to the singular electric phenomena described on pages 193 of your current volume, as being in some respects opposed to hitherto observed facts, I decided to investigate the case thoroughly, and ascertain in the first place what the facts were, and then see whether they were in accord with previous observations. For this purpose, I sent one of my assistants to the house where the electrical displays occurred, furnished with the proper instruments for making careful and accurate measurements of the resistances of the rods, pipes, and other conductors about the premises.

The first measurement taken was to ascertain the resistance between the two pipes leading to and from the Waterworks. This was found to be less than 0.01 of an ohm, and most of that was probably due to the connections of the galvanometer. Of course this proved conclusively that no sparks ever passed between these pipes, and Mr. Baldwin, the occupant of the house, said that the published statement was wrong in this regard.

The resistances of the supply pipe, overflow pipe, waste pipe, and lightning rod were then measured, with the following results: Resistance of the lightning rod = 181 ohms; of waste pipe = 284 ohms; of overflow pipe = 15 ohms; of supply pipe = 0. The house stands on a hill on the dividing line of a slate and limestone formation, and the lightning rod has been placed in the form of the rock to the depth of, perhaps 6 or 7 feet, and is therefore partially insulated; and its normal resistance is doubtless much more than 181 ohms, which was found while everything was wet, a resistance having come up just before the tests were made. A resistance of 181 ohms in the lightning conductor, is sufficient, in my opinion, to occasion all the phenomena of discharge which have been observed during heavy storms. The waste pipe runs in iron, and leads off to a spring half a mile distant, where the best earth connection in the country is found. Owing to the insulating quality of the foundation upon which the house rests, the house constitutes one side of a leaky condenser, of which the slate and limestone form the dielectric, and the earth the opposite side. When a thunderstorm occurs, the whole house is charged in a greater or less degree; and as the only connection of the lightning rod is insufficient to carry all the electricity which it receives, the electricity is discharged through every available channel, of which the supply pipe is the best. In light storms, the phenomenon would not be noticed; it becomes very marked in heavy ones.

In this case the supply pipe was the safety valve of the house. The proprietor of the house was advised to connect the lightning rod to the supply pipe by a large copper wire, which will probably terminate the curious phenomena which have been observed.

I trust the time will soon come when lightning rods will be erected by persons possessed of sufficient electrical education as to be able to tell whether they have a resistance of 181 ohms or of 0. Probably no important business at the present time, is as a rule entrusted to a class of men so utterly ignorant of their duties as this one. In every case where a building supplied with a lightning rod is destroyed by lightning, the parties who put up the lightning rod ought to be prosecuted. A rigorous course of treatment of this sort would soon convince these people that a reasonable amount of study of the laws of electricity is necessary for their own safety as well as that of their patrons.

I wish that every electrical phenomenon which occurs could be promptly and carefully investigated by competent, practical electricians. Why cannot the scientific departments of our colleges undertake this service? It would furnish a fund of accurate information which would prove of very great practical value.

New York city. GEORGE B. PRESCOTT.

Anomalous Behavior of Selenium.

It has been lately observed that the electrical resistance of selenium is greater in the light than in the dark. It was at first thought possible that this increase of resistance might be due to heat combined with the light, but Prof. W. G. Adams, in his paper read before the Royal Society, June 17th, 1875, has shown that this is not the case, but that the phenomenon is a purely optical one.

The writer of this letter has to-day tried an experiment with a selenium bar belonging to the Cavendish Laboratory. Its length is 50 mm., breadth 8mm., thickness about 1mm.; platinum wires are soldered to its ends, and it has a hard metallic surface. Its electrical resistance is enormous. In the dark it is just over 100 megohms (100,000,000 B. A. U). When, however, the light of the prafts lamp of the galvanometer was allowed to fall on it from the distance of about a foot, the resistance dropped between 20 and 30 per cent. The experiment was repeated many times, with current now sometimes one way, sometimes another, and with different sides and edges of the bar turned to the light, but always with the same result, namely, that the effect of letting in the light was to largely decrease the resistance.

A second set of experiments was made with a selenium medal struck by Berzelius soon after the discovery of the metal in 1818, and presented by him to Mr. Dark, by whom son, Mr. Dark of Cambridge, it was kindly lent for the experiment. This medal was of circular shape, about 40 millims. long by 30 broad. Owing to the difference of form between the two specimens, their specific resistances could not be accurately compared; that of the medal was, however, not more than about 1-10 of that of the bar. The medal was exactly like black lead both to touch and sight, and quite different in appearance to the bar. The resistance of the medal was sensibly *the same, both in the dark and in the light: no difference could be detected.*

The experiments seem to show that the physical form of the metal has a great deal to do with its behavior when carrying an electric current and exposed to light.

J. E. H. GORDON.

Cavendish Laboratory, Cambridge, June 25.—*Nature.*

Aniline Black by Electricity.

It we take a strong solution of sulphate of aniline and anilenic it to the action of two Bunsen elements, employing platinum electrodes, we soon see the positive pole become coated with a violent blue covering, gre-nish in places, a fact remarked by Letieby. If the experiment is prolonged for 12 or 24 hours, we find fixed to the positive pole a black mass, easily detached. On treating this substance with ether and alcohol, and drying it, there remains a amorphous black body with some greenish reflections, insoluble in most solvents. If this body is treated with sulphuric acid, and spread out upon a p rcelain saucer, it takes a greenish coloration, but on treatment with alkalies it resumes its jet black color. It is not affected by nascent hydrogen. To ascertain that the production of this black was due to nascent hydrogen, and not to the platinum employed as electrode, I made use of electrodes of gas-coke, and obtained in 12 to 24 hours identical results; a black adhesive mass was fixed to the carbon of the positive pole. Nitrate of aniline gave also a black deposit, which, on treatment with alkalies, took a velvet like appearance; but in presence of sulphuric acid a decomposition took place, and I obtained a brown mercury coloration. The composition of this black is, therefore, different from that obtained with aniline salts. Metals of aniline gave, around the positive pole, a black cuoghlon but it is probable that, in this case, the action is complicated, and that there may be at the positive pole, besides nascent oxygen nascent chlorine, which complicates the results.

With the organic salts I have obtained differences which require notice. Aniline acetate gave, at the positive pole, a black glutinous substance, partly soluble in the surrounding salt. Aniline tartar gave, as result, not even the least coloration of the positive pole. Hence it appears that aniline blacks may be obtained without the intervention of metals, and that the salts of aniline behave in different manners with the nascent oxygen.—*J. J. Coquillon, in Comptes Rendus.*

1875

Some important researches in the flow of mercury in capillary tubes and the electric phenomena which accompany them, are described in a recent paper by Mr. Hockin, Assistant Professor of Physics. He considers especially the influence of metallic contact, on the efficiencies, by comparison, of the capillary tubes employed in the experiments. Spring demonstrates: formation of drops of mercury of electricity through capillary tubes, and stoppage of flowing from friction of the liquid against the tube. Also, that from thermo-electric currents in the drop. An electric current *favoring* the liquid column from the exterior to the interior, increases the quantity of mercury which flows out, while an opposite current diminishes it. Also, that simultaneous currents retarding in the flow. M. Gore thinks this is because the electricity of different elements employed to saturate the conditions of the atmosphere has been in contact with metallic tubes through capillary tubes, and elsewhere in the drop. M. Spring's investigation seems to throw a good deal of light on the nature of molecular action.

MOTIONS PRODUCED IN MERCURY BY ELECTRICITY.

In the spring of 1853, the attention of the late Sir Charles Wheatstone was directed to the discovery of Ersman (1809), that a globule of mercury in contact with an electrolytic liquid within a tube of small calibre moved forward when a current of electricity was passed through it. Sir C. Wheatstone patented a form of telegraph-receiving instrument depending on this principle. Mr. Robert Sabine has been making some interesting experiments in connection with this instrument (*Phil. Mag. Suppl.*, December, 1876), and has been led to assign to the experiment cited above, and to others of a similar nature, an explanation different from that which has been usually accepted. This explanation is based on the observed fact that a mercurial surface, when exposed to the influence of air or of water, consists of mercurous oxide, and not of metallic mercury, that the electropositive condition of a mercury surface is greatly dependent upon the state of oxidation, that the expansion or contraction of such a surface is always attended with a corresponding alteration of the electro-positiveness, and, finally, that the motion of mercury cl e cooles under water (gas or solidified) are principally due to the reduction of superficial oxide. An ordinary U tube had mercury poured into the bend, to about an inch up each limb; acid water covered the mercury surfaces, and platinum wire, connected with a galvanometer, were inserted in the water. When the tube was tilted, the needle of the galvanometer showed a deflection, whose direction was reversed when the tube was tilted the opposite way. The electricity thus produced was due to the advancing surface of the mercury becoming brighter—unoxidized portions breaking through to the front—and, consequently, more electro-positive than the receding surface, which became duller. In his paper on the connection between volcanic and electrical phenomena (*Phil. Mag.* [iv.] xlviii. p. 249), M. Lippmann ascribed the electricity, which he observed to be produced when a mercury surface into water advanced, to a similar cause, to a change in its capillary constant. Mr. Sabine's experiments show that this explanation may be accounted for by different amount of oxidation of the advancing and receding surfaces. When a current of electricity is passed through a horizontal tube containing water or dilute sulphuric acid, with a globule of mercury in the centre, the globule is seen to move in the direction of the current. This arrangement constitutes, in fact, practically Lippmann's capillary electrometer, and its action is explained by its author as being due to a change of the surface tension of the mercury as its two ends, where oxygen and hydrogen are respectively evolved. According to Mr. Sabine, capillarity has very little to do with the phenomenon, which is to be ascribed to the chemical changes taking place in the mercury globule. At the electrified end its atomic volume diminishes, but increases at the oxidized end, where, in consequence, a relative expansion takes place. Circulation of the mercury particles ensues, and if the tube be horizontal the globule marches with the current. A number of experiments are adduced in favor of this view. Mr. Sabine, however, probably depreciates too much the effect of capillarity.

JULY 20, 1875. ENGLISH ME

to be lighted up after the shocks." December 27th, N. K. Italy: "At Parma a sudden light, loud clap of thunder;" night between 26th and 27th, "at Genoa, in the midst of a terrible storm." 1847, March 11th, E., Valley of Chamouni and at St. Gervias: "lightning was of several over Mont Blanc, and a sort of light on the snow-clad side of the valley." 1854, Jan. 7, Perugia: "Flashes of the whole sky." 1854, *A storm* which I regard this day over Pescara, Marseilles, Savona, and Northwest of Var: at Amiliau (Var) "the weather had been very rough; at a few minutes past 7 p.m. a rush of the subterranean noise was then heard, and the shock took place. The wind then rose, and the storm raged as before." 1822, February 19th, E., S. of France and Switzerland: "violent turbulence of the surface of the lake." 1854, September 9th, E., Sicily: "a loud noise like that of waggons, but interrupted." 1854, until the thunder was heard; and, although the air was perfectly calm, the trees, grass, &c., were found to have been blown about as if by a whirlwind. At Ven Hoff recently, it is very doubtful whether this took place. It is very earthquake phenomena." 1854, November 11th, E., Sweden: "shortly after December 27th, August. The shock was not at all felt at the bottom of the mines, but those who were on the ladders of the same were so shaken that they let go the ladders were about to fall." 1854, December 13th, E., Bellay, Department of Ain: "a violent shock, followed by a great ing-place of meteors." 1854, January 1st, E., Sauges, Var: "was on the day of a fall of the size of a man's fist, reported that the heavens appeared to take all on fire at instant after the explosion, although he saw nothing." 1854, December 17th, E., Venezuela, M. Codallo says, regarding the earthquakes in Venezuela, that "great irregularity generally exists in the appearance of these shocks, and often no correspondence can be traced between them at places very near each other." 1829, March 8th, E., Siberia: "at Kiachta and Troitzkosawsk, a noise like that of a violent fall of wind in a storm. At Irkutsk a clattering noise, as a discharge of musketry, was heard by all, whence Dr. Erman concludes that it was not a subterranean but atmospheric phenomenon." 1829, February 8, Valley of Bartaisk, Sardinia: "a tremendous explosion which was overwhelming. Animals and vegetables, too, were killed." 1829, January 8th, E., Bengal, "accompanied by a noise which seemed to be on the surface of the earth and immediately beneath it, like that of the firing of cannon, and also like that of thunder." In another place a crackling noise is heard in the air." 1829, October 24th, E., at Concon—no sure day magnetic perturbation. At Chili, on the next day at Concon, Parral, Brussels, Milan, Naples, Perugia, and St. Helena. December 19th, E., Baden: magnetic perturbations on the 19th and 20th. At Paris, Brussels, Rome, Prague, and Milan. On the 18th and 19th a remarkable fall of the barometer at Paris. During the night of the 20th-20th an aurora borealis at Concon.

But we must not intrude further upon our Editor's space. The cases which the reader will find in E. Mallet's and Perrey's catalogues of earthquakes, Herschel's "Aerial World," publications—not omitting a notable case in the Bostonian Repository of the middle ages, and of the development of electricity in mountains during storms.

ELECTRO-MOTIVE CHANGES PRODUCED BY LIGHT.

PROFESSOR DEWAR, of Cambridge, gave the "Friday evening discourse" at the Royal Institution on the subject being the "Physiological Action of Light." He first referred to the experiments of Du Bois-Reymond, who found that strong muscular movements of the arm and leg produced changes in electrical condition which could be easily detected by a galvanometer. We know now the Sir W. Thomson's reflecting galvanometer, a much more delicate instrument, and it occurred to Professor Dewar that it might be possible, in this fact which must more delicate changes than Du Bois-Reymond could. He observed, by having two wrangles connected with the galvanometer and containing saline solution, that putting one hand in each, the mere muscular effort of shunting the fluid caused a difference in the amount of the electric current. Other experiments also showed how readily the slightest electrical or electro-motive force could be in this way detected. It had occurred to him that the test might be applied to the excitation of the external organs of sense, especially with regard to the eye. Professor Dewar then proceeded to explain the way in which the experiments on eyes of different animals were effected. The eye, on being removed from a recently killed animal (the rabbit and guinea pigs were used) is placed between two little supporting cloth pads are called electrodes, and are then connected; these are in two little troughs, made of zinc, mounted on vulcanite plates and carefully amalgamated. A small glass tube, drawn out to a point, is nearly filled with fine clay, and this is placed on the cornea, the amalgam of zinc coming some little distance up the tube, and the ends of the tubes present any minute clay points. The object of this is to protect the animal structures from the irritating effects of the solution of sulphate of zinc. These electrodes are to be regarded simply as an arrangement for collecting and conducting off electrical currents from the structures under examination. Wires are connected from the troughs with the galvanometer, arranged so that the current can be cut off or put on at any moment. This arrangement is now found exceedingly free for the examination of the eyes of living animals as well as of those recently killed. In the case of animals just killed, the eye is recently removed as skillfully placed between the two clay points of the electrodes, and then the moment the connection is made with the galvanometer a mirror is made to swing round, indicating the presence of an electric current. If, on a short time the reflection will settle down at some fixed point on the scale, and this amount of deflection will indicate the amount of electric current passing in the cornea or the cornea-sclerotic section of the eyes. Since almost every variety of living animal has been shown to electrical current when examined in this way, it became an important question to see how much of the action lay on the side of light. The test this is to easy to put the eyes with the electrodes under the microscope, and with white light on them. This was allowed for the oscillating reflection on the mirror to settle, the indicating the natural electric current of the eye. The needle of the galvanometer at a fixed position. Light was then allowed to fall on the eye, and a diminution of current in the eye as the reflection of the galvanometer needle indicated a change in the electric condition of the eye produced by the light. The next question to be solved was whether this action occurs in only particular part of the eye. To test this, the cornea of the eye is cut away and one of the clay points brought in contact with the retina. This is an important point, as the electrical changes produced by the action of light might be supposed to be due to the contraction of the iris, the pink bulge of muscular structure contracting on the action of light in a well known reflex mechanism in normal circumstances, and even after the removal of the eye from the head. A contraction of the iris might produce a negative variation of the electric current. This is why it is removed. The action observed coincided with that of the complete eye. The current is affected when light shines on the retina. Still further experiments, that of flashing on the retina and leaving only the sclerotic, showed that little or no current was obtained, it was not affected by light. Therefore it seems certain that the variation produced by the action of light is due to some change which light affects in the retina. In experiments so far mentioned were, of course, made on eyes taken from recently killed animals, and up till lately there have been difficulties in experimenting in warm-blooded animals, as long as the nerves and the eyes also after removed from the body. Professor Dewar has, however, found that by placing an eye-ball in such a position that some saline solution can be put on the optic nerve, and placing on this solution one of the electrodes, with another electrode on another part of the body, successful experiments can be made. He has had the experiments tried on himself, so that there can, he explained, be no severe charge of cruelty to animals in experimenting on living rabbits, cats, lobatues, etc., as he has. The general conclusions arrived at are in accordance with those made on eyes recently removed from dead animals. Considerable difference is noticed whether the light brought near the eye is fixed or moved about. A light was arranged to oscillate by suspension, and the amount of deflection produced on the scale is far in excess of that

when Hertz. Just care was taken, as far as possible, to ascertain that heat had nothing to do with this action. Professor Dewar then went on to speak of experiments on the time occupied in a nervous sensation. The instrument used was the chronograph of Hipp mith, made by Hardy, of Paris. It consists of a large tuning-fork, giving 200 vibrations a second, fitted up so that the vibrations can be recorded on a blackened cylinder by an electro-magnetic apparatus. A stylette is placed at one end of the tuning-fork, and on a level with this is a strip of blackened paper, pulled down gradually by pulleys, and so arranged that the stylette can mark on it. Each vibration of the fork indicates the 1/200 part of a second. With the stylette, in another electrical apparatus, consisting of an electro-magnet, the passing of a current of which carries a marker. As a current passes the marker descends, making a mark on the blackened paper. It is arranged so that one of these makers signals at the moment the impulse is sent out; the other, under the eye of the observer, signals directly the reflection of the impulse sent to the screen. The position of these marks, with reference to the vibrations traced by the fork on the area of the tuning-fork, gives the interval of time. It was found that with a candle-flame as a stimulus, 1/5 of a second. This, however, includes also the time the observer took to see the phenomenon and record it, and in the end time elapsing between the admission of light and the change in electric condition is less than this. Experiments show that there is an alteration in the excitatory function by continued action of light, and this is, no doubt, the physical explanation of what, in physiological language, is called fatigue. A number of tables showing the rate of fatigue were exhibited.

EFFECT OF ELECTRICITY ON PARTICLES SUSPENDED IN LIQUIDS.

The Lancet, June 18/6

Some interesting observations on electricity have recently been described by M. Holtz in Poggendorf's Annalen. A "vehicle" of particles suspended in a liquid, when submitted to electric currents, has been known of, and was fully studied by M. Quincke. M. Holtz finds that in all cases of such motion, there is at the same time a clinging of particles to one of the poles, and this often with such precision that one might construct an electroscope on this principle for ascertaining the polarity. Especially notable is the tendency of *Semen Lycopodii* in insulating liquids, particularly sulphuric ether, to cover the negative pole with a thick coating, while sulphur, cinnabar or sulphide of antimony in the same liquid, only coat the positive pole. A simple medicine glass even suffices for the experiments; a conductor or half conductor being introduced through the stopper. The glass is held in the hand, and the conductor pushed down into the liquid. The two poles of a Bunsen battery may be used.

M. Holtz did not, like Dingenen and Quincke, use capillary tubes, but hide vessels, and this, he thinks, maybe the reason why many substances, e.g., sand, manganese, sugar, &c., seemed to be quite indifferent, neither wandering nor adhering to the poles. But here occurred another interesting phenomenon. If a portion of the vessel was left straight and smooth, and not rendered conducting by a layer of moisture condensed from the air, or by the particles formed figures, under the action of the electric current, of various characters according to their size and structure, and according to their own conductivity or that of the liquid. Figures of extraordinary liveliness and regularity, and quite corresponding to those assumed by iron filings under action of the magnetic poles, were obtained with finely wandering ear-shaped, wavy, and nodic al lines, in petroleum, oil of turpentine, benzine, and sulphuric ether. Still finer, and consisting of largely entwined lines, were the figures formed under reduced iron; but extremely little of this substance must be used, owing to its great conductivity. The figures formed of sawdust were more regular, and branching like trees. Cinnabar in ether gave a cloud-like form which, on account of the polarity referred to, surrounded the positive pole. Sugar and bran mostly formed thick connected skeins, through which the electricity then flowed as by a conducting bridge.

In very few cases, however, is the figure stable during the electric action. In general, while the figure does not essentially alter in character, one may readily distinguish in it a double movement, first a threating to and fro of the separate particles within the lines; they form (and this motion is stronger the larger the particles and the smoother their surface); then a continuous displacement of entire lines vertically to the connecting line of the poles, and this apparently more outwards if the electric current is strong, more inwards if it is weak. This latter motion, however, frequently becomes of a rotatory character, the connecting lines sometimes breaking, and each part for itself tending to circle round the pole to which it adheres. Such circular motion occurs in greater measure with cinnabar, sulphide of antimony, and some other matters, which generally do not form connected lines. It appears in a peculiar halting together and gliding forward of separate parts.

But the circular movement is greatly favoured if a wire ring be taken for one pole, and the other pole be placed in the centre of it. In this case, naturally, the external form of the figures is altered, and in most instances, whatever the polarity of the central conductor, one obtains figures which in their radiating structure resemble the Lichtenberg figures. With those materials which do not connect themselves in lines, the circular motion now becomes so distinctly the prevailing one, that the figures produced fully correspond to the negative Lichtenberg figures.

The remarkable phenomenon was best obtained in a glass zoometer, with high and nonconic diameter, having a perfectly even and smooth bottom, and which had not been used for previous experiments. In the axis was fixed a wire which, with its lower point, touched the middle of the bottom, and this glass vessel standing on a conducting basal was slowly and constantly electrified with one pole of an influence machine. M. Holtz describes in detail the effects obtained when this vessel was charged after the fashion of a Leyden jar.

Another but similar phenomenon in some of the above experiments was the formation and rise of the liquid on the insulated wires. This takes place to greatest degree on the negative wire, and with sulphuric ether it is intimately connected with the polarity of the surrounding particles, for through adhesion of these to the one pole the rise of the liquid on the other pole is favoured. M. Holtz hopes to study the phenomenon further.

MUSCULAR contraction, it is known, is always accompanied with electric phenomena; the difference of electric potential between two points of a muscle, undergoes a diminution, which according to Bernstein, precedes by about 1/10 of a second, the contraction of the muscle. This *electrical negative bar* has been observed on various muscles, and in particular on the heart (by Du Bois Reymond and Kölliker), and recently M. Marey has represented it graphically by photographing the indications of a Lippmann capillary electrometer. We learn from the *Journal de Physique*, that M. De la Roche has tried the experiment on the heart of a living man. The points of the epidermis of the chest were connected with the poles of a capillary electrometer, by means of electrodes, formed each of a bar of amalgamated zinc, with a plug of muslin at its lower end saturated with solution of zinc. Held with insulating handles, the bars were applied, one with its plug opposite the point of the heart, under the left nipple, and the other to another point of the chest. The mercurial column was then seen to execute a series of very distinct periodical pulsations synchronous with the pulse (each pulsation even marked the double movement of the heart (of the auricles and ventricles). The amplitude corresponded to about 1/200 Daniell.

Nature, 77

ACTION OF LIGHT ON SELENIUM.

LAST Friday week Mr. C. W. Siemens, D.C.L., gave, at the Royal Institution of Great Britain, the "Friday evening discourse" on the action of light on selenium. Mr. Siemens said that the influence of light on selenium makes itself known as an action which regulates the extent of an electrical conductor. Mr. May, a telegraph engineer at Valentia, noticed that a selenium resistance was required, offered considerably less resistance to a current when exposed to light than when kept in the dark. The facts were made known by Mr. Willoughby Jones in 1873, but these for a while the matter rested. The statement was received with great incredulity. Could it be that under the same superficial action of light upon a solid substance could so change its electric condition as to open among its particles floodgates for the passage of the electric current, or, again, close them? Again and again, in the interval of the last twelve months, have we had the matter of independent inquiry by Dr. Werner Siemens in Berlin, which agree in most points of fact, though they somewhat differ in the deductions they draw from them. Selenium, an elementary body discovered by Berzelius in 1817, is placed by chemists in the group termed by them metals and metalloids, and it does not seem to be amenable to the laws governing either of these natural groups. Instead of reduced it presents a known amorphous mass of considerable fracture, which is a non-conductor of electricity, but if a stick of this amorphous selenium is exposed for some time to the heat of boiling water it assumes a crystalline fracture, and when again tested in the galvanometer circuit it is found to be a conductor of electricity. Some experiments were shown of the action of light by a question of time. Werner Siemens, in which the duce its resistance effect. Two spirals of thin wire (iron or platinum) are wound on a glass rod in such a way that the wires be parallel to one another without touching. While in this position a drop of fluid selenium is made to fall upon the plate, filling the interstices between the wires, and to give fineness to the whole. The two protruding ends of the spirals serve to insert the platinum arrangement is no larger than a sixpence. Its action was shown in this way:—It was placed in a galvanic circle, at one time in Daniell's cell, and at the other a dissimilar series galvanometer, though—no movement of the needle was taken that had been kept in boiling water for an hour, and but as soon as the light was admitted the index registered a great passage of electricity. Another disc heated to 210 deg. C., and allowed to cool was then used, and a greater action still was apparent with this. Dr. Werner Siemens has worked at the meaning of this, but without tables and diagrams it is not possible to give an adequate idea of his results. The basis of the change in conductivity seems to be in the degree to which the selenium is heated, for when again allowed to cool its behaviour depends on the degree to which it has been heated. The experiment was shown of the effect of different parts of the spectrum on a selenium photometer was shown, and the difference increases as we approach the violet rays. The effect of two lights in affecting the conditions for the passage of electricity. At the end of the lecture a beautiful but interesting little apparatus was put at work, which Mr. Siemens calls a selenium cell, a small hollow ball, with two apertures opposite to each other. In one is placed a small lens, in the other a mirror, and at the centre is a "stalk." The disc is connected with a galvanometer, and this represents the retina. There are two slides which represent the eyelids. The action of light on the disc is indicated on the galvanometer. Not only was this shown to be sensitive to white light, but sensitive in different degrees to different colours. Mr. Siemens suggested it would be useful in the contact and electro-magnet in connection with the galvanometer in such a manner that a powerful action of light would cause the automatic closing of the eyelids, and have the effect of instantaneously train action of blinding the reader in consequence of a flash of light. To physiologists this analogy may be suggestive regarding the important natural functions of the human frame.

31. Sur quelques effets mécaniques de l'électricité statique, par E. Mach et J. Wosykes. (Ann. de Poggendorff, vol. CLVI, page 407).

Ces quatre auteurs, poursuivant de différents auteurs, traitent du même sujet. Il s'agit de reproduire sur une plaque de verre qui est couverte d'une couche de noir de fumée les étincelles électriques qui se produisent, soit par une machine de Holtz ou une bobine d'induction, soit de toute autre manière. MM. Mach et Wosyka sont de l'opinion que ces images sur le verre noirci ne sont pas les véritables images des étincelles qui les ont produites, mais les effets d'une force mécanique de l'électricité. Cette opinion est appuyée par les résultats de plusieurs expériences.

32. Sur les glissements des étincelles électriques, par K. Antolik. (Ann. de Poggendorff, vol. CLIV, page 14).

33. Nouvelles observations sur les étincelles glissantes, par A. Peters. (Ann. de Poggendorff, vol. CLVI, page 307).

34. Des étincelles de grandes bobines Ruhmkorff et de leur différence avec les étincelles de la machine de Holtz, par A. Peters. (Ann. de Poggendorff, vol. CLVI, page 403) et

Notes. 33

As instance of the somewhat rare phenomenon of lightning in a clear sky has been described to a scientific society in Dresden, by Dr. Roch, of Senftenberg. In the early days of July there has been a good deal of thunder and lightning. On the afternoon of the 4th the sky overhead was quite clear, and only a few heavy thunderclouds rested on the horizon in the W., S.W., and N.E. About four o'clock Dr. Roch, with some friends, was walking in the garden, enjoying the fresh air. They were able to count 13-15 seconds between each flash and peal from the distance. Suddenly, just above them, a brilliant, loud-crackling flash passed through the heavens, from N.W. to S.E., throwing the company into some alarm. It was a justification of the poet's line: "Auch aus entwölkter Höhe kann der sündende Donner schlagen." It is notable, further, that, after this flash, there was no more of the distant lightning and thunder. The heavy clouds soon retired, and the sky was once more clear throughout.

We are glad to observe that the lightning-conductors of our countrymen, Messrs. Sanderson and Procter, have gained a medal at the Brussels Exhibition, and that M. Michel, Secretary of the French Committee for lightning-conductors, has commended the system "*comme le plus fonctionnel que je connaisse.*"

A NEW ELECTRIC REPULSION AND ITS APPLICATION TO THE THERMO-MOTOR.

When the finger or a conductor of any kind is brought near to the luminous medium produced in a Geissler's tube, we observe an attraction, which is explained by the known laws of electric induction. But M. Heilriegel and D'Ursulaire (by *Comptes Rendus*), discover that this attraction is converted into a repulsion when the introduction of the gas in the tube is pushed beyond a certain limit. By operating with a number of gases, they found between two points 8 mm. and 2 mm. the known at particles. In continuing the observation, a neutral point was reached, at which there was neither attraction nor repulsion; after which the same gases exhibited repulsion as pronounced as was the attraction. It may be observed at a distance of six centimetres, but does not manifest itself when an insulator instead of a conductor is approached. The authors apply this observation to explain the repulsion of comets' tails by the sun.

INFLUENCE OF LIGHT AND HEAT ON SELENIUM.

Paper, W. G. ADAMS, lately gave before the Physical Society, London,an account of some researches on which he has been engaged, on the selenium with the influence of light and heat upon its electrical conductivity at ordinary and exhibited numerous experiments in illustration. The subject has also been studied by Lieut. Sale and Dr. W. Siemens of Berlin, and as a general result it is found that after it has been kept in the dark, the resistance of the metal is diminished by exposure to light. The effect, however, both of heat and light, is different in the several states through which the metal passes. Thus when a piece of amorphous selenium is gradually heated to about 100 C., kept at that temperature and slowly cooled, its resistance at first is so great that it can not be measured by the ordinary arrangement, but as its temperature increases, the resistance diminishes and increases again more slowly when the metal is allowed to cool. The resistance of several pieces which at the higher temperature were from one to three megohms was found to be from 100 to 150 at the ordinary temperature. If this selenium be placed in a paraffin bath and heated, its resistance diminishes, and when the temperature is kept constant above 140° C. for some hours and the metal is then slowly cooled, it assumes a crystalline structure, and its resistance diminishes as it cools. The resistance of such crystals at ordinary temperatures increases with the temperature. Light also diminishes the resistance of the crystalline bath in some cases. In applying the effect of light, the metal which had been kept in the dark was exposed to a candle at distances of 4, and 1 metre ; the initial resistance being 110,000 ohms. The readings in these three cases were 112,000, 102,500, and 101,500. Reducing each from the initial number we have 2500, 6800, and 8500 ohms as the changes of resistance due to exposure at these distances. Hence the effect of light varies inversely as the distance, or, what amounts to the same thing, directly as the square root of the illuminating power. These considerations have led Prof. Adams to suggest the use of selenium for comparing the illuminating powers of different sources of light, and he exhibited the arrangement which he proposes to use for this purpose. The actions of light of different degrees of refrangibility was then exhibited, by allowing the light from several parts of a spectrum of the electric lamp produced by a bisulphide of carbon prism to fall on the metal, the remainder being cut off by means of a screen, in which there was a narrow slit. The violet, blue, green and yellow, and next two divisions of the screen, the green and yellow, the orange red five and a half, and the deep red nine and a half. The effects were tried by the greenish yellow and the orange. The rays are at times nearly equal. It may easily be shown by the same temperature that the metal that the effect of light on its conductivity is essentially the same in kind at a low and moderately high temperature. The fact that light and non-dark heat produces the observed effect has been shown by recalling the beautiful experiment of Sellme by the bisulphide of carbon. A very small effect on the metal was always observed, but this may be assumed to have been due to light, as it all ceases to be possible to recite the form of the carbon passes through the solution. This fact may be strikingly shown by experimenting with prisms through which a current is passing to the flame of a Bunsen burner, first when in its ordinary condition, and afterwards with the air openings at the base closed. It was shown that, whereas in the first case the effect produced was equivalent to three divisions of the scale, in the latter case one-tenth of the current produced by the exposure deflects the needle to the end of the scale. Prof. Johnstone Stoney then explained the theory which he has suggested in explanation of the phenomena observed in the radiometer of Mr. Crookes, which has been published in the *Philosophical Magazine* for the current month. The theory rests on the supposition that there is an excessively small trace of residual gas in the spheres in which the moving discs are enclosed. When the apparatus is exposed to heat the illuminated side of the disc is slightly warmed, and this warms a layer of air in contact with it. At the ordinary atmospheric pressure, Prof. Stoney assumes the layer so warmed to have the thickness of a sheet of paper, when the temperature of the disc is 59° C. shows that of the resulting air, based on such a supposition we may calculate that the thickness would increase inversely as the square of the pressure the thickness varies inversely as the pressure raised to the power 1. Thus if the disc is exposed to the above the surrounding air, and the exhaustion carried to the twiglith of an atmosphere, the layer will have a thickness of more than a decimetre, and the effect of the air will then be peculiar. If the gas is of such a density that the glass envelope is beyond the range of this action, the gas beyond the limiting distance will be cold, but if the effect reach the glass, combustion will take place to it. There will then be a procession of warm molecules towards the glass, where they will be cooled down, and form a number of cold, slow-moving molecules, which will go back to the disc and beyond it. And these processions will be intermixed with molecular taking place in every part. In consequence of this, very few molecules will reach the front of the disc, and the number of such, however, will be carried forward in the right direction. Belong as these processions go on, the slowly moving molecules which reach the front of the disc are thrown off more vigorously than from the back. Prof. Stoney considers the pressure thus produced to be that measured by Mr. Crookes. With a pressure of the gas of twiglith of an atmosphere, the thickness of the layer of A C, will produce the force actually observed, while if the exhaustion be carried to twiglith the elevation of temperature necessary will be A' C. Those who the greater pressures with tens- pentures will suffice, but other influences will then be brought into play leading to an opposite direction. It was pointed out that on this theory the action may be considered as closely resembling electricity, and Mr. Crookes has shown that the glass envelope is often itself slightly electrified.

TELEGRAPHING BY THE AURORAL CURRENT.

MR. G. N. HEWOOD, telegraphic operator at London, Texas, 14th, 1874, his attention was attracted to a peculiar action in the record his relay magnet, similar to that found during a thirty. It gradually increased until the relay worked at some one was signaling and closing the circuit. At first he almost on the line, but was at a loss to account for the unusually disturbed condition of the current. This same atmospheric electrical disturbance was going on for two hours succeeded, and while using his imagination as to what that self to his mind. Then some disconnected the battery from the ing and closing of the keys, as if the battery had never been disconnected. He worked the line for nearly two hours without any apparent difficulty, without a single battery being in circuit ; but after the first two hours it became too weak to ing. As it grew weaker it permanently settled to zero. Upon try in opposition to the direction in which his battery formerly tery with reference to the line, so as to neutralize with the natural current, which was strong enough to demagnetize the the battery current when connected in opposition to it. turning every trace of it had disappeared.

Potculum Changed into Electricity and Light.

PROFESSOR W. A. ANTHONY, in discourse of a recent series of experiments with an electro-magnetic machine of his Gramme pattern, made the following interesting observations:

The electric machine was driven by a five horse Brayton petroleum air engine. The engine consumed a little over six and a half pounds of crude petroleum per hour.

The lamp used in the engine, by which the explosive mixture is fired, had a one inch coil wire, and consumed 29·8 grammes (420 grains) of oil per hour. The power resulting from the motion of the engine, when applied to the electric machine, produced a current of electricity, or electric light, by using an illuminating power equal to that of 241 of the lamps mentioned, showing that three times more light may be produced from a given quantity of oil, if its energy is converted first into mechanical power and then into electricity, than if the oil is directly burned in a lamp.—*Scientific American.*

JOURNAL OF THE TELEGRAPH.

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THE PHENOMENA OF CHARGE AND DISCHARGE IN TELEGRAPHIC LINES.

If one connect one end of a telegraph line with one pole of a battery and place the other pole of the battery and the other end of the line in connection with the earth, the current pervades the entire line almost instantaneously, reaching the farther end at the line at nearly the same moment that contact is made with the battery. Upon the first appearance of the current at the extreme end of the line, however, it is exceedingly weak, but it constantly increases in strength until it reaches a maximum, which it maintains without further change so long as the connection with the battery continues, and the line is perfectly insulated. If we insert a galvanometer at the distant end of the line, the latter shows no deflection until the current becomes sufficiently strong to influence the needle. The more sensitive the galvanometer is, the sooner it will be affected by the current and the shorter will be the time that will elapse between the making of the contact with the battery and the perceptible appearance of the current at the distant end. The deflection of the needle continually increases as the strength of current augments, but does not become constant until the current has attained its maximum, which requires a perceptible though very brief interval of time. If we insert several galvanometers at different points upon a long line, and make connection with the battery, the needle of the galvanometer which is nearest the battery will first be deflected, a moment later the second follows, then the third, and finally the most distant from the battery. In the case of all the galvanometers that are on the hull of the line nearest the battery, the angles of deflection will be equal, and will remain so while the connection with the galvanometers that are placed on the second half of the line, if they are sensitive, also remain stable at first, continually increase until after a certain time has elapsed, when the galvanometers at the extreme points all show the same deflection, which continues permanently if the insulation of the line remains constant.

The condition of the line during the time that the strength of current is constantly increasing, that is, from the moment that the line is connected with the battery until the strength of current in all parts of the line is the same, is called the variable state, to distinguish it from the permanent state in which no changes of this kind occur. The permanent state occurs first in the middle of the line, and it continues there four times sooner than at either end.

The time which it takes the current to make itself manifest upon the galvanometer depends upon the sensitiveness of the latter, consequently, neither the instant when the first portion of the current reaches the end of the line, nor the moment when the current begins to be constant, can be exactly determined. Of two galvanometers, the one which is most sensitive is first to show the passage of a current. In consequence of this the duration of the variable condition cannot be stated with absolute exactness, and we are obliged to confine ourselves to the determination of the time which is required for the current to reach a state that approximates closely to the permanent state.

DURATION OF THE VARIABLE STATE.

If we assume with Ohm that electricity flows through a wire in accordance with the same laws that govern the diffusion of heat in a rod which is heated at one end, we are led to the conclusion that the duration of the variable state is in proportion to the square of the length of the line. If for instance a certain line is 2, 3, 4, or more times as long as an-

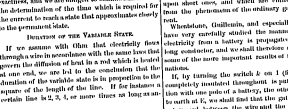

Figure 1.

other, then the duration of the variable state is 4, 9, 16, etc., times as long as it is for the shorter line.

Gangain and Guillemin have experimentally proved the accuracy of this law. The duration of the variable state depends also upon the conductivity, the sectional area and the degree of insulation of the line, and upon the quantity of electricity which is required to produce a certain potential through the unit length of the line. In an ordinary iron telegraph wire of No. 8 gauge the duration for a length of 300 miles, varies according to atmospheric

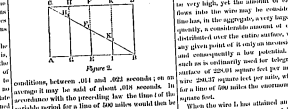

Figure 2.

conditions, between ·001 and ·022 seconds ; on an average it may be said of about ·008 seconds. In accordance with the preceding law, the time of the variable period for a line of 600 miles would then be given by the proportion

$$t_1 : .008 :: 1 : (2)^2$$

or

$$t_1 = .0080001022 \text{ second.}$$

We shall hereafter see what influence the other circumstances above mentioned have upon the duration of the variable period.

CHARGE OF AN INSULATED LONG LINE.

Ohm's laws give no sufficient explanation concerning the manner in which electricity diffuses itself under some conditions. Many phenomena appear upon long telegraph lines which we do not notice upon short ones, and which are entirely distinct from the phenomena of the ordinary galvanic current.

Wheatstone, Guillemin, and especially Gangain, have very carefully studied the manner in which electricity from a battery is propagated through a long conductor, and we shall therefore state briefly some of the more important results of these examinations.

If, by turning the switch *k* on 1 (fig. 1) a wire completely insulated throughout is put in connection with one pole of a battery, the other pole being to earth at E, we shall find that the galvanometer G, being perfectly insulated, at the moment the switch is turned on 1. This current, which is perceived in proportion to the length of the line, originates therefore without the existence of a closed circuit, but its intensity diminishes only for a very small portion of a second. After the first and almost instantaneous deflection, the needle of the galvanometer again returns to its state of rest, or at most only shows a very small deflection in consequence of the line not being perfectly insulated.

As soon as the line wire L is connected to the pole of the battery, it becomes electrified, and almost throughout its entire length this same potential as the pole of the battery itself possesses ; consequently, as the current passes into the wire it manifests it presence first in the neighborhood of the battery. This effect, however, ceases as soon as the charge reaches the extreme end of the line, and the line itself attains at all points the same potential as the battery pole. The earth E with which the other pole of the battery is connected, may be replaced by any other conductor having the same resistance as the line L.

Although the electrical potential of the battery and of the separate parts of the line may not be very high, yet the amount of electricity which these into the wire may be considerable, on a long line has, in the aggregate, a very large battery, consequently, a considerable amount of electricity will be obtained over the entire surface, would present at any given point of it only an inconsiderable density, and consequently a low potential. A line 3 wire, such as is ordinarily used for telegraph lines, has a surface of 226·01 square feet per mile, and a No. 6 surface of 280·01 square feet per mile, which would give for a line of 600 miles the enormous surface 110,155 square feet.

When the wire L has attained an equal potential at all points, in consequence of having been connected with the pole of the battery, the wire is said to be statically charged, and the operation is termed charging the wire.

The charge extends only over the surface of the wire, and its amount is determined both by the magnitude and form of this surface. It is proportional to the length of the line when the

well insulated that all its parts attain the same potential; it increases also with the volume of the conductor, and is in exact proportion to the electromotive force of the battery.

DISCHARGE OF INSULATED LEAD LINES.

If we insulate a charged conductor L (fig. 1) by removing the switch S from 1 and placing it between 1 and 2, thus breaking connection with the battery, its electrical condition will remain unaltered, provided the insulation is perfect. As this is never actually the case in practice, the charge of the line passes off at the points of support and at such other points as derivations may occur. The more defective the insulation is, the sooner will the charge become dissipated.

This flow of electricity from a charged wire takes place with extreming rapidity on air lines. Even with the best insulated ones it rarely occupies more than a very small fraction of a second. The case is quite different with underground or submarine lines, in which the wire is carefully covered with insulating substances. A tolerably well insulated cable will, according to circumstances, retain its charge so well that even after a lapse of twenty or thirty minutes it will only have lost half of the electricity which it received when being charged.

When, however, after having charged the wire L, we separate it from the battery, and then, before any considerable loss of electricity occurs, connect the same end of the wire to the earth E, the electricity which at first flowed in, suddenly flows out into the line again, and the inserted galvanometer G marks the passage of a momentary current whose direction is opposite to that of the charging current. This may be accomplished in the simplest way by quickly turning the switch S on 2, after having placed it on 1 to charge the wire. By this means the end a of the wire is separated from the battery and placed in connection with the earth. This second current flowing from the line to the earth is called the discharge or return current.

If, instead of the end a, we had connected the end b of the line to earth, then the discharge current would have taken place in the direction a b; and the deflection of the needle of a galvanometer inserted at b would have been in a direction opposite to that of the preceding one.

When the line is discharged, the galvanometer needle is also deflected to a certain maximum, and then after several oscillations, finally returns again to its state of rest. As the defective force of the return current acts on the needle in these cases almost instantaneously, the mode of its action upon the needle is similar to that of a blow against a pendulum, that is to say, the defective force, or the magnitude of the discharge, is in accordance with physical laws, proportional to the sine of half the angle of deflection, and is entirely independent of the kind of galvanometer used.

It is evident that the same law also holds good for the charge, consequently if we indicate the magnitude of the charge by A, that of the discharge by B, and the corresponding angles of deflection by α and β respectively, using the same galvanometer for both deflections, then,

$$A : B = \sin \frac{\alpha}{2} : \sin \frac{\beta}{2}$$

As the electricity with which the wire is charged becomes gradually dissipated after the charge has been effected, either through the air or by means of other partial conductors, the return current becomes proportionately weaker as a greater length of time elapses between the charging and discharging. If the line were perfectly insulated, and there was, however, no escape of the electricity, or if the discharge could be made to take place simultaneously with the interruption of the battery, the discharge current would be just as strong as the charge current; but as this can in reality never occur, and as some time always elapses between the operations, the discharge current is necessarily always less than the charge current.

The more perfectly a line is insulated the less will be the loss of the electricity with which it is charged, in a given time, consequently, the proportion between the quantity lost and the primitive charge will be found to serve as a means of determining the condition of the insulation.

If we retain the same indications for quantity of charge and discharge as before, and assume that the discharge takes place 1 second after the charge, then the line in this space of time loses a quantity of electricity A–B. The proportion between this loss, caused by imbibitions or leakage, or, in general, by defective insulation, and the primitive charge, amounts, therefore, for half a second, to A – B. The smaller this proportion, the better is the insulation of the line.

If, as of late of 5 to 10 miles in length these conjunts are not perceptible even when using a battery of 300 elements, but with a length of 20 miles both properties are easily rendered apparent by using a powerful battery and a very sensitive galvanometer; when the length exceeds 100 miles even the relay magnets of the telegraph apparatus will show them.

In what has been said it is to be borne in mind that the end b of the line (L fig. 1) is insulated, while the charging or discharging is done at the end a.

CHARGING AND DISCHARGING A LAND LINE CONSIDERED AS EARTH.

If we put the end b of a land line L (fig. 1) to earth by connecting b with A_1 and earth plate E_2 a constant current, as we know, traverses the line as soon as the battery is connected. This current is indicated by a permanent deflection of the galvanometer needle and lasts as long as the battery remains in circuit. In this case the electric potential of each point of the line is not equally great, but decreases continuously throughout from the pole 1 to the extreme end A_2 and E_2. Owing to this decrease of potential from point to point, a constant flow of electricity from the battery through the line to the earth is thus charged with electricity, but the amount of the charge is smaller than when the end b is insulated, and the time in the latter case the potential is the same at all points.

Hlatter very properly compares both the charging and discharging of a line, when the distant end is insulated and uninsulated, with the movement of a gas through a tube, one of the ends of which communicates with a very large reservoir, in which the gas is under a constant pressure, the other end being placed in a vacuum.

If we interrupt the connection with the vacuum and close the opening of the tube at this end, the gas does into the tube only so long as the pressure is not the same at all points.

This is precisely the case with a telegraph line when uninsulated. The reservoir represents the battery, the tube the wire, and the gas the electricity.*

* The comparison, however, is not exact, since in charging the wire with electricity we need not suppose a real propagation of the electrical fluid from one point to another, but we should rather consider it to be the result of a progressive decomposition and recomposition of the natural electricity.

When, on the contrary, the end of the line is placed in the vacuum, and the gas is allowed to flow through it, then the pressure in the immediate neighborhood of the reservoir is equal to the pressure of the gas in the reservoir itself, and it decreases gradually to the end of the tube where it becomes zero. Consequently the total amount of gas in such a tube is less than in the former case, when the tube is closed at the end.

We may obtain a good idea of the condition of the static charge in a line insulated at the remote end, and of one having the remote end connected to earth, if we suppose the electric potential of the separate points to be represented by vertical lines which are erected at the respective points.

Let A B (fig. 2) be the length of the line; suppose it to be connected to one pole of the battery of A, and let the potential at this pole be represent by the vertical line AC erected at A B. If the extreme end B of the line is now insulated, by which the potential at all points of the line becomes equal to AC, then the vertical lines C H, F F, I K, B B, which are each equal to AC, represent the potential at the points A, G, E, I, B. The total charge of the line is, therefore, the sum of all the perpendicularies of the length A C, which it is possible to conceive of as existing between A and B; that is to say, it is proportional to the contents of the rectangle A C B R.

When, on the contrary, the end B is connected to earth, then the electric potential from A towards B decreases in proportion to the distances taken, if we still represent it at A by A C, then for the distances A G = $\frac{1}{4}$ A B, A E = $\frac{1}{2}$ A B, A I = $\frac{3}{4}$ A B, it will be respectively $\frac{3}{4}$ A C, $\frac{1}{2}$ A C, and at the point B it falls to zero. Consequently, if we draw the line C B, the verticals G H, E F, I K, will represent the charges corresponding to the points G, E, I. The total charge of the line A B is, therefore, equal to the sum of all the verticals included between A B and C B. Consequently, it is proportional to the area of the triangle A C B.

It follows, then, that the total charge of a line when distant and is connected to earth, is only half as great as when the line is completely insulated.

RETURN CURRENT IN LAND LINES WHEN PUT TO EARTH.

When the line L (fig. 1) is in contact with earth at E_2 at the point b, and the switch S is turned on 1, then L receives a charge half as great as if it were insulated. If now the connection between the line and battery is broken, the electricity which is distributed on the line rapidly escapes through b to the earth E_2. For this reason, the duration of the discharge for ordinary land lines is exceedingly short, or any rate, very much shorter than when the line is insulated at A; in which case the discharge can only be effected through the air and by the poles, as long it remains between 1 and 2.

When, however, the line is very long, for instance 100 miles or more, the discharge does not take place in an immeasurably short period of time.

If we turn the switch very quickly from its position 1 to 2, then the discharge takes place in two opposite directions; the greater part of the charge in the vicinity of the battery passes over A and b to earth E_2 producing the return current, whose direction is opposite to the direction of the charge; the other and smaller part flows in the direction of the charge (from a to b), through b to earth E_2. The return current may be observed on a sensitive galvanometer G.

The discharge may also be delayed and made apparent on a line without insulating its end b, by inserting a considerable resistance between b and the earth E_2.

As this supposes to a considerable extent the flow of electricity at A, the return current at a will be much stronger when the switch S is quickly turned from 1 to 2.

The same effect takes place when, instead on an artificial resistance at b, a considerable resistance is accidentally present in the line itself, such for instances as may occur in consequence of defective wire connections or bad connections in the instruments. This fact often enables us to form a conclusion from the appearance of the return current, whether there is a defect at the other end of the line.

We must not however, confound the return current with the so-called extra current, which originates at the moment the battery is placed in circuit, and also opposes the main current, this extra current occurs only at the moment that the battery is closed while the extra current which appears at the interruption of the battery, has the same direction as the main current in the line.

On breaking battery connection by turning the switch S (fig. 1), from 1 to 2 quickly, there results, especially in very dry weather and upon long lines, say of at least 250 miles in length, an extra current as well as a return current. These are, however, of opposite direction; the return current being opposite to that of the battery current, the extra current opposite, that is in the same direction as the battery current. By means of a very sensitive galvanometer we may therefore see which of the two is the strongest.

On very short lines the extra current which appears when the battery is interrupted and whose direction is the same as the line current, is the most powerful, that is to say, the extra current is more powerful the shorter the line is, while the return current may not be perceptible at all.

If the length of the line is increased and the battery suddenly disconnected, by turning the switch S from 1 to 2, the return current makes its appearance, and is distinguished from the extra current by its direction. It increases also, in the same proportion that the length of the line is increased.

Both currents may be recognized when the battery is suddenly interrupted and the line connected to the ground, with the ordinary Morse duplex apparatus, by the attraction of the armature levers. With the step-by-step printing instruments both currents are increased when the line is more than 100 miles long and the transmitter makes from 10 to 12 pulsations per second.

Electrical Phenomenon

LAST night I noticed a powerful development of electricity in a curious manner. I had thrown a piece of white cloth, whitened paper upon a hot fire which was tolerably full of ashes. When it was charred so as to be black and brittle, I happened to take it up with my fingers. The intense heat of the ashes caused me to drop the piece of paper, which, on striking the floor, was broken into a number of small pieces, each was capable of rotating (though with very great friction). When brought into contact with other supplies of paper forcibly, I experimented with these pieces for several minutes without perceiving any diminution in their electrification. Both sides of the paper seemed to be in the same condition. I then laid them down, and left the room to finish a piece of writing—a test of the nature of the electricity. But by the time I returned, all trace of electricity was gone, and by no means could I repeat the experiment so as to get the slightest charge of electricity.

It is more than probable that the electricity was developed by the chemical action of combustion of the coals, and that the dry air rising up and heating just the paper acted as a carrier of electricity of one kind to the paper, and of the opposite kind from it, until it acquired a very high potential. I should be interesting to learn exactly in what manner induction takes place, and whether the electrification was positive or negative.

Ardenconlee College, Glasgow GEORGE FORBES

The results of a series of experiments by M. Cazin and the heat measurements gave the following laws: "When straight iron cores is surrounded by a series of similar coils, when the current flows in alternately opposite directions, and when these coils produce poles at equal distances from each other, the maximum heat which are produced in the core by the same intermittent current are inversely proportional to the squares of the number of the coils."

In the foregoing experiments heat was developed in the core, while a regularly interrupted current produced in this core a series of magnetizations and demagnetizations. M. Cazin now sought to determine the amount of the developed of heat, and proceeded as follows: Round the iron core in the percolaux thermometer two coils of 630 turns were passed, one of them being in the interrupted magnetizing circuit, while the other formed a special circuit, while in each turn of the interrupting apparatus was closed. The first coil could now induce a current in the second, if the closures of the two circuits took place at the proper times, as might be arranged at will. These experiments gave the greatest development of heat when the circuit of the second spiral remained continually open. The heat was not altered when the circuit was closed at closing of the magnetizing current. There is thus no thermal action during the variable period of closure. Lastly, the heat was smaller when the circuit of the second spiral, during the opening of the inducing circuit, was closed; it was then as much as the half. It thus proved that the production of the magnetic heat takes place during the opening of the voltaic circuit, consequently, that it accompanies the disappearance of magnetism in the core.

Absorption of free hydrogen under the influence of the electric current.

The electric current—g–ll, Berthelot—hydrogen is absorbed by organic matter under the influence of the electric current much more rapidly than ozonization, and with the formation of a polymer of C_4H_{10}, or $(C_4H_{10})_n$. Similar absorption occurs in the case of terebenthine and amylene.

The Chemical News.

No. 857.

On electrical phenomena, the alleged etheric force, and experiments as to its identity with ordinary electricity.—E. J. Houston and E. Thomson.—The results described as manifestations classed as "etheric" can depend solely to inverse currents of induced electricity.

[2911.]—Spontaneous of Telegraph Wire.—The use to only our wires with insulators, at least some faults, and prevent the simultaneous being carried to your board. The pieces of wood are best steeped in paraffine, which will not prevent the sound being carried to your board. Paraffine is a much better conductor of electricity than wood. Leaving the upper ends of the wires as possible—feet, you must remember that the conductivity of the wire used will be increased by the conductivity of the wire used will be increased with; hence whatever you use will be increased by the conductivity of the wire. Between the insulator and the wall I would place a piece of thick, soft, and dry woollen fabric, well wound round the wire, and then well packed before entering the wall. The insulator, so as to make a cushion on which the wire would rest. Before the insulator, I would have wooden cleats attached loosely to the wire to prevent them using the wire of 1, 2, 3, and 7 inches of distance from one another. The object of these cleats is to prevent the wires coming into contact. The shape of a V shape, with two holes running through from side to side, and the wire to be passed through them, will never be ascertained. Paper, or that kind of paper, lace and tin, dry on each side. These pieces of lace would vibrate independently of the wire, and would destroy the vibrations of the wire to a considerable extent, especially if placed at the extremities. I have seen the wire fastened to the inside of the V still greater, and by means of a wooden wedge. This will further reduce the vibrations of the wire. Of course, you will run the V pieces into each other, and will run them the V pieces into each other, and will run them the V pieces into each other, and will run them

ELECTRO-CAPILLARY PHENOMENA.

The electro-capillary machine of Lippmann and his capillary electrometer, besides the capillary electroscope of Wagner Hermann and the electro-chemical relay of Wiedemann, are all illustrations of a phenomenon resulting from *application* of an electric current. I am not aware that the *converse* phenomenon is so generally known, namely, that the motion of a conductor in the tube *produces* an electric current. If we substitute a galvanometer for the battery in a Lippmann capillary electrometer, and move the liver by hand, the galvanometer needle is deflected. Similarly, if in any of the electro-capillary arrangements a galvanometer is substituted for the battery and a bubble caused to move by mechanical action, electrical currents are produced which deflect the galvanometer needle.

The following small instrument may serve to show this action for lecture purposes: *e e* is a glass tube of any convenient bore, say 10 to 30 millimetres, by

300 mm. length; *k* is a cork fitting tightly into the middle of the tube, and perforated in two places where are inserted—at *c* a tube of 1 mm. bore, slightly longer than the cork is thick, and at *d* a longer tube, extending half way into both compartments. The ends of the tube *e* are stopped by the corks *e e*, through which pass the platinum wires *f g*. Sufficient mercury to quarter fill each compartment is introduced into the tube *e e*, with a small quantity of dilute sulphuric acid. The apparatus being now complete, the wires *f* and *g* are connected to the terminals of a somewhat delicate galvanometer.

By inverting the tube, as is done with an hour or egg glass, a current flows through the galvanometer from the upper mercury mass through the tube *c* into the tube *d* in air bubbles, thence traversing the lower mass, and finally in an opposite direction, the wires being at first completely sealed. To this the short pieces of tube and hermetically sealed platinum wires are to be fitted and fitted with a commutator, so as to be made to give a constant current in one direction, and in the opposite direction.

With a fine funnel, the tube of which is drawn out to a fine point placed above *c*, a very small quantity of mercury and dilute acid were made to flow into the funnel and lower vessel to the galvanometer, some interesting results are to be noticed which serve to throw considerable light on the action in electro-capillary phenomena. It will be found that when the mercury breaks away from the funnel a very great height interrupted, and of course no current passes through the galvanometer; and when the funnel is brought so as to dip into the lower vessel as in the figure, only a continuous column, there is an short circuit and the galvanometer needle undeflected. There is a point, constantly changing, between these two positions giving a maximum current in the outer circuit, and this is easily found experimentally.—P. HIGGS.—*Nature*.

Curious Electrical Experiment.

If an ebonite electrophorus be whipped with a fox tail, it is negatively excited, and the condenser gives positive sparks. If, again, the electrophorus be rubbed with leather on which is some musicle gold, the ebonite disk is positively excited, and the condenser gives negative sparks. It is stated by M. Schlosser, however, (*Journalof's Annales*), that if the surface ebonite disk be excited on one side with the fox-tail, on the *other side* with musicle gold on leather, one may at any moment obtain from the same disk positive or negative electricity, according as the one or the other surface of the electrophorus is used as the source. The most important point in this double excitation is the very much greater length of spark, as is readily observed by the eye. On the other hand, considerably shorter sparks are obtained from the same electrophorus when both sides are similarly excited, for example, whipped with the fox tail.

Diagnosis by Telegraph.—We clip the following from an Eastern paper: "Recording pulse beats by telegraph is a feat recently accomplished by Dr. Upham, who, in a lecture lately delivered in Salem, Mass., by telegraphic communication with the Boston City Hospital, exhibited the phenomena in question by throwing a beam of light upon the wall of the lecture room, which vibrated in unison with the exciting cause."

This reminds us of the pleasure we enjoyed when at the anniversary of Science, at Salem, Mass., in 1874, the Boston City Hospital were made audible to those in Salem by telegraph by telegraphic communication with the Boston City Hospital, exhibited the phenomena in question by throwing a beam of light upon the wall of the lecture room, which vibrated in unison with the exciting cause."

This reminds us of the pleasure we enjoyed when at the anniversary of Science, at Salem, Mass., in 1874, the Boston City Hospital were made audible to those in Salem by telegraph by telegraphic communication with the Boston City Hospital, different beats of the pulse of various patients in the pulse in patients laboring under attacks of pneumonia, phthisis, fever and ague, etc., was quite marked, and perfectly satisfactory to give data by which to recognize the disease. Making the vibrations also visible is a step in advance.

Something New in Electricity.—If an ebonite electrophorus be whipped with a fox-tail, it is negatively excited, and the condenser gives positive sparks. If, again, the electrophorus be rubbed with leather on which is some musicle gold, the ebonite disk is positively excited, and the condenser gives negative sparks. It is stated by M. Schlosser, however, (*Journalof's Annales*), that if the surface ebonite disk be excited on one side with the fox-tail, on the other with musicle gold on leather, one may at any moment obtain from the same disk positive or negative electricity, according as the one or the other surface of the electrophorus is used as the source. The most important point in this double excitation is the very much greater *length of spark*, as is readily observed by the eye. On the other hand, considerably shorter sparks are obtained from the same electrophorus when both sides are similarly excited, for example, whipped with the fox-tail.

ELECTRICAL SMOKE FIGURES.

When frictional electricity is caused to act on quiet smoke surfaces, it produces (according to Prof. Antolik, who has recently made observations on the subject) a number of very curious and pretty phenomena.

To produce the smoke surfaces tobacco was used, mixed with a little sugar, and the mixture burnt in an iron pipe surrounded with cold water. By means of a bellows, with caoutchouc tube, the burning was slowly maintained; the smoke was conducted through a caoutchouc tube to a second cooling apparatus, thence through a glass tube and paper funnel, finally streaming out on a smooth black table, and expanding in a circular surface. If the smoke be not properly cooled it forms irregular waves on the table, which are unsuitable for the experiment.

If, now, a Leyden jar, with about 500 sq. cms., internal coating, and charged with positive electricity, be brought to about one metre above the smoke surface, there appear in the whole of the latter for a moment, proceeding outwards from a central point of action, sharply defined cloudlets of roundish and elliptical form. The entire smoke-surface divides into numerous concentric surfaces, which appear to be as numerously broken, though only in a regular way. This is the climax of the experiment, but it lasts only a brief to one second. Almost at the same moment has the aspect of the well-known bands' wood clouds. In the most favorable moments these appear, but they immediately vanish. The number of cloudlets may in some cases be estimated as several thousands; their size varies from 1 to 2 sq. cms. or more.

A part of the above-named boundaries of an individual cloudlet less remain still visible some time, and expand from the middle point towards the outer edges of the smoke surface.

The production of the figures appears to M. Antolik to be due to a communication of electricity, and not to be an effect of induction, for on using instead of a thin glass disc an ebonite disc even the smoke surface, the figures were formed only round about the glass disc, not under it. Perhaps," he says, "the formation of the phenomenon may be ascribed to very slight and long continued electric oscillations, or to a series of extremely short rises from the Leyden jar to the smoke surface, and causing in the cloudlets themselves a momentary separation of electricity. In this way the phenomena may be explained, yet its cause is not yet given with certainty. The production of the concentric circles may be attributed to the smoke waves arising in the streaming out from the paper funnel, the coherence of which waves seems to persist, though at a short distance from the funnel they flow into each other. The individual smoke-waves separate from each other, and in this state go further if the charged jar be continually brought nearer to the funnel. The initial cloudlets (more difficult to explain than the concentric circles) have probably their source in the regular arrangement of the cloudlets, which flow into each other pretty."

The figures may be maintained even if the jar be neared to the smoke-surface slowly, but they are always more and more blended.

A second phenomenon is that, if the somewhat weakened jar be brought near the smoke-surface, the cloudlets at a certain limit assume, instead of the roundish and elliptic forms, a ruffled (*gekrauselter*) appearance (like tan-maker's wool). Individual cloudlets rise, whirling slowly, but mostly fall back again. The ruffled appearance is only of some time, especially if they occur near the edge of the smoke, where at the same time traces of the radial divisions are perceptible. M. Antolik considers them a result of the individual rays.

If, now, the jar be brought quite close to the smoke layer, so that a small spark between it and it take place, the entire smoke layer is quickly driven outwards in form of a concentric circular surface. But, before this stage, the smoke commonly disappears on the table, while the small surface particles in it adhere to the table, and cannot now free themselves from it.

A third phenomenon, when it once occurs, subsists till the last moment of the experiment. There appear, namely, on the smoke layer, winding and sharply defined furrows, which seem round, similar-like, in the layer, and follow the movements of the Leyden jar. At first there are only a few furrows, often only one; but they afterwards multiply greatly.

This phenomenon seems to point to the fact that on the head of the furrow jar are small particles of dust from which, as from points, the electric wind streams out in infinite fine cone-like bundles, which seem to very strands and uncommonly delicate at their surface, since the borders of the furrows they produce seem to be sharply cut. A furrow often sinks only to the half of the by no means thick smoke layer, and in it the cloudlets of the first phenomenon occur and fill it up. If we hold the jar quite still on production of the furrows, there appear only sharp larger and smaller points in the smoke surface, which continuously maintain their positions, even when the smoke waves stream more quickly out of the paper funnel. If the jar be moved, however, and only two or three cone-like rays occur over each other, they wind parallel to each other. The outlines of the furrows remain visible several seconds, especially at the border of the smoke surface, where this is less movable. Once they occur, they are broader the farther the jar is from the smoke surface.

Good conductors and glass tables under the smoke layer seem to have no influence on all these phenomena. If the Leyden jar be charged with negative electricity the same phenomenon occur, only the jar must be brought much nearer to the smoke.

If these phenomenon seem to render it probable that the hazily-broad clouds visible in the sky have their cause in the air currents saturated with electricity. Whether these are positively or negatively electrified they must certainly act on the cooled water vapor of the atmosphere, even at a great height, either commensalitively or inductively. The needed air must highly favor the action at a distance of the electricity, and accordingly the clouds in question may continue at rest a long time in the place of their origination.

The Northern Lights.

The Finland observations of northern lights in the years 1846-1877, numbering 1,160, have recently been compared by M. Peitz, in the *Wochenschrift für Astronomie*, with auror.i phenomena of the same period in all other regions. This comparison leads to results which are interesting as bearing on the theory of the phenomenon. The table shows that of 2,025 days of the months August to April, on which northern lights were seen, 1,167 days were days of northern light for Finland. On 784 days northern lights were visible simultaneously in America, and mostly also in Europe; on 101 days only in Europe, and on 282 days only in Finland. They were on 88 days visible in Europe and America, and not visible in Finland. The conclusion is thus reached that a large portion of the polar lights have as very great extension, or that the causes producing them more often be of a very local nature, while in another portion of the phenomenon the regions of simultaneous appearance are very considerable. The number of these phenomena which are limited to Finland is very small. With the increase of frequency of the phenomena, at the time of maximum, their number observed in Finland and America on the same day increases; while those observed in Finland and only in Europe, or those in Finland only, decrease. These relations correspond to the known law, that with the frequency the intensity and extent of the polar lights also increase.

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Electric Fire Balls.

M. Planté reads in the foregoing experiments of his an explanation of the *feuâtre globulaire* or "fire ball." They show that with a sufficient quantity and tension of electricity we can obtain the electric light in a globular form. He therefore thinks that this manifestation of the lightning discharge is due to an abundant flow of electricity in the dynamic state in which great quantity and potential are united. These particular cases wherein the fire ball is seen to move and to stop are explained by the motion or rest of a column of humid air, strongly electrified and invisible, which serves for an electrode. In order to imitate this effect it suffices to oscillate the platinum electrode in the above experiments, pendulum fashion, over the water, or a metallic surface, when a little fire ball is seen to move over the surface opposed. This explanation of the fire ball has been advanced before by Mr. Cromwell F. Varley.

IS THE BODY AN ELECTRIC MACHINE?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Allow me to bring the following (to me) strange phenomenon under the notice of your scientific readers. To many of them doubtless it will not be *strange*, and they will be able to account for it.

I have frequently observed during the past winter, on removing my innermost garment (a flannel vest), that the under surface has been *highly luminous*.

Sometimes the light is of a pale phosphorescent hue, like winter or sheet lightning; but often it assumes an angry red, like the forked dose, and at this latter case, when the house has been quite silent, I have distinctly heard that crackling sound characterized with the electric spark.

Is it possible that one bodier resemble so many Leyden jars fully charged? and that the flannel acts like the silk "robber" in producing electricity by friction on the person? and all this without any aid from Fahrenheiter's apparatus.

Let me add that I have noticed the above phenomenon only on *deep, frosty nights*, and that on undressing I have *hastily* taken off the fiery vest and thrown it *briskly* to some three or four feet distance.

I shall leave it to some of your learned readers to account for this. I can only assure them I was not mistaken, as I have often and closely observed it.

I hull with pleasure the appearance of your excellent paper, *The Electrician*.

Hoping some correspondent will enlighten me on the foregoing,

I am, sir, your obedient servant,

W. S. O. B.

A reprint of the Number of the Fifth Volume.

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CHEMICAL PHENOMENA PRODUCED BY ELECTRICITY.

By M. Berthelot.

Ozone is formed equally under the influence of both electricities, the oxygen in each tube only being in contact with the internal armature. The proportions are very variable; but as a rule the positive electricity produces in the majority of cases the more ozone. In none of the experiments made with the Holtz machine was the *ozone* observed in smaller trace of nitrous compounds produced from mixtures of oxygen and nitrogen. Another point of fact. With the effects of Rühmkorff's apparatus traces have been observed, but only at the highest tension. Anything, on the other hand, is produced in notable quantity, in the cases of ozonic compounds included along with platinum in tubes overcoming a metallic armature, independent of the discharges of the Holtz machine. The absorption of oxygen by organic compounds is effected equally by both electricities, and at the weakest as well as at the greatest tensions. I thought the final results in the former case to be larger. Along with the nitrogenous compounds there is formed and a trace of ammonia, nitric or nitrous acid, or hydrocyanic acid.

Influence of Electricity upon Evaporation.—M. Mascart.—The author has examined if the slow formation of vapours is modified by the influence of electrized bodies. A number of small evaporating capsules, communicating with the ground, and containing, some water and others moist earth, were placed beneath conductors kept in a constant electric state. The results of evaporation was always increased beneath the conductors, whether the electricity was + or −, sometimes being even doubled.

ELECTRICAL MOVEMENTS OF CAMPHOR ON WATER.*

By P. Casamajor.

You are doubtless familiar with the singular motions of camphor when placed on the surface of water, which are of such extraordinary nature as to attract the attention of even the most careless observer. Very eminent philosophers have studied these wonderful gyrations, but little has resulted from their labors to explain the cause of this phenomenon. Among those who have worked on the subject we find the great Volta; we also find Venturi, Brugnatelli, Peverary, Biot, Matteucci, Marianini, Mr. Charles Tomlinson, who has given great attention to the subject, published in 1846 a work which has given a full account of previous labors of eminent physicists and chemists on these motions of camphor, to which he added many interesting experiments of his own. I cannot do better than advise those who wish to study carefully the history of the subject to consult this excellent book.

I find in this work that in 1788 Ibañez communicated to the Royal Society of Montpellier his observations on camphor, in which he advanced the idea that electricity is the cause of these singular motions. Ibañez states that camphor does not rotate on the surface of water placed in vessels of iron or copper, but the experiment succeeds very well in those made of glass, resin, or resin. He also states that while camphor is spinning in these vessels it is arrested if the surface is touched with the finger, with iron or brass wire, or a rod of wood, but glass, sealing-wax, or sulphur cannot arrest these motions.

This idea that the motions of camphor on water are due to electricity has met with the disapprobation of all subsequent observers, among whom may be found the names of men who are famous in the history of electricity. Coulomb among these is Alessandro Volta, who made several experiments to show that electricity had nothing to do with these motions.

Now, I propose to show you this evening that there is at certain moments between electricity and these motions of camphor, and, as Volta and other eminent philosophers of mine, in asserting that there is no such connection, I may be allowed to say that in the experimental sciences there is no authority of as much value as a fact, if the fact has been well observed. I propose, therefore, to show you the facts, and you are to be the observers. These facts naturally lead to the conclusion that the remarkable motions presented by camphor on the surface of water are electrical phenomena. I am not prepared at present to go beyond these facts, and drawing from them what seems inevitable conclusion. The phenomena which accompany these motions of camphor are very complex, and they have stubbornly resisted every attempt on my part to bring them under a general theory. I am in hope, however, that what I have to present this evening may serve to elucidate this interesting subject.

Camphor is not the only substance which moves spontaneously on the surface of water. Volta discovered the same property in benzoic and succinic acids. Others have added the stearoptenes of essential oils, the butyrates of soda and potash, carbolic acid, and citric acid; even pieces of cork soaked in ether will exhibit the same phenomenon for a short time. Naphthalen is mentioned in some books as possessing the same property, but I have found that it has not. These substances, with the exception of the stearoptenes, are heavier than water, and they are with difficulty kept afloat; they are also more soluble than is quite convenient for the experimenter. As they behave exactly in the same manner as camphor towards electricity, I will confine my remarks to camphor, as I have almost entirely confined my experiments to that substance.

If we throw pieces of camphor in water they rise to the surface, and, if the conditions are favorable, they will move on the water as if gifted with life. The larger fragments have slower motions than the smaller, which are due to their greater inertia, for if we subdivide the smallest the water with trepidation, after the ingenious idea of Mr. Tomlinson, we will find that the fragments that set from the larger pieces are stronger than from the smaller. The mobility of the latter being greater than that of the larger pieces the latter move away from the camphor. The shapes of the fragments of camphor have a great influence on the rapidity of their motions. A spherical piece will exhibit very little motion, while an elongated piece of the same volume, terminated by two pointed pyramids, will rotate with the greatest energy.

Very often the conditions under which the motions take place do not exist, and then camphor remains perfectly quiet on the surface of the water. It has generally been supposed that this arrested the surface of the water was covered with a film of dirt—either oil, dust, or something else—which for the time prevented the camphor from displaying itself. If, however, we keep the same water in a glass for several days, and place in it at different times fragments of the most pieces of camphor, we will sometimes have motions, and at other times none, which points to the conclusion that these irregularities are independent of the camphor, of the cleanliness of the water surface, and of the vessel which holds the water.

In the daytime the motions are more apt to take place than after sundown. Also when the weather is bright, or when it storms, than when the sky is cloudy and the air damp, but without any pressure of a storm. In many books we find that these motions of camphor on water are due to electricity. Although these may be truthful remarks I think this explanation is not satisfactory. When I began these researches I tried several times to determine these motions by heating the water, but without success; while at other times they appeared to me to be active on the surface of ice-water. Evaporation was clearly not the cause.

At this stage of the matter a gentleman, who is one of our associates, communicated to me an observation, which I here present to the meeting. Pieces of the same pieces of camphor are placed on several successive days in the same basin of water, sometimes there is motion and sometimes not. It was suggested at the same time that perhaps magnetism or terrestrial magnetism had to do with it.

Although magnetism as improbable, and not being aware at the time of the disapprobation by eminent philosophers of the existence of any connection between the motions of camphor and electricity, I made the following experiments, which I propose to repeat before you after reading this paper.

Having before me a beaker-glass holding water, on the surface of which small fragments of camphor were dancing with great energy, I rubbed a clean glass rod with flannel, and dipped the rod in the water, when I was surprised to see all the small pieces of camphor suddenly reduced to immobility. This experiment was repeated several times with fresh portions of water and of camphor, and always with the same result. Subsequently, the same glass rod, rubbed with tin-foil to render it electrically neutral, failed to produce any effect.

* Read before the American Chemical Society, October 4, 1877.

of my pleasure when the fragments of camphor began again their gyrations as the vulcanite insulated the water. I afterwards ascertained that a rod of shellac or of sulphur had the same effect as one of vulcanite.

The first deduction I made from this was that positive electricity stops these motions of camphor, while negative electricity increases their intensity. The deduction is however, was erroneous, as I subsequently found that if, after the motions are stopped by an excited glass rod, it is taken out, wiped dry, and excited again, and dipped in the water, and if the same operation is repeatedly gone over, the motions recommence and increase in intensity every time the excited glass rod is placed in the water. I also found that motions due to positive electricity may in their turn be stopped by dipping in the water an excited rod of vulcanite.

This requires a word of caution, as by rubbing glass very little positive electricity is obtained, when compared to the negative electricity which may be had, in the same manner and in the same glass, from vulcanite, shellac, or sulphur. This difference should be a negatively electrified rod be used with great nicety, as otherwise we bring in contact with the water more negative fluid than is necessary to neutralize the positive electricity, and, as a consequence, the water becomes at once negatively electrified, and the motions of camphor continue without interruption.

When the passage from one kind of electricity to another is very gradual there always occurs an intermediate stage at which, if several pieces of camphor are on the water, they become calm. Afterwards, when the water becomes more decidedly electric, these pieces just compassy, sometimes in quite a violent manner. A point of great importance to note is that when the surface of the water is electrically neutral, and pieces of camphor adhere to one another, they remain for a long time without perceptibly diminishing, while when they are in active motion they waste away in a much shorter time.

Gentlemen, I do not feel that I am against any rule of the strictest logic when I conclude from the facts which I have now presented that there is a connection between electricity and these motions of camphor. As to the cause of these motions, it resides in the camphor itself, and the explanation of the phenomenon must be found in some property possessed by certain substances of which camphor is the type, by virtue of which water which has been electrified dissolves them with greater rapidity than when not electrified. If a piece of camphor is held first on the surface of the water, and hydrosulphuric is sprinkled on its surface, as was done by Mr. Tomlinson, we will see currents flowing outwardly from the camphor. This may be explained by supposing that the water, holding camphor in solution by the aid of electricity as the camphor itself. If the fragments of camphor in small and are free, their great mobility allows them in their turn to be repulsed by the surface of the water, which makes comparatively stationary. Where we hold fast on the surface of the water a piece of camphor with an irregular surface, and sprinkle upon it the means of hydrosulphuric, the currents flowing outwardly from the camphor are very uneven in different directions. The inequality of the currents must, when the camphor is set free, determine its motion in a direction opposite to the resultant of these currents.

The enquiry which now presents itself relates to the nature of the remarkable property which enables some organic solids—such as camphor, benzoic acid, and others which I have not mentioned—to move on the surface of water when it is electrified. Duprectet ascribed these motions to a new force, which he called *repulsive force*. This amounted to giving up the problem. For my part, although I have endeavored to discover the nature of this property, the results which I have obtained are as yet too meagre and too contradictory for presentation before this Society. I do not despair, however, at some future day to present you with results worthy of your attention.

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CRYSTALLINE SELENIUM.—Mr. R. Sabine, in the June number of the *Phil. Mag.*, fully describes a series of electrical experiments with crystalline selenium. After describing the methods he employed for inserting the platinum wires, he points out that it is necessary to discriminate between the resistance of the selenium and the resistance of the junctions. The resistance of the junctions was found to be very various, but did not depend upon the manner in which the wires were imbedded in the selenium. The conducting power of the selenium was found to differ materially in different parts of the same plate, and the resistances of junctions and selenium were both affected by variations of temperature in nearly an

equal ratio. Mr. Sabine experimented on the change of current strength when the current was reversed, but the majority of specimens did not alter sufficiently to afford definite evidence; and those recently prepared specimens which showed a considerable change generally gave unsteady readings. Careful investigation seems to point to the junctions, and not to the selenium, as the seat of this change. Professor W. G. Adams has pointed out that on increasing the battery power the apparent resistance of the selenium is diminished. Mr. Sabine states that, while the current was weak in some specimens, up to a certain limit, the resistance *increased* in one direction and *decreased* in the other direction, but after passing the limit in question the resistance decreased in both directions for any further increase of current, and suggests this result to be either a consequence of the operation of a Peltier effect or of electrolytic polarisation. He continues: "When the current passes through the selenium, it encounters a compound conductor analogous to that in which Peltier observed the cooling and heating effects of the junctions between antimony and bismuth. The crystals round the point of contact which cools contract, and have a tendency therefore to recede and to make the contact with their neighbours still worse; the crystals about the heated contact expand and improve the conduction. The effects are opposite, but not necessarily equal, because one junction may be more susceptible than the other. It is, of course, questionable how far this heating and cooling of an uncertain number of points of bad contact between the crystals of a selenium plate near the electrods would be sufficient to produce a sensible effect. But it is necessary to bear in mind the nature of the doubtful contacts which we are presented with, and which the smallest conceivable approach or recession may improve immensely or break entirely. The supposition that the behaviour is due to polarisation is the more probable. The increase of the resistance with increasing current (when weak) in one direction indicates the existence in the selenium of a small independent electromotive force, and leads to the suspicion that a portion of the material in contact with one of the platinum electrodes is in an electrolytic condition, or both perhaps, one being more so than the other. As the measuring current increases in strength, it appears to polarise the electrodes in the selenium, as in an ordinary electrolytic conductor, and the small independent current is overpowered and lost sight of. The apparent decrement of resistance by increasing the battery is probably due to the fact that the polarisation increases in a less ratio than the measuring current, so that when this current is weak the polarisation is proportionally stronger, and the apparent resistance higher than when the measuring current is strong. The discharge after removing the battery is such as would answer to the depolarisation of an electrolyte. The experiments of Mr. Sabine on the action of light on selenium lead him to conclude that it is a surface action. He made up a plate in the form of a galvanic element, so that the surface alone might come under experiment. A platinum wire was fused into it by which it was suspended in a test-tube. The back of the plate and the wire near it were insulated with a coat of varnish. The apparatus was placed in a lighttight box, in which a shutter could be open to admit light on the uncovered face. Platinum foil was the opposing surface, and in the dark the E.M.F. of the element was 0·112 volt., the selenium being positive to the platinum. On admitting diffused day-light the selenium became negative to the Pt., with an E.M.F of 0·66 volt. The paper also shows that the action of heat is identical with that of light.

EFFECT OF FLAME ON AN ELECTRIC SPARK.—Have any recent experiments been made in this direction? We know, for example, that M. Mische inserted a jet from a glass tube drawn out to a point, with a flame an inch long and one-eighth of an inch in diameter, between the terminals of a Holtz machine, and increased by this means the length of the spark from ten inches to more than twelve. J. A. F.

Nitric Acid Produced by the Electric Light.

MR. T. WILLS, F.C.S., has been making some experiments on the production of oxides of nitrogen in the electric arc. The atmosphere of course consists mainly of oxygen and nitrogen, but simply in a state of mechanical mixture; if those gases become chemically combined, they form several oxides of nitrogen, most of which are strong and corrosive acids. At a high temperature small quantities of these gases can be made to unite. This is the case when electric sparks are passed through air; and during the combustion in air of a very hot flame, such as that of hydrogen; it therefore seemed probable that, as the temperature of the electric arc is undoubtedly very high, nitric acid, or some other oxide of nitrogen, might be produced by the electric light. The first experiment was rather surprising. A glass cylinder placed over an electric lamp (Siemens's regulator) for two minutes, and afterwards examined, was seen to contain a perceptible amount of N_2O_4 fumes, due to peroxide of nitrogen (NO_2). The air surrounding the lamp was next drawn through a solution of potash, and the amount of nitric acid estimated; this gave 10 to 12 grains of nitric acid produced per hour (it may eventually prove to be more, the difficulty being to collect the whole of it). The next step in the research will be to examine the various forms of electric light, with a view to determine the amount of nitric acid produced by each. One of the advantages heretofore claimed for the electric light over gas light has been that the products of combustion of the former were harmless, while gas light produces the deadly carbonic acid. *Am. Exch.*

FRICTIONAL ELECTRICITY.—PECULIAR PHENOMENA.

One of our correspondents, in an early number, described his experiences, during frosty weather, of personal electrical phenomena, and, as several letters have appeared recently in *The Times* and elsewhere on the subject, it may be interesting to our readers to see the following abstract of a paper by Prof. Loomis, at the report of the twenty-seventh meeting of the British Association (1857). This paper contains an account of curious and interesting phenomena. The paper is under the title, "On Certain Electrical Phenomena in the United States," and reads thus:—"Atmospheric electricity is very abundant in the United States, and often exhibits phenomena more remarkable than are witnessed in the most considerable storms, especially in England and Germany. These phenomena are not confined to any particular season of the year, but the exhibitions in summer appear under a different form from those of winter. In summer they frequently exhibit themselves in the form of lightning during thunderstorms, and these exhibitions are often among the most sublime and impressive phenomena witnessed in any part of the globe. The telegraph wires are exceedingly sensitive to the approach of a thunderstorm. The wires are often charged with electricity from the effects of a storm so distant that no thunder is heard in the vicinity. I have often stood at such times in a telegraph office, and introduced my own body into the electric circuit, by taking hold of the telegraph wire without hand, and with the other grasping a wire which communicated with the earth. A frequent voltaic shock in the arms, and sometimes through the breast. The shock is prompt and painful, even when scarcely the slightest spark can be obtained by bringing the two wires nearly in contact. Such experiments are usually when the storm-cloud is near. If, during the passage of a thunder shower, the telegraph apparatus is left in communication with the long telegraph wires, the fine wires of the electro-magnets are almost sure to be melted and the magnets thereby rendered useless. Sometimes, in telegraph offices, there occurs an explosion, which fills the large wires, and is dangerous to human life. The effect of a feeble current of atmospheric electricity on the telegraph wires may be seen in a current from a galvanic battery. It makes a dot on the telegraph register, and when a thunderstorm passes in the neighbourhood of a telegraph line these dots are of constant occurrence, and being interposed between the dots of the tele-

graph operators, they render the writing confused and often illegible. The operators are, therefore, commonly required to abandon their work when a thunder shower prevails in the vicinity of any part of the line. Such difficulties on these lines have been overcome to a considerable extent.—[*Ed. El.*] The aurora borealis is very frequent in the United States even in summer, but on account of the long continued twilight it is not until about 10 o'clock in the evening of winter. During winter thunderstorms in the United States are of very rare occurrence, but even at this season they are not entirely unknown. Sometimes in midwinter, after a series of unusually warm days, a strong wind suddenly springs up from the west, attended by a shower, during which several flashes of lightning, accompanied by thunder, are noticed. Such a shower is invariably followed by a great and sudden fall of the thermometer, but, while electrical discharges in the form of lightning are rarely witnessed in winter, other electrical phenomena of great interest are of almost daily occurrence. These phenomena consist of free electricity manifesting itself in bodies resting on the earth, but sufficiently insulated. This free electricity is particularly noticeable on the clothes and hair of the human body. During cold months of winter, the human hair is commonly electrified, and the degree to which it is charged with a fine comb. Often at such times the fine hairs are seen to stand erect, and the person can comb to make them smooth the more obstinately they refuse to keep their proper place. If you wish to present a person to be electrified in a dry room, give him a book, like a lack of dry hair attached to the prime conductor of an electrical machine. In such cases there is but one remedy—the hair must be thoroughly moistened, after which it flies quietly in its place. During the same season of the year all woollen articles of clothing become highly charged with free electricity. The pantaloons, in particular, are found to attract light feeding particles of dust, down, &c., especially near the feet, and it is impossible to cleanse them by brushing. The longer you brush the more your clothes are covered with dust and lint. Nothing less than a wet sponge is sufficient to cleanse them. At night, when you take off your pantaloons, you hear a distinct crackling noise, and in a dark room perceive a succession of flashes. You draw your fingers down over them, especially near the lower extremities, and you perceive a repetition of the crackling noise, accompanied by distinct flashes of light. As you take off your flannel drawers the crackling is again heard, louder than before, and the flashes of light are more vivid. If you take a woollen blanket from your bed, hold it suspended in your hand, and draw the fingers of your right hand over it, the crackling is equally loud and long continued. Your fingers seem enveloped in a shoal of light, and the flashes can be several times renewed. Brute animals do not escape the general electrical influence. In a cold frosty night, put down your loud gentle cat when she is purring most loudly, and you hear a distinct crackling noise, while her consent to play the philosopher with you. Persons riding on horseback during a snowstorm in the night have frequently noticed the extremities of their horse's ears tipped with light, like that of a pitch, steady flame. The preceding phenomena are either unknown in this country, or are only noticed occasionally, and in an inferior degree; but the aurora borealis is often witnessed in the United States, and is frequently attains a splendour such as is surpassed in but few portions of the globe. During the severity of winter, and especially in houses which are furnished with heavy carpets and kept thoroughly warmed, even more remarkable electrical phenomena are often witnessed. If you walk across such a carpet with a slight shuffling motion, and then present your knuckles to some metallic object, as the knob of a door, you perceive a decided shock and a faint spark. By walking rapidly two or three times back and forth the spark may be increased, and becomes, perhaps, a quarter of an inch or more in length, and has great intensity, accompanied by a smart snap. This phenomenon is not confined to any particular house or style of carpet, but in the cold months can be witnessed in almost every house in New York where there is a thick woollen carpet, and the room is kept habitually well-heated and dry. In some houses these phenomena are so remarkable that persons who have never witnessed them have listened to the accounts with evident incredulity. A few winters ago I received from a female friend an account of some phenomena which she had witnessed at the house of Mrs. C., in New York, and which appeared so remarkable that I concluded the account must be greatly exaggerated. I was induced to call on Mrs. C., and request her to favour me with an exhibition of her electrical powers, to which request she very politely acceded. We were sitting in a parlour covered with a heavy velvet carpet, and lighted with gas by a chandelier suspended from the ceiling. Mrs. C. rose from her chair, advanced one or two short steps, and gave a slight spring towards the

chandelier, which was above her reach when her feet rested upon the floor. As she approached the gas she held the metal I perceived a brilliant spark, and heard a snap much as would have attended the discharge of a small pistol. Immediately walking through the hall, separated from the parlour by a closed door. The spark was more brilliant than before, and the report furnished by an ordinary electrophorus when most highly excited, but its length was not so great. As the door was open the current was sufficient to repeat the electric charge, and the spark was perceived whenever Mrs. C. touched a metallic object, like the knob of a door or the ribbed frame of a mirror. The facts which had been before related to me now no longer appeared incredible, and most of them I verified by my own observations. On approaching the speaking tube to give orders to the servants, Mrs. C. repeatedly received a very unpleasant shock in the mouth, and was very much annoyed by the electricity until she learned to touch the tube with her finger. In passing from one parlour to the other, if she chanced to step upon the hearth-plate which served as slide for the folding doors, she received an unpleasant shock in the feet. A visitor who, in leaving the house, in attempting to shake hands with Mrs. C., received a shock which was quite noticeable, and somewhat unpleasant. A lady on attempting to kiss her son saluted by a spark from her lips. Her little girl on taking hold of the knob of a door received as severe a shock that she ran off in great fright. Larger children frequently amused themselves by shuffling about on the carpet, and giving each other sparks from their fingers. The preceding is the most remarkable case I have myself witnessed, but I have heard of several other houses in New York which appeared about equally electrical; and most of these phenomena here become so familiar in New York that they have ceased to excite surprise. The electricity thus developed exhibits the usual phenomena of attraction and repulsion, and is capable of igniting combustible bodies. By skipping a few times across the room with a shuffling motion, and, then presenting the knuckle to an open gas-burner, the gas may be ignited.

this experiment generally fails unless the burner be warm; but if, after a jet has been some time burning, you extinguish the flame and then draw a spark with your knuckle from the warm burner, the gas is readily ignited. After a careful examination of several cases of this kind, I have come to the conclusion that the electricity is excited by the friction of the shoes of the invalid upon the carpets of the house. I have found, by direct experiment, that electricity is developed by the friction of leather upon woollen cloth. For this purpose, I stood upon an insulating stool, and, spreading a small piece of woollen upon a table before me, rubbed a piece of leather vigorously upon it, and then, bringing the leather near the copy of a gold-leaf electrometer, found that the leaves were repelled with great violence. The electricity of the leather was of the resinous kind. Electricity must, therefore, necessarily be excited wherever a person walks with a shuffling motion across a carpet, but it may be thought remarkable that the electricity should be intense enough to give a bright spark. In order to produce the highest effect there must be a combination of several favourable circumstances. The carpet, or, at least, its upper surface, must be entirely of wool and of a close texture. From my own observations, I infer that heavy velvet carpets answer this purpose best. Too thick-ness of ingrain carpeting answer very well. A dragget spread upon an ingrain carpet yields a good supply of electricity. The effect of the increased thickness is obviously to improve the insulation of the carpet. The carpet must be quite dry, and also the floor of the rooms, so that the final drying and the vegetable gas soon as it is excited. These conditions will not generally exist, except in winter, and in rooms which are habitually kept quite warm. The most remarkable cases which I have heard of in New York have been in well-built houses, kept very warm by furnaces. The furnaces are erected in the cellar, and are filled with anthracite coal, which is kept constantly burning from autumn till spring. The heat is then conveyed to the hall, the parlours, and to every room in the house, so far as is desired. Through large flues built in the walls, the fires having a section of about nine inches square. Such flues the wood during winter becomes very dry, and all the furniture shrinks and cracks. The electricity is most abundant in very cold weather. In warm weather only feeble signs of electricity are obtained. The rubber, i.e., the shoe, must also be dry, like the carpet, and it must be rubbed upon the carpet somewhat vigorously. By skipping once or twice across a room with a shuffling motion of the feet, a person becomes highly charged, and then, upon bringing the knuckle near to any metallic body, particularly if it have good communication with the earth, a bright spark passes, and a sharp snapping sound is heard. If furnished with a thick woollen carpet, and in a room which is and dry, a spark may thus be obtained in winter, but in some rooms the insulation is so good that it is impossible to walk across the floor without exciting sufficient electricity to give a spark.

Electrical Phenomenon

I HAVE just read in NATURE, vol. xiv. p. 230, an account of a strange electrical phenomenon observed at Teignmouth. In connection with it the following incident may be of some interest:—When in Switzerland, last spring, I was visiting one of my friends the manse of Mörel, in the Upper Valais. It was late in the evening, and on gaining the summit we saw a thunderstorm advancing from the direction of the Italian valleys, and not wishing to be soaked to the skin on the long descent we deemed it best to turn our steps homewards. We had not traversed a very short distance along the ridge when the storm-clouds swept up upon us; the flashes were fall so thick that we could hardly see one another, and we were all suddenly attracted by a peculiar hissing sound, which I at first thought was caused by the rain falling upon the thunder-cloud, and we fled from the top of it. Looking through which the ground electricity was flowing off into the cloud; if it had been dark, the whole thing would have been a most beautiful sight. As it was, it was grand enough. I do not remember what month it was, but I think it was in August or September. When the phenomenon was observed, I forget.

Alta Terrace, Manhattanville, York.

W. S. GREEN

Electrical Phenomena

MR. GREEN, in his letter to NATURE, vol. xiv. p. 230, omits to state the route by which he ascended Monte Rosa "not long since." This is a detail of interest, because the rocks of that range are decidedly magnetic, and, much hidden on the north side by ice.

In 1825, much out of sorts, I was ailing by short climbs, and at the Kuffelberg, well known for its effect upon the magnet, strolling up the Gorner Grat in company with three other members of the Alpine Club, and several more, the sky quickly clouded over, it thundered, and the axe of the Alpine stock fizzed in most orthodox fashion, especially when held up, and the long sticks of the non-climbing men also crackled. A transitory but vivid lightning storm followed.

Several days later, during an attempt to ascend the Stockhorn, in company with a young Englishman, from the north side, by the Triftje glacier, the same fizzing, concurrently with a strong thunder, and lightning, took place, and half up the last glacier a thunder storm came upon us, and throwing caution to the winds, we both sheltered down the snow and ice slopes with great respect for crevasses, but never part with your axe," we were much inclined to throw ours on one side. Soon we got below this critically charged stratum of the air and earth, and the fizzing ceased. I shall never forget that terrible half-hour, only to be imagined by mountaineers or mariners. Forbes, in his splendid work on glaciers, relates a similar incident somewhere in this same range.

Positive and negative charges of earth and air, combustibility of these and of axes, and laboratory experiments suggest themselves. In our later cave all were more than dosy.

I have not Forbes' book here, and can therefore give no details. Thunderstorms are characteristic. In 1859 (I think) I was 4 weeks at the Grimsel, called the Nova Vlaco Yber. Does head it was fine. A mile below was a thunderstorm, and during our descent on the Italian side, we came into it, and were refreshed first by snow, then by rain, till we reached Meiringen.

MARSHALL HALL.

Verner-Montreux, Canton Vaud, Switzerland, January 27

ELECTRIC LUMINOSITY OF GASES.—M. Gillard Wiedemann from experiments made by passing discharges from a Ruhmkorff induction-coil excited by two Bunsen cells through a tube filled with air, has determined that a current will become electrically luminous by the passage of sufficient strength, while yet at a temperature far below that of C., indeed, 65° C. is not the lowest temperature at which a gas may emit light under this condition.

ELECTRICAL PHENOMENA DUE TO ETHER.—Within the last few years Professor J. Clerk Maxwell has shown the possibility that all electrical phenomena are due to pressure in the same ether, and this has long been assumed as the means of the propagation of light. Acting upon this assumption he has deduced what the laws of transmission of light in ordinary crystalline and magnetised media would be, and from such deductions he arrived at the laws of those phenomenon. In a Paper recently read before the Royal Society, Mr. G. F. Fitzgerald, F.T.C.D., investigates the laws of the reflection and refraction of light upon the same assumption, and he has obtained the same results as Professor MacCullagh long ago deduced from his theory, and which are known to represent almost exactly the laws of reflection and refraction at the surfaces of ordinary and crystalline media. Still further, he investigated the laws of reflection at the surfaces of magnets, with theoretical results which essentially agree with and completely confirm Mr. Kerr's recently-published experiments on the reflection of light from the pole of a magnet.

NOTE

SUR L'ÉTUDE DES ORAGES ACCOMPAGNÉS DE GRÊLE ET DE PHÉNOMÈNES ÉLECTRIQUES.

La formation de la grêle, les diverses causes qui peuvent y contribuer, sont des questions très intéressantes et encore très obscures de la météorologie, et toutes les théories émises depuis un siècle laissent beaucoup à désirer. Rien l'état actuel, il convient surtout de réunir des observations nombreuses et exactes sur les faits principaux.

M. Colladon indique les questions suivantes :

1° Dates aussi exactes que possible et rendues comparables avec l'heure de Paris, de Berne, ou de Genève, du commencement et de la fin de la grêle; la largeur de la surface grêlée?

2° Dimensions moyennes et maximes des grêlons, leur forme, le nombre moyen ou maxime des couches qu'ils présentent; les couches successives augmentent-elles d'épaisseur à partir du noyau central?

3° Forme apparente et élévation des nuages à grêle; présentent-ils l'apparence d'un vaste mouvement giratoire continu, ou seulement des mouvements d'attraction et de répulsion; multiplicité des éclairs, leur nombre moyen par minute; sont-ils, ou non, accompagnés de bruits retentissants et de chutes fréquentes de la foudre sur le sol, ou sont-ils pour la plupart muets? existe-t-il des chutes notables de grêle sans phénomènes électriques apparents bien marqués?

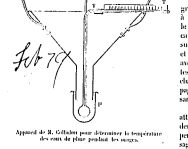
4° Température moyenne de l'air avant ou pendant un orage électrique et température de l'eau de pluie qui l'accompagne au moment même de sa chute.

Cette température de l'eau de pluie pendant les orages d'été, est une des données intéressantes à constater. M. Colladon a fait construire un appareil peu coûteux qui remplit le but proposé; il se compose d'un thermomètre à minimum (T,T) recourbé en équerre, fixé sur un entonnoir dont l'axe est vertical.

Ce thermomètre est gradué sur sa partie supérieure horizontale, le bas de la tige et la boule traversent l'entonnoir dans une position verticale qu'on coincide avec son axe, la boule qui dépasse l'extrémité inférieure de l'entonnoir est logée dans un petite capsule (P) où se rend l'eau de pluie.

Un filet (F) placé au-dessus de l'entonnoir garantit le thermomètre contre la chute des grêlons. (Voir la figure ci-contre, 1/3 grandeur naturelle.)

M. Colladon rappelle que, lors des très violents orages de grêle des 7 et 8 juillet 1875 (*Comptes rendus de l'Institut* des 6 et 13 septembre) des défâts immenses se succédaient à une fraction de seconde; mais presque tous étaient muets et ils ne



Appareil de M. Colladon pour déterminer la température des eaux de pluie pendant les orages.

furent accompagnés d'un une chute de foudre constatée sur le sol.

Au contraire, l'orage de grêle qui, le 3 juin 1877, à 6 h. du soir, a traversé le canton de Genève et causé de grands dégâts sur les cantons de Vaud et de Fribourg, a coïncidé avec de nombreuses chutes de foudre sur le sol et chaque éclair était accompagné d'éclats retentissants.

Des observations très attentives pendant ces deux orages et postérieurement ont appris à passage de la colonne de grêle, n'ont laissé sur aucun mouvement giratoire dans la masse nuageuse d'où tombait la grêle.

Huit lieues l'orage qui a traversé, dans la nuit du 7 au 8 juillet, le canton de Genève a laissé d'innombrables traces de son passage; partout ces traces donnent des directions semblables et parallèles pour le chute des grêlons et la direction du vent sur tout le territoire qui a été frappé.

Sur une largeur de 7 kilomètres et une longueur de 25 kilomètres plusieurs centaines de maisons portent encore les marques très visibles des coups frappés par les grêlons contre les façades et toutes, sans exception, ont été frappées du côté ouest-sud-est au-delà du canton, dans les départements de l'Ain et de la Haute-Savoie, l'orientation des traces de la grêle est encore la même, ce qui ne permet pas d'admettre un grand mouvement giratoire de ces grêlons, ni même des nuages d'où s'échappait la grêle.

Le Propriétaire-Gérant : G. TISSIÈRES.

1882. — Typographie Lahure, rue de Fleurus, 9, à Paris.

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A New Phenomenon in Statical Electricity.

M. E. Duter, in a paper read before the French Academy in December, showed that when a Leyden jar is charged with either positive or negative electricity its internal volume increases, and that this effect is a new phenomenon, unexplicable by either a theory of an increase of temperature or of an electrical pressure. The experiment was performed by means of a flask-shaped Leyden jar with a long tube attached to its neck, and containing a liquid which served as the inner armature. The author's attention had been called to the fact that this phenomenon had been observed ten years ago by M. Gore.

His researches, just made public, leave no doubt of the accuracy of M. Duter's view, that the glass of the jar really expands. According to the theory of elasticity, the effect of an internal charged with a hollow sphere is in the inverse ratio of its thickness. M. Duter, therefore, had three flasks made of the same volume, but of thicknesses of 4 mm., 9·3 mm., and 0·5 mm. respectively. They were filled with water and enveloped by tin foil. Each carried a capillary thermometer tube, in which the variations of the height of liquid served to measure the changes in volume due to electrification. He found that these changes were inperceptible in the thick glass, very marked in the flask of mean thickness, and rose to 30 mm. in the thinnest. The variations in volume were very nearly in inverse ratio of the square roots of the thicknesses.

English Mechanic & World of Science July 22nd 1881

Appareil pour expérimenter l'action de l'électricité sur les plantes vivaces (1).

L'appareil consiste en une grande cloche dans laquelle on fait arriver l'électricité obtenue de la façon suivante :

On place un vase métallique sur un support de 2 mètres de haut où il est isolé pour que l'électricité ne se perde pas. On remplit ce vase d'eau. Quand on laisse l'eau s'écouler par un tube très-étroit, le vase se charge continuellement d'électricité positive en temps ordinaire, c'est-à-dire l'électricité atmosphérique dans l'air. Si au contraire, au contraire, d'électricité négative, dans les cas peu fréquents où l'électricité atmosphérique est négative.

« Ces phénomènes, que M. Palmieri appelle la *veine liquide descendante*, ont été découverts et étudiés par lui en 1850, et décrits dans un Mémoire présenté à l'Académie des sciences de Naples. Dans ces dernières temps, M. Thomson a cru pouvoir se servir de ces faits pour mesurer la tension électrique de l'air.

« Un fil métallique est placé à ce vase que nous appellerons *collecteur* il pénètre dans l'intérieur d'une cloche de verre, où il

(1) Note présentée à l'Académie des sciences dans la séance du 22 octobre, par M. Berthelot, au nom de M. Cell.

se relie à une couronne de pointes métalliques très-aiguës, destinées à distribuer l'électricité. On place, sous cette cloche, les plantes dans des vases qui sont en communication avec le sol. Pour fermer hermétiquement, on fait passer la cloche sur une plaque de verre rodée; elle porte des tubulures par lesquelles on peut faire entrer et sortir l'air au moyen d'une trompe. D'autres plantes identiques sont placées sous une cloche semblable à la première et de même capacité, mais dans laquelle ne pénètre pas l'électricité atmosphérique.

« Le 30 juillet dernier, on sema trois grains de maïs, en prenant des grains de poids égaux pour chaque cloche et de la même terre. De plus, chaque vase reçut la même quantité d'eau. Le 1er août, les graines commencèrent à germer ; pendant deux jours, l'accroissement fut à peu près le même dans les deux cloches. Le troisième jour, les plantes de la cloche dont l'air était électrisé commencèrent à se développer plus rapidement que celles de l'autre cloche. Le 10 août, on mesura les plantes, qui ont les dimensions suivantes prises de la base de la tige à l'extrémité des feuilles supérieures :

Plantes dans l'air électrisé.....	17 c.
Plantes dans l'air non électrisé.....	8

« M. P. Palmieri a entrepris, au laboratoire de l'École supérieure d'agriculture, des recherches relatives à la composition de l'air dans chacune des deux cloches et à la composition de nues dans les conditions ci-dessus énoncées. »

—

New Phenomenon of Voltaic Electricity.

M. Reinold Kerr sends to the *Stiatly Journal of Science* an account of a very interesting experiment by Mr. Sleginoff, which is likely to be fruitful in physical research. He takes, as the two electrodes of the battery, a thin platinum plate, placed horizontally to the plate, and nearly in contact with it. A small quantity of water acidulated with sulphuric acid is poured onto the plate. If a current from a battery of 8 to 10 cells be passed through this arrangement, a spot of light is observed on the point of the wire where this constitutes the cathode. With fifteen couples this quadruplicates the cathode, the direction of the current is reversed. During the phenomenon the water is only slightly decomposed, and the needle of a galvanometer introduced into the current is only slightly deflected. It was also remarked that the surface under the water of the wire is depressed, taking the form of a cup. The bubbles of gas arising from the decomposition of the water, in this case, travel constantly round the wire, forming a very pretty figure of 8. It was further discovered that during these actions in the apparatus the current is intermittent.

Selenitic Ether.

A MEMOIR, published by M. Pauli with the French Academy of Sciences on June 13, 1877, has been opened by that body and found to contain the author's researches on currents of high tension. These studies tend to prove, in the author's view, that the electric discharge consists of a movement or transport of a very small quantity of penetrable matter at a very high velocity.

From experiments made by passing induction currents from *liquid* electrodes through Geissler tubes, Herr Paulson is led to doubt whether a plurality of spectra is to be obtained from the same gas under different conditions of pressure and temperature.

According to M. Henri Becquerel, in the *Comptes Rendus* for Jan. 29, base of nickel become saturated with magnetism much more promptly than iron bars, and hence are better suited for magnetization —a fact which might be useful in telegraphy. Cobalt gives results similar to nickel.

Animal Electricity. 19

In a remarkable lecture delivered before the Medical Society of Zurich, on February 2nd, 1876, and published in *Nature* for April 17th, Dr. L. Hermann summarizes that "the whole of the electrical phenomena of muscle and nerve may be readily deduced from a very few simple proportions. Irritable protoplasm responds both to destructive and to exciting influences by an electro-motive sign. The altered substance takes on a negative potential with respect to the unaltered. This, together with the doctrines of internal transverse polarization, and of the polarizational increment of excitation, appears fully competent to explain all the facts hitherto observed.

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OBSERVATIONS EXPÉRIMENTALES

M. Villari a envoyé à l'Académie des Sciences une communication fort intéressante sur les lois thermiques et galvanométriques de l'étincelle électrique.

L'auteur a réalisé ces expériences à l'aide d'un thermomètre particulier de son invention et trouvé des lois identiques à celles qui étaient démontrées pour les décharges dans les circuits métalliques.

On peut dire que ces effets sont proportionnels aux quantités d'électricité employées et aux longueurs des circuits reliés.

Ces curieuses déterminations sont une confirmation des idées sur l'unité du mode d'action des fluides électriques, quelle que soit leur origine. Elles sont de nature à soutenir les idées précoces des électriciens qui ont été si longtemps des adversaires de la division de la lumière, et qui, si nous sommes bien renseignés, sont en train de se convertir à des idées plus exactes.

Nature Aug 19 1880

Magnetic and Earth-Current Disturbances.

IT may be of interest to point out that a magnetic disturbance has just been experienced at the Royal Observatory greater in magnitude than any that has occurred for some years.

On August 11, at 10.30 a.m., active disturbance suddenly commenced, and continued until midnight, recognizable, as usual, by the exhibition of earth currents. The magnets were then generally quiet until about noon of August 12, when disturbances of still greater magnitude began to be shown, continuing till 6 a.m. of August 13. During the latter period the variations in the magnetic declination and horizontal force were frequent and large, especially between noon and 4 p.m., and between 7 and 9 p.m. Between noon and 4 p.m. there was also a considerable appearance of vertical magnetic force. During the whole period, from noon of August 12 to 6 a.m. of August 13, earth-currents were unusually active and strong, especially during those times at which the magnets are most disturbed.

It seems well at the present time to call upon our engineers, and especially those concerned in the laying of telegraph cables, that disturbances of the character of that described above are now become not unfrequent as compared with the existence of recent years. I may perhaps be permitted here to refer to a short paper, "Notes on Earth-Currents," to be found at p. 211 of vol. viii. of the *Journal* of the Society of Telegraph Engineers, as containing information on the question of magnetic disturbances and earth-currents, probably not without interest at this time.

WILLIAM HUGGINS

Royal Observatory, Greenwich, August 14

P.S.—During the evening and night of August 13-14 large magnetic disturbances again occurred, accompanied as before by strong earth-currents.

Scientific American, Sept 24, 1881

An Electric Storm at Sea.

The German war schooner Nautilus reports passing through a singular storm while crossing the South Pacific from Tahiti to Sydney, Australia.

On the afternoon of May 11, the whole heavens appeared to be enveloped in cloud, which made it so dark that the crew could scarcely see the length of the ship. The thunder became deafening, and the flashes of lightning almost blinded the sailors' eyes. All around the vessel the light ning was striking the water, so that persons on board expected the vessel itself would be hit. But this they were spared. The effect, however, was singular and grand, and at times the vessel appeared to be in flames in several places at once. Balls of lightning on several occasions fell in the water within 20 or 40 yards of the ship's side. While this peculiar storm lasted very little rain fell and the sea was almost entirely still.

Nature Jul 25 1879

A PECULIAR SPARK DISCHARGE.

WHEN the electrodes of an induction apparatus consist of a point and a ball or plate, the striking distance of the spark produced is considerably greater if the point form the positive pole and the plate the negative, than if the point be negative and the plate positive. With the latter arrangement, under certain conditions, Herr Hankel (of the Leipsic Society of Sciences) has observed the remarkable fact, that from the negative point *positive* electricity may pass over in long sparks to the opposite plate.

To the pole of an induction apparatus, which is positive for the break of the current, a blunt point was attached, and opposite to it was fixed a brass disc 200mm. in diameter, which, with the negative pole of the inductorium, was connected to earth. With this arrangement, there passed, at an interval of 240mm. zigzag sparks from the point to the plate, while, with greater intervals, a brush discharge took place from the point. The point being then, by turning the commutator, made the negative pole of the inductorium, sparks first passed (the primary current having the same strength) at an interval of 96mm. When the point was removed further from the plate there appeared only radiations. The sparks which appeared at 96mm. interval were zigzag in form, thin, and without much sound, and they continued so till the interval was contracted to 56mm. Then the spark altered in its nature, it became pretty straight, and produced a more intense sound.

The peculiar aspect of the spark between 96mm. and 56mm. interval, suggested the idea that positive electricity was carried over, and the insertion of a Holtz funnel tube confirmed this fully. By other means, and directly with the electrometer it was demonstrated, that with an interval between the point and the plate of from 96mm. to 56mm., there passed from the point which was negative at the break of the primary current positive electricity, whereas with a less interval of spark negative electricity passed.

For this interesting phenomenon, which the author intends to study further in its details, he offers the following explanation:—

The opening of the circuit of the primary coil at first brings to the point at the so-called negative pole, negative electricity. If now the distance of this point from the opposite plate be greater than 96mm. the negative electricity cannot pass in sparks; but also the oscillation which immediately thereon occurs in the induction wire, and which now brings positive electricity to the previously negative point, has not power enough to discharge this positive electricity in sparks, because the tension produced by this backward oscillation (Rückschwingung) is weaker than that produced by the first direct impulse at break of the primary (this was capable of breaking through an interval of 240mm.). When the point at the negative pole is approximated to a distance of 96mm. to 56mm. from the plate, still the negative electricity driven to the point by the break of the primary circuit cannot pass over in sparks; but the positive which thereupon comes to the point in the oscillation which then occurs, can do so. Since, however (as already remarked), the tension produced by it is less than that produced through the direct action from the break; the spark is thinner and less powerful than if, with the same interval, the point be made the positive pole by reversing the direction of the primary current. If the negative point be now brought nearer to the plate, to a distance less than 56mm., the negative electricity brought to it by the break of the primary current can pass in sparks. But by this discharge the following oscillation is so weakened that it does not render luminous the corresponding funnel tube, or does so very little.

Telegr. [illegible] Aug 15 1879

ELECTRIC DISCHARGES.—M. Gaston Planté, in a communication to the French Academy of Sciences, recently described the results of his latest experiments on sparks from the Planté Rheostatic Machine. The length of the sparks given by this machine are proportional to the number of condensers employed. With 48 condensers charged by a Planté secondary battery of 800 pairs, he obtains brilliant sparks [illegible] metres long, and if these sparks above an insulating surface powdered with flowers of sulphur, they attain a length of even [illegible] m. In this case they form in their passage a sinuous furrow from 0·002 m. to 0·003 m. wide, and if the insulating surface be a mixture of resin with [illegible] of paraffin they leave a very distinct [illegible] trace, like a pencil [illegible], along the middle of the furrow, which permits the course of the discharge to be easily seen. When these sparks are not so long as they can be made, closed branches or derived circuits are observable. There is also a crook or bend in the track of the discharge near the negative pole, which seems to result from the angle caused by two meeting streams of matter proceeding from the excited points, the stream leaving the positive pole being the swiftest. Arborescent forms are also discovered on lightly shaking the insulating powder. They ramify from the main tract or furrow on both sides, and help to explain the tree-like figures sometimes delineated on the skin of persons struck by lightning. These visible paths of the discharge can be easily fixed with varnish. These sparks also pierce glass and give at its surface the figures observed by M. Rees's static electricity. Quantity discharges can also be obtained by joining up the condensers in parallel circuit. These are equally brilliant, but do not traverse more than $\frac{1}{10}$ths or $\frac{2}{10}$ths of a millimetre in presenting the appearance of a very brilliant point surrounded with an aureole of flame, and projecting rays of particles drawn from the electrodes. Intermittent discharges passed through a voltameter give a rapid succession of explosions, amounting to a loud sound.

English Mechanic & World of Science — July 22nd 1881.

Aurora Borealis and the Telegraph.—The latest part of the German official Post-office periodical (*Postamtsblatt*) contains a report from Privy-Councillor Ludewig, of the Central Telegraphic Department, Berlin, on the disturbances in telegraphic communication caused last August by a display of aurora borealis. It is well known that both storms and the aurora borealis disturb the currents which are being conveyed along telegraphic cables. But recent experience seems to prove that the disturbing influence of storms chiefly affects short lines, while the longer lines are more liable to be affected by the northern lights. There was a disturbance of this kind of considerable intensity from the 11th to the 14th of August, 1880. It seems to have manifested itself throughout the greater portion of the northern section of the eastern hemisphere, sending off, however, a southerly stream in the direction of Mozambique, which reached to Natal. It does not appear that the Western Continent was affected. The general features of the disturbance consisted in manifestations of the presence of strange currents ("earth currents," as they are called) of fluctuating intensity, the duration and fluctuations varying in different localities, and the direction of the currents changing frequently. This last feature would seem to indicate a movement of revolution, or at least of approach and recess, with regard to some line or point. These disturbances were traceable alike in underground lines and in lines carried through the open air. In Germany all the longer lines were very much disturbed in the ways mentioned on August 12, from noon till late at night. The interruptions frequently involved the omission of several signs, or even words, and in the Morse apparatus continuous strokes appeared on the paper.

Electrician Aug 2 1879

PRODUCTION OF ELECTRICITY BY EVAPORATION AND OF EVAPORATION BY ELECTRICITY.—At a time when the electrical world is not startled by new revelations every week, when the societies have their vacation, and generally there exists a dearth of news—when, however, everybody is talking of the abnormal state of the weather, it may be well to refer to some of the theories connecting electrical and atmospheric phenomena. For this purpose we shall in a note or two draw upon Sturgeon's "Annals of Electricity" for information. Sturgeon, writing on this subject in 1842, says:—"We are not certain that Dr. Franklin was the first philosopher who entertained the idea of the electricity in clouds being taken up from the earth in its aqueous vapours; but such was his opinion, however, as early as the year 1749, as is clearly stated in his fifth letter, which is highly probable to be the first time that such an idea received publicity. From the results of many experiments on atmospherical electricity, Franklin was led to suppose that the generality of thunder clouds are negatively electrical with respect to the earth." Hence he says, in his twelfth letter, "For the most part, in thunderstrokes *it is the earth that strikes into the clouds, and not the clouds that strike into the earth.*" And, in order to give an explanation for this negative electric condition of clouds, he proceeds thus:—"I conceive that this globe of earth and water, with its plants, animals, and buildings, have diffused throughout their substance a quantity of the electric fluid, just as much as they can contain, which I call the *natural quantity*. That this natural quantity is not the same in all kinds of common matter under the same dimensions, nor in the same kind of common matter in all circumstances; but a solid foot, for instance, of one kind of common matter, may contain more of the electric fluid than a solid foot of some other kind of common matter; and a pound weight of the same kind of common matter may, when in a rarer state, contain more of the electric fluid than when in a dense state. For the electric fluid being attracted by any portion of common matter, the parts of that fluid (which have among themselves a mutual repulsion) are brought so near to each other by the attraction of the common matter that absorbs them, as that their repulsion is equal to the condensing power of attraction in common matter; and then such portion of common matter will absorb no more. Bodies of different kinds having thus attracted and absorbed what I call their natural quantity, *i.e.*, just as much of the electric fluid as is suited to their circumstances of density, rarity, and power of attracting do not then show any signs of electricity among each other. And if more electric fluid be added to one of these bodies, it does not enter, but spreads on the surface, forming an atmosphere, and then such body shows signs of electricity. I have in a former paper compared common matter to a sponge, and the electric fluid to water; I beg leave once more to make use of the same comparison to illustrate further my meaning in this particular. When a sponge is somewhat condensed by being squeezed between the fingers it will not receive and retain so much water as when in its more loose open state. If *more* squeezed and condensed, some of the water will come out of its inner parts and flow on the surface. If the pressure of the fingers be entirely removed the sponge will not only resume what was lately forced out but attract an additional quantity. As the sponge in its rarer state will *naturally* attract and absorb *more* water, and in its denser state will *naturally* attract and absorb less water, we may call the quantity it attracts and absorbs in either state its *natural* quantity, the state being considered. Now, what the sponge is to water the same is water to the electric fluid. When a portion of water is in its common dense state, it can hold no more electric fluid than it has; if any be added it spreads on the surface. When the same portion of water is rarefied into vapour and forms a cloud, it is then capable of receiving and absorbing a much greater quantity; there is room for each particle to have an electric atmosphere. Thus water in its rarefied state or in the form of a cloud will be in a negative state of electricity; it will have less than its *natural quantity*—that is less than it is naturally capable of attracting and absorbing in that state. Such a cloud, then, coming so near the earth as to be within the striking distance, will receive from the earth a flash of the electric fluid; which flash, to supply a great extent of cloud, must sometimes contain a great quantity of that fluid." Again, our philosopher states:—"Thus thunderclouds are generally in a negative state of electricity compared with the earth, agreeably to most of our experiments; yet, as by one experiment we found a cloud electrised positively, I conjecture that in that case, such cloud, after having received what was, in its rare state, only its *natural quantity*, became compressed by the driving winds, or some other means, so that part of what it had absorbed was forced out, and formed an electric atmosphere around it in its dense state. Hence, it was capable of communicating positive electricity to any rod." The principal object for bringing forward these quotations is to show that, in the opinion of this great philosopher, the aqueous vapour rising from the surface of the earth is *negatively electrical* with respect to the natural electrical condition of the water from which it ascended. There are, however, other topics of high theoretic importance contained in these few paragraphs. One of the great beauties in Franklin's theory is that, under natural circumstances, each peculiar kind of matter is possessed of a *specific quantity* of the electric fluid; an idea parallel to that of Dr. Black respecting the specific heat of bodies, and may eventually perhaps become of parallel practical importance. In support of this part of his theory Dr. Franklin invented a very interesting experiment with a can and chain, now well known amongst electricians. A brass chain of some few yards long was coiled in a silver can, and a certain degree of electric action, measured by an electrometer, was given to this apparatus by a spark from a machine. One end of the chain was now lifted up by a silk thread previously attached to it until most of the chain was out of the can. With this increased surface the electric tension became much lessened, but when the chain was again let down into the can the electric tension increased almost to its original degree. "Thus," says Franklin, "we see that increase of surface makes a body capable of receiving a greater electric atmosphere. But this experiment does not, I own, fully demonstrate my new hypothesis, for the brass and silver still continue in their solid state, and are not rarefied into vapour as the water is in the clouds. Perhaps some future experiment on vapourised water may set this matter in a clearer light. One seemingly material objection arises to the new hypothesis, and it is this: If water, in its rarefied state as a cloud, requires and will absorb more of the electric fluid than when in its dense state as water, why does it not acquire from the earth all it wants at the instant of its leaving the surface, while it is yet near and but just rising in vapour?"

La pêche à l'électricité

Ayant renoncé à l'espérance de relever le *Vanguard*, qui s'était coulé il y a trois ou quatre ans par l'Iron Duke, sur les côtes d'Irlande, le gouvernement britannique a pris la résolution de faire sauter l'épave avec de la dynamite. Cette mission difficile a été confiée au *Volunteer*, qui s'en est acquitté à l'aide de torpilles explosionnées, à l'aide de l'électricité.

Les effets ont été extraordinairement énergiques, comme on s'y attendait; mais ce que l'on ne prévoyait point, c'est l'énorme quantité de poissons de toute nature qui avaient été foudroyés et qui furent trouvés flottants à la surface de la mer. Les marins de l'équipage du *Volunteer* auraient pu faire une pêche si abondante que le pont en aurait été encombré

Pêche miraculeuse produite par l'action de l'électricité mettant le feu à des torpilles.

s'ils avaient ramassé tous les cadavres flottants dans le voisinage du navire.

Nous avons cherché à peindre la scène qui se passa à bord quand le cuisinier des officiers vint choisir dans le tas les poissons qui lui convenaient.

Un peut conclure de la richesse de cette pêche miraculeuse, que les torpilles pourraient être parfaitement utilisées, lors du passage d'un banc de harengs ou de morues sur un fond. L'essai n'a point encore été tenté; aussi il mériterait d'attirer plus spécialement qu'il ne paraît pourvoir être prévenus télégraphiquement ou par pigeons du l'arrivée prochaine des poissons dans les parages qu'ils fréquentent.

C'est à l'incompressibilité presque absolue de l'eau qu'est due l'énergie de cette action destructive, car les poissons reçoivent ainsi un choc équivalent à un coup de marteau, dont l'énergie décroît en raison inverse du carré de la distance au centre d'ébranlement.

Si l'on voulait employer pratiquement cette méthode, on devrait répartir sur un espace plus ou moins grand un certain nombre de foyers.

L'expérience seule indiquerait la masse de dynamite qu'il faudrait employer à chaque centre d'explosion, masse qui serait plus ou moins grande celle-ci étant suivant la profondeur de l'eau.

La condition la plus essentielle à remplir, pour arriver au maximum d'utilisation, sera la simultanéité absolue de l'explosion.

Aurora Borealis and Magnetic Storms

THE epoch of great auroras and magnetic storms has again returned, as was evident from the fine displays seen here on the evenings of the 11th and 12th, and these are as usual accompanied by an increase in the number and size of the sun-spots, and in the developement of the solar prominences. The aurora on the 11th was grand, but that which followed it on the 12th excelled greatly the magnificent display of 1869, 70, and 71.

On the 12th my attention was first called to the phenomenon at 10h. 25m. p.m., when the northern horizon was skirted by a bright white fame terminating in an undefined arch, from which results. The bank of white light on the horizon extended from about 32° E. of N. to 40° W. of N., and none of the streamers attained an altitude of fully 60° at 26h. The brilliancy of the individual streamers was varying rapidly, but there was little variety in the character of the phenomenon.

At 11h. 30m. the brightest streamers were W. of N. Ten minutes later this brilliant white band of light had spread gradually westward, and was some 25° W. of N., when it faded away. Some streamers were still more W. of N., and others again were slightly E. of N.

At 11h. 40m. there was nothing remaining of the aurora except a cloudy whiteness in the north, the seat of the heavens being a deep blue. A minute later streamers were again apparent.

At 11h. 45m. a very bright streamer formed 5° E. of N., and then a similar band of light appeared 5° W. of N., followed in rapid succession by other streamers 10°, 20°, and 45° W. of N., each streamer fading away before the succeeding one became very bright.

At 11h. 50m. a single narrow band of intense white light stretched from the horizon towards the zenith, passing through Cor Caroli.

At 11h. 52m. the light in the N. and N.N.W. again heightened up, but there was no further appearance of streamers.

The magnetic storm that accompanied the aurora of the 12th was one of the most violent ever recorded at this observatory, and was very similar in character to the magnificent storm of 1869.

On the evening of the 11th the magnetic needle was very irregular in its movements, but it was only towards midday of the 12th that the storm really began. The oscillations from the beginning were very rapid and extensive. The first great movement began at 11h. 30m. p.m., and between 11h. 45m. and 12h. 20m. the declination magnet moved 1° 6′ 45″ eastward. They returned westward, and at 1h. 20m. the reading had increased by 1° 18′ 15″. Between 7h. 50m. and 8h. 20m. p.m. the needle moved 1° eastward, but it attained its extreme E. position slowly and quickly towards the west, and after a double sweep it reached its maximum at 8h. 13m., the change of declination in 4m. being 1° 27′ 30″.

The oscillations of the V.F. magnet were as great as those of the declination. The chief sensitives occurred at 5h. 40m. p.m., and there were three marked minima at about 10 p.m., midnight, and 2 a.m., the two latter of which were lost from the oscillation being too great to be recorded. The horizontal force was also in the first hours a decrease of 1 in lock of ordinate in 5m.

The variation of the H.F. magnet was very large, but not so remarkable as that of the V.F.

On the 13th the magnetic storm continued greatly to disturb all the magnets, but it was less violent than on the preceding day.

Stonyhurst Observatory, August 15 S. J. PERRY

THERE was a beautiful display of the aurora here last night. Between ten and eleven o'clock the streaks extended from the horizon to the zenith. The colour was principally pale blue, but a reddish tinge was occasionally discernible. I observed what I thought was a distinct movement of some of the streaks. A bright comet suddenly made its appearance to the westward of a small black cloud, seemed for some slowly eastward and disappear. There was a slight breeze from the east at the time, but I do not think that the clouds were moving sufficiently rapidly to account for the phenomenon.

Springburn, Glasgow, August 13 J. A. B. OLIVER

A Case of Slow-Sub-Tepical Discharge of Earth-Electricity, and the Sun Recognisant thereof

In the course of yesterday afternoon, in the midst of a sky otherwise clear and exquisitely blue, a large cloud of unusual shape and character began to form in the upper regions of the atmosphere vertically over, but very far above, the southern slope and even most elevated mountain tops of Madeira, and continuing there, as it did, most fixedly more than half the day, so contrary to the locomotive habits of ordinary clouds, it soon attracted the attention, and presently the fears, of most of the inhabitants.

As seen from this place, between 1h. and 3h. p.m., there was little more than a single dense cloud of peculiarly rounded outlines and somewhat elliptical figure, stretching from the western horizon to within 20° or 15° of the zenith, but no sign advanced.

Shortly after 3h. p.m. this cloud was seen to be divided into two, the first, having symmetrical and evocentric outlines thereafter, while the central vertical axis, which might be conceived as passing through the whole series, remained unchanged and fixed in space. The central fairly, too, of them all continued, together with the infinite concealments of the outlines of all the smaller lower terms of cloud, although the largest and uppermost one visible to us began to put forth a variety of fringes of silver-cumulus character; and, as tested by the spectroscope before sunset, all the lower smooth-massed clouds were remarkable for the large quantity of watery vapour they contained, and held fast too, for so rain fell. As sunset approached every one was gazing at the strange phenomenon of a cloud-congeries of most portentous size and absolute fixedness in the trade-wind, probably also the anti-trade region; and when at sunset the most gorgeous coloured illuminations through all the range of reddened, red, crim-crowned, silvered, red dun shadowed and grey passed from manifer to member of the series, although, as the various heights of its strata rose above the other; while the centrality of the general height was shown, even long after darkness had fallen, by a faint lunar-like illumination of the northern outline of the whole, that by ten o'clock this began to fall, and the system of superposed clouds was beginning to contract in its central axis, and faded away, without having its place, before morning.

In so far we had been witnessing, though without any positive light of its own, a vertical series of disks of cloudy matter, extremely like the lower end of the successive, transverse, di-cone arrangements seen in a gas vacuum-tube of large dimensions, when the electric discharge from a powerful induction-coil is passing through it; and we were inevitably remi-ded thereby that the accepted electric theory of M. Gaston Planté (of "secondary batteries or storage" fame) justifies an escape of the earth's inverse electricity from time to time into planetary space, and more particularly to the sun.

What there, however, in this case was symptom of the sun receiving or falling for, my such discharge, and from this part of the earth?

The sun was undoubtedly in the Northern Tropic, and the highest northern declination of the sun had just been reached; but for a fortnight or more past the solar spot manifestations had generally been weak, almost fading away, for the most part well, leaving taken a picture of the sun-spots every day (Sunday excepted) since I have been here. However, though the appearances were not so great as they could be on June 21, 22, and 23, yet on Friday, June 24, there was a little improvement, some new, though small symptoms appearing in either solar tropic. On Saturday, June 25, these new features were confirmed and slightly increased. But what were they on Sunday, June 26, when the extraordinary cloud-arrangement was hanging so long above Madeira?

I, who am here merely as a private amateur in a different subject, know only too well on Monday morning, early at 9h. 30m. a.m., I was astonished and delighted at the solar scene then presented. The spot—the principle sight of on Friday were now well advanced and much developed: a new group with extensive double ramification had also appeared in the same tropic nearer the equator; while finally, near the middle of the sun's disk in the same tropic, were two large spots, with connections extending over 60,000 miles in length of solar surface, and indicating more extensive changes to have been developed, if not suddenly revealed within the last forty hours, than anything which I, at least, have witnessed for a very long time past.

PERCY SMYTH,
Astronomer-Royal for Scotland

Jones's Hotel, Quinta do Carvalho,
Funchal, Madeira, June 27

P.S.—The grand, and now circumpolar, comet was not neglected here on the same night.—P. S.

LA NATURE

L'ÉLECTRICITÉ

REVUE SCIENTIFIQUE ILLUSTRÉE

BEAUX-ARTS — INDUSTRIE — MARINE — ART MILITAIRE — MÉDECINE

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5 JUILLET 1879

LES GRANDS PHÉNOMÈNES ÉLECTRIQUES

Les Orages

Nous avons signalé, dans notre numéro du 3 juin, la négligence extraordinaire des météorologistes réunis à Rome, qui ont oublié d'éclairer leur lanterne; car, aucun de ces savants officiels n'a paru s'apercevoir que l'électricité était la plus importante des spécialités dont ils eussent à s'occuper s'ils tenaient à gagner leur vie d'une façon plus sérieuse qu'en rédigeant des prédictions que les augures de l'ancienne Rome d'amusant jamais consenti à signer.

On dirait que les forces brutales de la nature ne sont point si avengles qu'on veut bien le dire et qu'elles prennent un malin plaisir à montrer l'insuffisance des théories à l'aide desquelles des hommes à courte vue s'imaginent lui avoir arraché ses secrets.

En effet, il y a longtemps que les orages n'ont été si fréquents, si terribles, non pas seulement de ce côté de l'Atlantique, mais encore dans un autre continent.

Nous ne pouvons entreprendre du discuter toutes les circonstances bizarres qui se sont produites cette année et que les journaux politiques des différents pays ont relatées avec un zèle fort louable.

Bornons par l'espace nécessairement limité dont nous disposons, nous avons dû nous borner à résumer rapidement quelques circonstances qui sont de nature à éclairer la théorie des paratonnerres ou d'une façon générale quelque point particulier de l'histoire de l'électricité.

Cependant, nous manquerions à notre mission si nous ne saisissions cette circonstance pour indiquer tout le parti que la météorologie peut tirer des observations électriques que les physiciens du service international dédaignent d'une façon véritablement surprenante.

Dans nos *Eclaires et Tonnerres*, nous racontons l'histoire d'un coup de foudre qui frappa, il y a cinq ou six ans, l'observatoire de Paris et dont personne ne s'était inquiété, excepté le portier! Sans cet estimable fonctionnaire, nous n'aurions pu retrouver la trace d'un phénomène fort intéressant, précisément parce qu'il démontrait que l'Académie avait commis une erreur en ne recommandant pas de conduire les décharges des eaux pluviales jusqu'au ruisseau (1).

Avant l'invention du télégraphe, on est arrivé à décrire la trajectoire de certains orages qui ont traversé le royaume de France dans toute sa longueur. Ces grands météores privilégiés laissaient derrière eux une trace facile à suivre, un sillon de grêles marquant la trajectoire qu'ils avaient parcourue. Quelques autres parce qu'ils étaient accompagnés de trombes qui attiraient, d'une façon toute particulière, l'attention des populations.

Mais, les nuages orageux possèdent, en général, une constitution particulière qui permet, avec les moyens dont la physique moderne dispose, de déterminer leur route même dans le cas où ils ne donnent naissance à d'autres produits météoriques que de l'eau et du feu, et sans qu'ils laissent rien tomber du plus solide.

En effet, leur arrivée est toujours signalée par un rapide abaissement dans la température de l'air, par une diminution notable de la quantité de humidité qui vient du ciel, et par des mouvements plus ou moins rapides dans l'électricité ambiante.

Le plus souvent, ils sont accompagnés par des courants électriques spontanés qui se développent à

(1) C'était du temps où M. Delaunay régnait encore! Ce portier rappelle involontairement le portier de l'Observatoire de Marseille, lequel découvrit une comète avec la lunette de son maître. Ce dernier, qui était d'humeur quelquefois, se fâcha tout rouge et le portier, remplaçant du rôtire du lunette, fut renvoyé. Ce qui est encore plus grave, c'est que des astronomes français lui ont volé sa comète pour en faire cadeau à un Prussien. (Voir ce que nous en disons dans notre *Astronomie moderne.*)

Bibliothèque Nationale R.F.

ON THE ACTION OF MAGNETS ON LIQUID JETS.*

By Benjamin P. Thompson, B.A., D.Sc., Professor of Experimental Physics in University College, Bristol.

In studying the phenomena of electric tension the author has been led to inquire into the actions produced by magnets upon movable conductors, such as flames, liquid jets, flexible metallic leaves, liquid conductors, gases in high rarefaction, flames, and liquid jets, traversed by currents.

Nearly all the phenomena of rotations and translations due to electro-dynamic and electro-magnetic attraction or repulsion have been demonstrated to hold good for liquid conductors, both those which possess metallic conductivity and those which possess only electrolytic conductivity. Davy, Cassebmann, and Wolfter have shown the electric arc to behave as a mobile conductor. Plücker and De la Rive, and more recently Crookes, have observed the existence of these electrodynamic actions on the luminous discharges in highly rarefied media, and which appear to be electric convection currents rather than electric currents proper.

The author has examined the case of liquid veins, both of dilute acid and of mercury traversed by currents, and finds that they become subjected to the action of powerful magnets, exhibit analogous motions of translation, rotation, etc. Thus a liquid vein carrying a current between the

* Paper read before Section A of the British Association at Sheffield, August 20th.

poles of a horizontal horseshoe electro-magnet no longer falls straight, but is thrust aside and falls down an inverted curve. A vein falling in front of the pole of a vertical magnet is likewise drawn aside, tending to become parallel to the hypothetical Amperian currents, and to rotate in an opposed sense around the pole. Further, a liquid vein carrying a current falling upon the pointed pole of a vertical magnet is twisted, the sense of the torsion depending on the direction of the current and the polarity of the magnet. The author has also sought to extend his observations to the case of flames. He finds that the flame of the Bunsen burner, traversed by electric currents proper, but only electric convection currents, and the results obtained, though not yet completed, thrown him to include in this act of phenomena the so-called diamagnetism of flames and of jets of smoke and steam.

Alcohol by Electricity.

Berthelot's experiment was conducted as follows: "A battery of from six to eight Bunsen elements was arranged in connection with an oscillating commutator, so as to give alternately positive and negative currents twice to fifteen times a second, to two cylinders of spongy platinum, acting as electrodes. These platinum cylinders were immersed in acidulated water, and the contacts were so arranged that neither oxygen nor hydrogen was disengaged, the water being reformed as soon as decomposed. Thus regulated, the electrodes of the apparatus were immersed in an aqueous solution of glucose." In this way alcohol was formed, although in very small quantities, but it is expected that when some improvements in the apparatus are made, the process will be much more rapid.

Bibliothèque Nationale R.F.

Boston's Yellow Day.

A visit to the roof of the Equitable Building at 11 o'clock on Tuesday revealed a curious sight. To the westward vision was unobstructed by fog or haze to a distance of some ten miles. The green foliage in the interval was brilliant under the strange illumination, and the waters of the Charles River gleamed with silvery brightness. To the eastward, down the harbor, the view was unobstructed to a distance of a mile only, Fort Independence appearing to be enveloped in a light haze, and the fleet of vessels lying at anchor with the exception of the outline of the fortress. Fort Independence was an almost sharp-cut dark mass against a background of grey cloud. In all directions distances appeared to be greatly diminished, and objects near and far could be seen almost with equal distinctness, resembling little electric lamps, but being in reality the sun. On the roof of the Postoffice different operators had a portable furnace, the blaze in which, as it leaped into the air, was marked with strokes of brilliant white. Away in Scott's Baths a steam jet was visible, but the steam was not condensed, but it was not marked by the usual milky gloss of such jets. The atmosphere itself was seldom with a radiance that took all color out of other flames.

The view from the water was very strange. Looking from the landing and the piers were alike discomfited with the strange light, and the water, and the hues of the water, being supplemented by saffron, was transformed to green. The effect on the green of the field and trees was to produce a brilliant emerald. One of the greatest curiosities was the Boston Belle and Belle Isle Tubular, the chocolate color of which appeared to be transmuting into sometimes yellows fresh from the Mint. A rather effect was had from the interior of the Athenæum Library, the northern windows of which revealed the golden hue streaming through drooping willows and creepers, and the effect of the light falling a richer dye on the yellow and scarlet volumes beneath. It was remarkable that, while the green light appropriated the electric hue, the latter put on a slightly bluish tinge. An exceedingly beautiful effect was noted in a blacksmith's shop near the North Ferry, the shower of sparks from the forge and anvil being transformed from a fiery to a silver spray.

The phenomenon became more marked in the afternoon than it was during the forenoon. At late as 1 o'clock it was possible for a person situated in the middle of the Boston Belle Isle Tubular to read artificial light, but after that hour the gloom deepened rapidly. The sky grew still more lemon in appearance, and the green was that of late twilight. The front windows of stores on Washington street remained lighted all night, and there was not a single usual aspect of the city that was not lost in the yellow haze. There was something terrible in the scene, and it is not to be wondered at if some weak minds allowed themselves to be tormented by fears of what the extraordinary event might presage. The climax was reached at about 7 o'clock, and after that slight gradual improvement set in, and by 9 o'clock the yellow had entirely disappeared, the clouds had disappeared, and the atmosphere had assumed its normal condition.—*Boston Journal*, September 5.

Nature 5 Dec 1879

INFLUENCE OF ELECTRICITY ON VEGETATION

SEVERAL months ago, it will be remembered, M. Grandeau described to the Paris Academy experiments made by himself and M. Leclerc at Nancy and Meurcy, whence it appeared that flowering and fructification are retarded and impoverished if plants are excluded from the influence of atmospheric electricity—as by being inclosed in a metallic cage, or being near trees or other objects which may carry off electricity of the air.

Recently M. Naudin has repeated the experiments referred to, but with other plants and in a different climate, and, without wishing to contradict the conclusions arrived at for tobacco and maize (the plants that had been experimented with), he is led to regard the declarations made as too general, inasmuch as his results are almost exactly opposite to those obtained by MM. Grandeau and Leclerc.

It was at Antibes, in the large botanical garden formed by the late Thuret (now Government property), that M. Naudin made his experiments. He had an iron quadrangular cage made, covering a surface of fifty-one square decimetres, and about one metre in height; the frame carried points above (like small lightning conductors), and was covered with iron netting, the lozenge-meshes of this being 0·030 long by 0·024 m. broad (it intercepted more light than M. Grandeau's, but this is thought insignificant). The cage was placed in a kitchen garden, and the plants it was made to inclose were kidney beans, lettuce, tomato, and herbaceous cotton (the last alone being sown as seed). In the same garden, at 7 metres distance, plants as like the others as possible were planted, and cotton seeds of the same kind sown, but without a cage-cover. The soil was perfectly homogeneous throughout, and all parts of the plot were equally exposed to sunlight, dew, and rain. The experiment began on May 25.

For a fortnight there appeared no sensible difference between the two portions; but about the middle of June it was remarked that the plants of the cage were stronger than those in the open air, and this difference became more pronounced as time went on. The plants, indeed, progressed side by side in this sense, that the flowerings were absolutely contemporaneous in the plants of the same species; and it was the same with formations and maturation of fruits. But it was quite otherwise with the quantity of vegetable matter produced in a given time and on the same extent of soil, and this difference was entirely in favour of the caged plants.

We may take the figures tabulated by M. Naudin for the tomato (examined August 14), as a good example of this :—

	Plants in cage.	Plants under the cage.
Total weight of the plant cut at the level of the ground, fruits included	2·972 kg.	3·734 kg.
Number of ripe fruits and green fruits of all sizes ...	37	83
Weight of the whole of the fruit detached from the plant	1·80 kg.	2·162 kg.

The other plants gave a similar testimony in favour of the utilisation of atmospheric electricity. Thus, the total weights of the bean plants were respectively 2·27 and 166 gr.; and of the lettuce 137 gr. and 227 gr. The cotton plants were weakly (as there had been no watering), but their evidence was in the same line as that of the others.

The injurious influence, whence, according to M. Grandeau's theory, trees exert on plants in their neighbourhood, by withdrawing atmospheric electricity, is also considered by M. Naudin to be only a special case. Besides, it is easy to ascribe to this withdrawal what is the result of the shade cast by trees, and especially roots, which often extend to a great distance. On the other hand there are many plants which seek the neighbourhood of trees, and which even thrive only under their shadow, and these, probably, must be subjected to a diminution of atmospheric electricity. At the Villa Thuret, M. Naudin remarks, there are several lawns quite inclosed by trees (pines, firs, cypresses, &c.), many of which are adult and of pretty good size. These lawns contain, besides their grass, thousands of anemones (*A. Coronaria, A. cyanea, A. stellata*), some of pure race, others hybrid, whose flowers present all shades of red, rose, purple, white, and blue. The appearance is striking when the flowers come out in March or April. The flowering is not entirely contemporaneous throughout the lawn; it begins near the trees, and gradually extends to the middle of the lawn; the difference of time between these two extremes being twelve to fifteen days. Moreover, the anemones nearest to the trees, in addition to their relative precocity, are generally stronger and taller, and have broader, perhaps more brightly coloured corollas, than those in the middle of the lawn.

From the observations described, M. Naudin is disposed to think the question as to the influence of atmospheric electricity on plants is complex, and far from being decided as yet. This influence, in all probability, is modified first by the very essence of the species, which must behave, in regard to atmospheric electricity, as to other agents of vegetation, that is to say, in very diverse manners; then it is modified by climate, season, temperature, degree of light, dry or wet weather, perhaps also by the geological structure or mineralogical composition of the ground, the layers of which, superficial or deep, may not be equally conductive of electricity. It is possible, lastly, that all tree species may not alike withdraw the electric *effluve* of the atmosphere, and this is a point necessary to be determined. Until these numerous and so obscure conditions of the problem before us are sufficiently known, we should regard as premature any conclusion which is applied to the whole, or even only to the generality of the vegetable kingdom.

CHEMICAL EFFECTS OF ELECTRIC DISCHARGE IN GASES.

—M. Berthelot finds that both the positive and negative glow in gases do not decompose carbonic acid, as a rule, at the ordinary temperature, but that of olefiant gas, hydrogen, whether moist or dry, the discharges from a Holtz machine did not produce the slightest trace of nitrogen compounds; traces were, however, observed with discharges from a Ruhmkorff coil, but only at the highest available tensions. When the vapor of organic compounds was inclosed along with nitrogen in tubes containing a metal electrode electrified by a Holtz machine, acetylene was produced in notable quantities. The absorption of nitrogen by organic compounds is effected equally well by both positive and negative discharges, and at as well as high tensions, although more time is required for the process with low than with high tensions. With these nitrogen compounds no traces of ammonia, nitric, or nitrous acids, or hydrocyanic acid, appear to be formed. M. Berthelot has also produced absorption of nitrogen by organic compounds with the current from an ordinary galvanic battery.

THERMAL CONDUCTIVITY.

—Dr. Lodge described a simple form of apparatus for determining the thermal conductivity of non-substances, such as crystals, which cannot be obtained in slabs or rods. It consists of two small tin cans with a copper arm about 6 inches long projecting horizontally from each, the external ends being very clean and flat. They are placed in a straight line with the crystal between them, and held together by a slight horizontal pressure. Holes are drilled in the copper rods for thermometers, and the curves of temperature being given by these, that for the intermediate crystal can be at once calculated.

THE GRAMME ELECTRIC LIGHT MACHINE

has recently been tried at the Palais de l'Industrie, Paris. A space of 12,000 square metres in area was brilliantly illuminated by two electric lusters, each of six lamps, and placed two observers feet above the ground. The machines were driven by two steam engines of 35 horse-power each. It is estimated that 1000,000 candles would be required to give the same lighting power.

Encore les Étoiles filantes

L'Éternelle

Comme nous avons été conduits à nous plaindre amèrement de l'état d'abandon dans lequel on laissait les observations d'étoiles filantes en France, on nous permettra de relever le résultat des observations dues à M. Chapelon Coulvier Gravier.

Ce laborieux observateur a constaté que malgré le mauvais temps qui a accompagné à Paris les nuits des 8, 9 et 10 août, quelques éclaircies indiquant déjà l'arrivée prob.ble d'une pluie météorique importante ont été aperçues dans cette période.

Ces précieuses se sont trouvées réalisées. En effet, l'observation faite pendant la nuit du 11 au 12, par un ciel parfaitement serein, donnait un nombre horaire moyen de 111 étoiles ramené à minuit.

Ce nombre, en tenant compte des moyennes précédentes, a été ramené à 138, à pour le maximum, ce qui donne une augmentation de 28, 1 sur le maximum de 1848, le plus remarquable du siècle.

Comme toujours, les centres d'émanations visibles à cette époque se trouvaient près du zénith et par conséquent dans les constellations de Céphée ou de Persée.

Faut-il rappeler que le grand Arago, dont on va bruyamment inaugurer la statue à grand orchestre à Perpignan, est un des premiers astronomes qui aient observé les étoiles filantes; que c'est grâce à sa protection que M. Coulvier a pu se livrer à la recherche des astres; que notamment, lors de la rédaction des instructions destinées aux officiers de la *Bonite*, il mit les observations des étoiles filantes au premier rang de celles que l'on devait faire; qu'il ne négligeait jamais de faire observer ces étoiles filantes à l'Observatoire dont il était le directeur, ni de communiquer le résultat de ces observations à l'Académie des Sciences dont il était le secrétaire perpétuel.

Nous avons honte de nous étendre plus longuement sur un sujet si triste, si douloureux pour notre amour-propre national.

Nous devons ajouter cependant que l'échéance de nov.mbre offre un intérêt part.culier, surtout pendant la nuit du 27, jour où l'on peut espérer retrouver les débris de la fragile comète de Biela.

C'est M. Newton de Yale Haven qui nous a communiqué lui-même à Sheffield ce renseignement.

Il a fait de même aux astronomes anglais qui ont pris la résolution d'organiser une série d'observations non-seulement en novembre, comme les années précédentes, mais pendant les nuits aux lune de septembre et d'octobre, en balayant certaines régions du ciel que M. Newton leur a indiquées, et où les débris de la comète, quoique encore éloignés de la terre, peuvent se trouver si elle n'a pas été réduite en poussière et complétement désagrégée.

Ces recherches sont exécutées, aussi en France, dans tous les pays civilisés.

Elles intéressent les électriciens d'une façon tout à fait directe, car il est possible que l'approche d'un courant météorique influe sur les éléments magnétiques du globe et produise même à la surface des régions voisines du point de rencontre des courants spontanés.

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OBSERVATIONS EXPÉRIMENTALES

Sur les effets mécaniques qui accompagnent les décharges électriques

En 1811, M. Abria, professeur de physique à la Faculté des Sciences de Bordeaux, eut l'idée fort ingénieuse d'employer à l'étude des phénomènes mécaniques qui accompagnent les décharges un procédé analogue à celui dont se servit Chladni pour l'étude des surfaces nodales.

Le savant physicien disposa l'excitateur universel de manière à faire passer entre les deux pointes placées sur une ligne horizontale, la décharge soit d'une bouteille de Leyde, soit d'une batterie quelconque.

A 20 centimètres au-dessous de la ligne des pointes, il plaça une plaque sur laquelle il avait répandu aussi également que possible, à l'aide d'un tamis à mailles très-serrées, de la craie finement pulvérisée.

Après quelques décharges, si l'on n'a pas mis trop de poussière, on trouve que les particules de craie offrent une forme parfaitement régulière.

Non content d'indiquer ce beau phénomène, M. Abria en donna l'explication complète. Il montra que ces accumulations de poussière sont dues à la dilatation de l'air qui s'échauffe lors de la neutralisation des fluides, et au mouvement contraire qui le fait ensuite fair remplir le vide produit dans les premiers instants par la chaleur corrélative de l'apparition de l'étincelle.

Les conditions de l'expérience ont été variées de mille manières différentes, en modifiant la distance des pointes et celle de la plaque, ainsi que la masse électricité en mouvement.

En général, les lignes tracées par la poussière sont des portions d'ellipse régulièrement orientées.

Si on remplace des boules par des pointes, l'action mécanique semble se propager à une distance plus grande.

On peut encore placer les pointes sur une même verticale et percer la plaque d'un trou central, et le cuivre, ou mettre les poussières sur une plaque de métal.

Dans ce cas, les lignes semblent appartenir à des arcs de cercle.

L'expérience réussit bien et n'offre que des différences secondaires, quelle que soit la nature de la plaque ou de la matière pulvérisée, pourvu qu'il n'y ait point d'humidité et qu'aucune adhésion ne retienne les particules de matière.

On peut reproduire ces phénomènes dans l'air raréfié, mais l'interval des lignes augmente à mesure que la pression de l'air diminue. On peut également opérer dans l'hydrogène et dans l'acide carbonique.

M. Abria s'est également préoccupé du soin de constater que l'électricité n'entre ici que comme un agent de combustion rapide.

Si, après avoir répandu de la poussière sur un plan de marbre, on forme des lutles semi-sphériques d'un mélange détonant, l'inflammati on chasse les particules qui recouvraient un espace plus ou moins étendu.

Mais au delà de la surface balayée, on voit reparaître des lignes près n anat les mêmes apparences que celles qui ont été produites par les décharges électriques.

On peut obtenir le même résultat avec le fulminate de mercure; cependant les lignes sont moins distinctes qu'avec les hémisphères d'eau de savon remplies de mélange détonant.

Ces recherches viennent d'être reprises par MM. Schellbach et Buchn, qui ont eu l'idée de les varier, de manière à obtenir des figures véritablement analogues à celles que l'on montre dans les cours d'acoustique.

Si on place à droite et à gauche de l'excitateur deux plans divergeals à la surface desquels les ondes d'ébranlement puissent se réfléchir, on obtient des ondulations renfermées dans l'angle de ces deux lignes.

En faisant varier la nature et la position des surfaces réfléchis antes, on pourrait obtenir une multitude de formes variées très-curieuses, mais trop compliquées pour que la description puisse être suivie avec fruit.

Les auteurs on ont tiré aur l'acoustique des déductions dans lesquelles nous ne les suivrons point.

Nous nous bornerons à faire remarquer que M. Abria et ses deux imitateurs vont peut-être un peu loin en excluant toute idée d'une action électrique proprement dite. Quelques anciennes expériences de Faraday, sur lesquelles nous aurons occasion de revenir, semblent précisément indiquer le contraire.

55

Transmitting Voice by Telegraph.

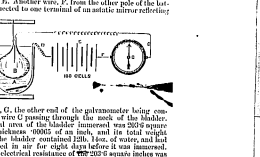
Dr. H. P. Lieke, of the Smith Institute, D., after three years' labor, has succeeded in his perfected an instrument by which forms and colors can be sent by wire the same as words are sent. He calls the instrument a diaphota. The word diaphota, from the Greek, dia signifying through and photos signifying light, has been selected as its name, implying that the light traveled through or along a wire. He read a paper on his invention before a scientific society.

The diaphota consists of four essential parts, the receiving mirror, the transmitting wires, a common galvanic battery and the reproducing speculum. The Doctor gave a detailed account of the many experiments undertaken to determine the proper composition and arrangement of the mirror and speculum. In the diaphota exhibited, the mirror was 6 inches by 4, and had 72 fine wires, which were gathered together in one about a foot back of the frame, the several being finely wrapped with an insulated thread. The corresponding receiving speculum each little wire connected to a division similarly placed as in the mirror. From a common galvanic battery wires run to the diaphota, and thus a circuit was formed which could be closed or not at pleasure. The theoretical action of the instrument appears now to be the following: The waves of light from an object are collected through the ordinary camera, so that they fall on certain of the divisions of the mirror when the electric circuit is closed. The light and corresponding heat produces momentary chemical changes in the amalgam of the mirror—which consists of a peculiar compound of selenium and chromium. These changes modify the electric current and cause similar changes in the corresponding portitions of the remote speculum, thus reproducing a similar image, which, by a second camera, may be readily seen by the eye or thrown upon a screen. Dr. Lieke explained how the proportions of selenium in the mirror and speculum were obtained by scientifically adjusted to the size of the divisions and the resistance of the electric circuit, so that the light which struck any portion of the reproduced image, that, he said, had been the problem which had caused him the most difficulty, and which at one time had seemed almost insurmountable.

All the rays of the paper on illustration was given of the powers of the instrument. The mirror of the diaphota, in charge of a committee of three, was taken to a room in the lower part of the building and the connecting wires laid through the halls and stairways to the speculum on the lecturer's platform. Before the mirror the committee held, in succession, various objects, illuminated each by the light of a burning magnesium wire, and simultaneously on the speculum appeared the secondary images, which for exhibition to the audience were thrown on a screen, considerably magnified. An apple, a pocketknife and a trade dollar were the first objects shown; in the latter the outlines of the goddess of Liberty were recognized, and the words "In God We Trust" were legible. A watch was held directly before the mirror, and the audience could plainly perceive the motion of the minute hand on the screen, but the movement of the second hand was not satisfactory and, although Prof. Kamich, by looking into the camera, thought that it was there quite perceptible, An ink bottle, a flower and a part of a theater handbill were also shown, and when the head of a little kitten appeared on the screen, the club testified its satisfaction by the most hearty applause. After the close of the experiments the scientists attended their congratulations to Dr. Lieke, and the President made a few remarks on the probable scientific and industrial applications of the diaphota in the future. With the telephone and the diaphota it might yet be possible for friends, separated by the wide Atlantic, to hear and see each other at the same time; to talk, as it were, face to face.

HARDENING ELECTRODES.—Mr. W. H. Barlow, the new President of the Institution of Civil Engineers, London, in his recent inaugural address, speaking of the rapid growth of telegraphy and other practical applications of electricity, said that the diminution of power, from increased length of the conducting wire, had been surmounted by relays of power at fixed stations. (This was the discovery of Morse.) By employing this ingenious expedient on the Indo-European Telegraph, Calcutta had frequently been put in direct communication with London, a distance of 5,000 miles. He further stated that Mr. Siemens had ascertained that in employing electricity for the transmission of power, including all sources of loss, one-half of the original power could be realized by electric wires at a distance of one mile from the motor; and that with adequate provisions against hostility it would be no dearer to transmit electro-motive power to a greater than to a smaller distance. Sir William Armstrong, by means of an electro-ballistic arm wire, wrote in circular saw at a distance of a mile from the water wheel that turns the electric machine. By the same means Dr. Werner Siemens works a locomotive that carries thirty persons.

At the last meeting of the Society of Telegraph Engineers, during the discussion of Dr. Gladstone's paper on "Induction in Parallel Circuits," Mr. Willoughby Smith described a very interesting experiment he had made with the Gutta Percha Company's gutta percha, which well illustrated the electrical character of that material. In an inverted glass shade, A, containing clear water, was suspended a blacker of gutta percha, B, filled with water; through the neck of the blacker was a copper wire, C, which was in contact with the water in the blacker. A copper plate, H, was immersed in the water in the glass vessel, and a wire, D, connected with it was attached to one pole of 100 Menotti battery cells, E. Another wire, F, from the other pole of the battery was connected to one terminal of an astatic mirror reflecting



galvanometer, G, the other end of the galvanometer being connected to the wire C passing through the neck of the blacker. The superficial area of the blacker immersed was 2826 square inches, its thickness .0005 of an inch, and its total weight 32 grains. The blacker contained 22lb. 14oz. of water, and had been suspended in air for eight days before it was immersed. The absolute electrical resistance of the 2826 square inches was 1.487 megohms at the end of one minute's electrification, and of ten minutes it was 41078 megohms. The absolute electrostatic capacity was .2290 microfarads. Its behaviour during the test was precisely the same as that of copper conductors and similar gutta percha for telegraphic purposes when similarly placed. Mr. Smith is continuing the experiments with the view of determining a true unit for the electrical capacity of gutta percha.

THE TELEPHONE AIDED AS INTERPRETER.—A correspondent sends us a Swansea paper, containing an account of how dent sends us a Swansea paper, containing an account of how an interesting entertainment came by telephone. It seems that the agent at the Swansea having undertaken to erect a telephone line for the Corporation advertised for poles. A Welshman, with poles to sell, called to strike a bargain, but on attempting business it was found that the Welshman knew nothing of English, and the agent nothing of Welsh. The common word was "telephone." The agent thought for a moment, and then walking to a telephone called to a friend at the other end of the line, who could understand Welsh. His friend conversed with the Welshman, translated the conversation to the agent, facilitated business, and made that plain which seemed so difficult

PHOSPHORESCENCE PRODUCED BY ELECTRICAL DISCHARGES.—Most of the phthalocyanides, according to the abstract of a paper by E. Wiedemann on this subject, in the *Chem. Soc. Jol.*, exhibit fluorescence under the influence of electrical discharges, but the fluorescence is dichroic only as the result of a partial decomposition. Dichroism is induced in barium platino-cyanide without any electrical action by placing the salt in a vacuum for a time. The author attributes this effect to the loss of water, by which loss the optical differences of the several directions in the crystals are more strongly brought out. That dichroism is so much more quickly developed in the salt when it is subjected to electrical discharges, he explains by the warming of the crystals by the discharge. The superficial parts of the crystals thus losing their water become dichroic, whilst the deeper-lying parts fluoresce under the influence of the electric discharge. These experiments were suggested by a research of Crookes's, from whose view of the cause of the phenomena, however, the author dissents. Instead of a stream of projected molecules, we have here, the author contends, to do with electrical disturbances or waves, communicating their motion to either of the solids in which vibrations are thus set up, that appear partly as heat, partly as light. A striking proof of the incorrectness of Crookes's theory is an experiment in which the positive current of a Holtz machine is passed through a discharged tube, made with thick glass, in such a manner that it may be diverted within the tube by the finger. A feeble phosphorescence then appears in the inside of the tube, but on the outside a very bright green light is seen. Closely connected with this phenomenon is that which appears when a spherical positive electrode is used within a glass globe, and a collecting point touches the external surface of the globe. On the opposite part of the globe is seen a well-defined shadow of the electrode, surrounded by a circle of beautiful green rays. The starting point for a theory of these phenomena is supplied in Maxwell's equations ("Wied. Galv.," p. 1230). An electrical discharge effected by the motion of material particles is out of the question, as the velocity of electricity in gases is immensely greater than that of any molecular motion whatever. The reflection of the negative discharge from surfaces on which it impinges is likewise in accordance with Maxwell's theory, if we attribute to the waves of electric polarisation sufficient energy; and that they do in fact possess this may be inferred from their melting the glass upon which they strike.

Electrician Sept 17 1880

Mineral Veins and the Electric Current

The Grass Valley *Union* of October 25th says:

"Mr. Phillips, who claims for his electric machine the merit of indicating the course of mineral-bearing veins, and their relative size and character, has lately been experimenting upon the Idaho Hill mine, below Rough and Ready. He found the shaft to have been sunk upon a stringer of good size, but not upon the main ledge. The instrument indicated the lay of the main ledge, which was some distance from the stringer, and from following this indication the main ledge has been found, carrying out strongly in a series, where it had not before been discovered, and showing a width of from ten to twelve feet. Miners generally do not place faith in the discovery of ledges by such means, but Mr. Phillips has unlimited faith in the efficacy of the machine, claiming that it is just as practicable to use electricity in discovering the existence and course of blind ledges as mineral is above ground or under water in transmitting telegraphic intelligence. Prof. Edison, we believe, advanced similar ideas when he visited the Comstock. The possibilities of science are very great, and experience will yet demonstrate whether this is one of them."

We give the above to illustrate the modern tendency of science to experiment upon old ideas with recent mechanical appliances.

Fifty years ago (in 1830), the relation between metallic veins and the electric current was discussed in the *Institut de France* (*séance du 12 Octobre*), and it was announced that William Fox, from observations made in the mines of Cornwall, had discovered that their veins exerted a manifest action upon the magnetic needle. *The direction of the currents being in general with the inclination of the vein, and the axis of the magnetic poles.* "*La direction des courants était en rapport avec l'inclination des filons et avec l'axe des deux magnétiques.*"

Becquerel, in his *Traité de la Commagnetie et de la Terrestre*," in 1834, upon the subject of the formation of metallic veins (page 240), says: "I attribute them (the veins) to the action of the telluric and even hydro-electric currents which traverse the terrestrial beds, and these incessantly deposit or modify certain metallic substances. Basing this hypothesis upon the belief that the earth is similar to a galvanic battery which transports elementary molecules in the same manner as the Voltaic pile.

"*Nous les attribuons a l'action des courants telluriques et meme, hydrogen, tres, lesquels les courants terrestres, y déposent ou y modifient, incessamment certaines substances metalliques.* " *Nous et transportant des molecules élementaires absolument comme les courants de la pile Voltaique.*"

We might cite many other instances of the connection between metalliferous veins and the electric current, but we have said enough to show that the idea is not new. Perhaps if the same amount of investigation were bestowed upon this theory of the formation of mineral veins, more might be accomplished than through other speculations.

Curious Electric Phenomenon

At about [illegible] with a deluge of rain came up from the South-west and lasted about an hour. At 5.30 my wife was standing at the window watching the receding storm, which still raged in the south, just over Leicester, when she observed, immediately over a double flash of lightning, what seemed like a fallen star, or a firelock from a rocket, drop out of the black cloud almost above the horizon, and descend perpendicularly till lost behind a belt of trees. The same phenomenon was repeated at least a dozen times in about fifteen minutes, the lightning flashes following each other very rapidly and the thunder consisting of short and sharp reports. After nearly every flash a firelock descended. These balls appeared to be about one-fifth or one-sixth the diameter of the full moon, blunt and rounded at the bottom, and seen not into a tail above, and leaving a train of light behind them. The colour was nearly white, but one was distinctly pink, and the course of one was sharply zig-zagged. They fell at a rate certainly not greater than that of an ordinary shooting star. I have never witnessed a phenomenon of this kind myself, but my wife is a good observer, and I can vouch for the trustworthiness of her report.

F. T. MOTT

Hurst Hill, near Leicester, June 22

Nature August 19 1880

THE AURORA Nature

OUR experiments on the electric discharge, which have been already published in the *Philosophical Transactions* and the *Proceedings of the Royal Society*, enable us to state with some degree of probability the height of the aurora when it exhibits its display in of maximum brilliancy, and also the height at which this phenomenon could not occur on account of the great tensity of the atmosphere.

In Part III., of our electric researches, *Phil. Trans.*, Part I. vol. 171, we have shown that the least resistance to the discharge in hydrogen is at a pressure of 0·52 millim., 684 M.; after this degree of exhaustion has been reached a further reduction of pressure rapidly increases the resistance. When the exhaustion has reached 0·002 millim., 3·26, the discharge only just passes with a potential of 1,000 chloride of silver cells (15,330 volts); at the highest exhaustion we have been able to obtain (real which we believe has not been surpassed), namely, 0·000003 millim., 0·005 M., not only did 11,000 cells fail to produce a discharge, but even a 1-inch spark from an induction coil could not do so.

Although we have not experimentally determined the pressure of least resistance for air, we have ascertained that while the discharge occurs in hydrogen at atmospheric pressure between disks 0·22 inch distant, they require to be approached to 0·13 inch to allow the discharge to take place in air. We may therefore assume that the pressure of least resistance for air is

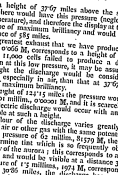
$$\frac{0{\cdot}52 \times 13}{22} = 0{\cdot}379 \text{ millim., } 498 \text{ M.}$$

At a height of 37·67 miles above the sea level, the atmosphere would have this pressure (neglecting change of temperature), and therefore the display at this elevation would be of maximum brilliancy and would be visible at a distance of 585 miles.

The greatest exhaust that we have produced, 0·000005 millim., 0·006 M., corresponds to a height of 51·27 miles, and as 11,000 cells failed to produce a discharge in hydrogen at this low pressure, it may be assumed that at this height the discharge would be considerably less brilliant, especially in red, than that at 37·67 miles, the height of maximum brilliancy.

At a height of 12·15 miles the pressure would be only 0·00000001 millim., 0·00001 M, and it is scarcely probable that an electric discharge would occur with any potential conceivable at such a height.

The colour of the discharge varies greatly with the tensity of air or other gas with the same potential. Thus in air at a pressure of 62 millim., 81·270 M, the discharge has the carmine tint which is so frequently observed in the display of the aurora; this corresponds to an altitude 12·4 miles, and would be visible at a distance 336 miles. At a pressure of 1·5 millim., 1·974 M, corresponding to a height of 30·65 miles, the discharge becomes salmon-coloured, having completely lost the carmine tint. At a pressure of 0·8 millim., corresponding to 33·96 miles, the tint of the discharge is of a paler salmon colour, and as the exhaust is carried further it becomes a pale milky white. The rescarce and salmon-coloured tints are always in the vicinity of the positive source of the electric current, the positive luminosity fades away gradually, and frequently becomes almost invisible at some distance from its source; in this instance, in the hydrogen discharge accompanying figure, *II*, which resembles in some



respects the phenomenon of the aurora. The discharge at the negative terminal in air is always of a violet hue, and this tint in the aurora indicates a proximity to the negative source.

The following table, [illegible] with the exception of pressure

[illegible]

[illegible]

[illegible]

58

 19 July

par des scories en décomposition. A côté de ce grand cratère, on en rencontre quatre autres beaucoup plus petits, et qui indiquent la direction de la pente éruptive.

Jusqu'en 1825, personne n'avait eu la curiosité de descendre au fond de ces quatre petits cratères. Ce fut à cette époque que l'intelligent observateur Mario Gemellaro, le frère aîné de l'illustre géologue de ce nom, voulut les explorer. Il remarqua alors avec surprise une ouverture horizontale au fond de la dernière cavité, s'y introduisit à l'aide d'une torche, et après avoir traversé une suite de cavernes ressemblant aux corridors d'une mine, il rencontra, à la distance d'une centaine de mètres, un large puits, où il se fit descendre lié à des cordes. A peu de mètres au fond de ce puits, il rencontra une vaste pièce rectangulaire, au fond de laquelle il trouva un passage qui se rétrécit de plus en plus et devient impraticable. Cette grotte remarquable, qui fut appelée *Grotta delle Palombe*, est exactement située au centre des *Monti Rossi*. Maintenant elle est ouverte aux voyageurs; un escalier en facilite la descente, et la lumière du magnésium remplace aujourd'hui les torches résineuses. Mario Gemellaro a laissé au fond de la *Grotta delle Palombe* l'épigraphe suivante : *Marius Gemellarius Primus Ima hæc in Tartara venit, Anno Domini MDCCCXXIII.*

V. Tedeschi di Ercole.

SUR LA FONCTION ÉLECTRIQUE
DE LA TORPILLE
COMPARÉE A LA FONCTION MUSCULAIRE

Les recherches exécutées sur la fonction électrique de certains poissons, et notamment de la torpille, ont eu pour but de déterminer la nature de cette fonction au point de vue physique et d'en préciser les caractères au point de vue physiologique.

On s'est tout d'abord préoccupé de savoir si ces décharges électriques devaient être assimilées aux décharges des machines et des condensateurs, ou bien aux courants de la pile, ou bien enfin aux courants d'induction. L'expérience a montré que l'électricité de la torpille possède, comme l'électricité statique, la propriété de traverser les liquides et même les corps faiblement conducteurs. Walsh, à la fin du siècle dernier, a fait circuler la décharge à travers une chaîne d'individus qui se tenaient par la main, et tous ont ressenti cette commotion singulière qu'on produit avec la bouteille de Leyde. Plus récemment (1861), A. Moreau a réussi à recueillir l'électricité de la torpille dans l'électroscope à feuilles d'or et dans un condensateur analogue à la bouteille de Leyde.

Mais on a pu aussi, comme avec le courant de la pile, obtenir la déviation du galvanomètre, l'aimantation d'aiguilles d'acier placées dans une spirale de laiton traversée par la décharge, la décomposition de l'eau salée, etc. (Davy). Le P. Linari et Matteucci ont observé la production d'étincelles, en rompant par le frottement d'un fil conducteur sur une lime le courant électrique de l'animal.

Enfin, en faisant passer cette [...] les muscles, on a vu qu'elle agis[...] ferait une série de courants induit[...] provoquant le tétanos musculaire; [...] sont soumis à l'épreuve ont ressent[...] ment douloureux identique à celui [...] les mêmes courants.

Voilà donc une série d'expérience[...] que la décharge électrique de la to[...] la fois les propriétés des décharge[...] courants voltaïques et des courants i[...]

Si maintenant on envisage cett[...] trique au point de vue physiologique [...] présente avec la fonction musculai[...] pantes analogies; comme la contra[...] cles, la décharge de la torpille est soumise à la volonté; l'animal peut donner une décharge forte ou faible, courte ou prolongée, absolument comme on peut exécuter un mouvement énergique ou modéré, bref ou de longue durée; cette décharge s'exécute à l'aide d'un appareil spécial, l'organe électrique, comme le mouvement se produit par l'action d'un organe particulier, le muscle; de part et d'autre, des nerfs, émanant des centres nerveux, apportent à l'organe d'exécution l'excitation qui provient de ces centres. Ces ressemblances, qu'on pourrait poursuivre beaucoup plus loin encore, sont donc évidentes et suffisent à légitimer le rapprochement admis comme base de recherches entre la fonction électrique et la fonction musculaire par l'un des expérimentateurs qui ont le plus complètement étudié l'électricité de la torpille, par M. Marey, dont nous aurons surtout à rappeler les travaux sur ce sujet. « L'électricité de l'appareil des torpilles et le travail des muscles se produisent donc, dit M. Marey, dans des conditions physiologiques semblables. Or cette conclusion, qui, il y a quelques années, n'eût présenté qu'un intérêt médiocre, en prend un tout nouveau sous l'influence des théories modernes de l'équivalence des forces. La thermodynamique, nous montrant comment la chaleur se transforme tantôt en travail mécanique, et tantôt en électricité, permet d'espérer qu'on saisira comment, sous l'influence nerveuse, et par l'intermédiaire de certaines actions chimiques, se fait une production d'électricité dans l'appareil de la torpille, une production de travail dans un muscle. » (Marey, *Compte rendu des travaux du laboratoire*, t. II. G. Masson, 1876.)

C'est en effet en répétant sur l'appareil électrique de la torpille des expériences qu'il avait déjà faites sur les muscles, que M. Marey est arrivé à préciser les analogies que nous venons de rappeler sommairement. Nous exposerons ces recherches avec quelque détail en raison du grand intérêt qu'elles présentent.

Il est nécessaire d'indiquer d'abord quelle est la disposition de l'appareil électrique de la torpille, quels nerfs s'y distribuent et quelle région du système nerveux central donne naissance à ces nerfs.

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Electrician

having a small orifice in its bottom, to one of the terminals of the circuit, and a shallow metallic basin to the other. The first vessel, being now filled with acidulated water, is held over the basin, so that the column of water from the orifice flows into it, and so completes the electric circuit. By gradually raising or lowering the upper vessel, a longer or shorter column of liquid can be made part of the circuit. On listening in the telephone, so long as the liquid vein is short and limpid, no sound whatever is heard. This shows that the electric current has uninterrupted circulation. On gradually lengthening the liquid vein, a point is reached when a rattling noise is heard in the telephone. This arises from the altered resistance caused by the liquid vein beginning to break up into globules. On still further lengthening the vein, a point is very soon reached when all sound in the telephone again ceases. This corresponds to the stage when the liquid vein has actually separated into detached drops, and so broken entirely the electric circuit.—*Proceedings of the Royal Society of Edinburgh.*

NOTE ON SOME EFFECTS PRODUCED BY THE IMMERSION OF STEEL AND IRON WIRES IN ACIDULATED WATER.

BY PROF. D. E. HUGHES.

During a discussion upon a very interesting Paper by our President, "On the Durability of some Iron Wire," I mentioned a fact which I had lately observed, viz., that steel or iron wires immersed for a few minutes in acidulated water, containing $\frac{1}{10}$th sulphuric acid became excessively brittle. Upon repetition of these experiments, I have found that this brittleness is no mere accidental result, due to some flaw in the steel or iron wires, but that the resulting brittleness is invariable in all kinds of steel as well as iron. Nor is the effect due to any specific proportions of sulphuric acid to the water; nor, in fact, as we shall see later, to any particular acid. The effects, however, seem confined to steel and iron, as by similar treatment I have as yet obtained no perceptible effect on copper or brass. Mr. W. Chandler Roberts predicted that the effects were probably due to the absorption of hydrogen. I have tested these wires in my induction balance, but can find no change whatever in its magnetic conductivity, if the conditions of the experiments are such as to favour the absorption of hydrogen. Using two steel wires as electrodes in sulphuric acid and water, we find that both wires have become brittle, though in a very different degree, the wire connected with the zinc or negative pole remaining bright, although excessively brittle, whilst the one connected with positive pole is much corroded, and but feebly brittle, with this arrangement. I believe that these effects are due to the absorption of hydrogen when the hydrogen is in the "nascent" state. Hydrogen seems to permeate through the entire mass, for iron rods ¼ inch thick were equally affected, requiring more time, or, in other words, a supply of nascent hydrogen sufficient for the larger mass; and once the wire has become hydrogenised (if we may be allowed the expression), it retains it under all circumstances of time and change of surrounding atmosphere. Heat alone of all the means I have tried has any effect, and if we heat a wire to cherry red in a spirit lamp, we find that it is completely restored to its primitive flexibility in a few seconds. These effects may be obtained over and over again. I have remarked that a wire immersed in sulphuric acid and water of any proportion, say $\frac{1}{10}$th, becomes more electro-negative than at the first instant of plunging. If we take amalgamated zinc as the positive element, and a steel or iron rod or wire for negative, we find that there is such a remarkable similarity of electromotive force between all kinds of steel and iron that we are forced to the conclusion that we are simply testing the electro-negative qualities of hydrogenised iron, the force being with amalgamated zinc ·56. I remarked here a remarkable fact, and which does not agree with the results of many authorities. I found that as soon as the iron rod had absorbed its maximum of hydrogen (a few minutes after being short-circuited) that it became a constant cell, giving but small traces of polarisation then or after being short-circuited for hours at a time. There occurs, however, a slight diminution of electromotive force after a few days' hard work, being then ·52, due to the acidulated water becoming more neutral by the formation of sulphate of zinc and iron. If, however, we wish to restore its full electromotive force, we have only to short-circuit the cell for a few seconds, torrents of hydrogen will be given off, and its electromotive force becomes, on testing of its highest value, ·56. If we short-circuit the hydrogenised iron cell for one minute, and at once test its electromotive force, we shall find at the first instant a certain amount of polarisation, about 10 per cent., but it rapidly recovers, being at its full initial force in ten seconds'

Electro-capillarité. — M. Debrun, préparateur à la Faculté de Bordeaux, présente une modification du remarquable électromètre capillaire de M. Lippmann, non pas

May 29 1880

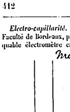

Fig. 1.

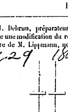

Fig. 2.

dans le but de l'améliorer, mais pour en faire un instrument courant moins fragile et moins cher.

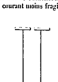

Fig. 3.

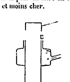

Fig. 4.

L'appareil se compose d'un tube capillaire (1 millimètre de diamètre), long de 30 centimètres, plusieurs

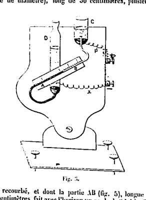

Fig. 5.

fois recourbé, et dont la partie AB (fig. 5), longue de 10 centimètres, fait avec l'horizon un angle de 8 à 10°. Son extrémité débouche dans une cuvette C, où vient aboutir le pôle positif β; le pôle négatif α est soudé dans le tube D. Derrière AB est une règle divisée en millimètres.

Pour mettre en expérience cet instrument, on réunit α et β, on met en C de l'eau acidulée, puis quelques gouttes de mercure pur; on verse par D assez de mercure pour remplir aux trois quarts le tube AB; on chasse l'air du tube capillaire et on ajoute un peu d'eau acidulée en D.

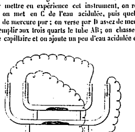

Fig. 6.

Une articulation permet de rendre l'appareil plus ou moins sensible en inclinant AB. Cet électromètre peut être gradué très facilement.

M. Debrun a imaginé un autre appareil, donnant des indications très rapides. Il se compose de deux tubes en U ayant chacun une branche capillaire (fig. 6). Ces tubes sont remplis de mercure et leurs extrémités capillaires plongent dans une cuvette commune pleine d'eau acidulée. Tandis que l'un des ménisques montera, l'autre descendra, ce qui doublera la déviation. La grandeur et même le sens de la déviation peuvent changer lorsque le mercure n'est pas absolument pur. Soient, en effet, deux tubes (fig. 7), dont l'un contient un globule de mercure pur, l'autre du mercure contenant un peu de

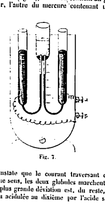

Fig. 7.

zinc; on constate que le courant traversant ces tubes dans le même sens, les deux globules marchent en sens inverse. La plus grande déviation est, du reste, obtenue avec de l'eau acidulée au dixième par l'acide sulfurique pur.

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PHYSICAL NOTES

HERR DORN of Breslau has published a fresh series of experiments on the propagation of electricity by current water in tubes, and allied phenomena (*Wied. Ann.*, Nos. 4 and 5). In agreement with Helmholtz's theory, he finds the electromotive force from current water in capillary tubes independent of the cross section and the length of these. The value of the "electric moment" of water and glass (3·936 Daniell) deduced from this electromotive force corresponds nearly to that deduced by Helmholtz from Quincke's observations on the propagation of water in glass tubes by the electric current. Observations of the electric current produced by water flowing in capillary tubes lead to a somewhat smaller value. For wider tubes (within pretty wide limits) the current strength, with a given mean velocity of the streaming water, proves empirically to be nearly proportional to the radius of the tube. Traces of a sliding of the water on the glass-wall may perhaps co-operate in producing the variations of electromotive force observed in course of time. Through motion of material particles in a liquid, therefore, an electric current arises.

THE diffusion of salts in aqueous solution has been investigated by Herr Long (*Wied. Ann.*, No. 4), by a method similar in principle to that of Schuhmeister (though different in detail), viz., making a continuous water-current flow over the salt solution and measuring the amount of diffusion by the quantities of salt that pass over in given times. Various interesting relations were found, *e.g.*, the chlorides, bromides, and iodides of the alkali metals form a series, in which NH_4 stands between K (the higher) and Na; and KCl, KBr, KI, and KCy have nearly the same velocity of diffusion. Such is the case also with the corresponding NH_4 and Na salts and with the chlorides of the bivalent metals Ba, Sr, Ca, and Mg, the nitrates, and the sulphates. It seems generally that those salts which diffuse most quickly also conduct best in aqueous solution. Salts with large molecular weight and volume seem to diffuse most easily, while among the waterless salts those which absorb most heat in dissolving or (the same thing) whose molecules, through the work done, finally reach the finest state of division, have the greatest velocity of diffusion. The chlorides of the alkalies stand in the same series with regard to molecular volumes, velocities of diffusion, conductivity, and absorption of heat. This is the case, too, with the corresponding bromides and iodides. Cyanide of potassium behaves as to diffusion and conductivity exactly like the chloride, bromide, and iodide of the metal. In the second group (nitrates) the order is the same as to conductivity and diffusion; but with regard to molecular volumes and heat-absorption the salts form a special series. In the group of sulphates the individual salts have the same order as to diffusion and conductivity, but the values for molecular volume and heat of solution are quite irregular; indeed as regards velocity of diffusion and absorption of heat the waterless salts seem to stand in inverse order. These results are fully discussed by Herr Long.

Scientific Amer. Supplement: Aug. 20. 1881.

ELECTRIC BEHAVIOR OF FLAME.

By W. HOLTZ.

THE author prefixes to his own experiments a general account of all researches on the electric behavior of flame. His own experiments refer chiefly to the changes of the form and color of flames when positively or negatively electrified. The flames are here so arranged that they form in a manner one of the electrodes of an influence machine. The positive flame becomes bluer, narrower, more pointed, while similar phenomena are scarcely perceptible in the negative flame. The latter displays, however, a curious phenomenon; its point is turned toward its own conductor. Hereby, according to the strength of the electrization and the width of the aperture of the burner, an intermittent and a constant retrogression may be distinguished. The negative flame takes the most curious shape when it issues from a large disk, or when it burns round a metal cylinder. It is then bent backward toward the metal surface, either in a curve or an angle, according to the strength of the electrization. Its point in the latter case is divided into two tufts of a peculiar shape, which on their part make movements more or less similar.

Further differences result if a conducting body is held opposite to a flame which burns as an electrode. At a considerable distance each flame bends toward it; on approaching nearer there occurs a repulsion of the negative and an attraction of the positive flame. In the latter case the attraction extends only to the upper more luminous part, not to the foot of the flame which is still repelled. Herewith is connected the circumstance that a positive flame easily passes through wire gauze, while the negative flame remains below. The pointed form of the positive flame is the cause that it readily drives a wheel with vanes, while the negative flame scarcely sets it in motion. All these and other distinctions appear especially in an unmixed gas flame, or in that of stearine, wax, or tallow, less in the flame of alcohol, and least in that of a Bunsen burner, being the less manifest the richer the flame in oxygen.

The phenomena in question are produced not merely on direct electrization, but also when the flame is exposed to the influence action of a large disk. If a flame is introduced between two smaller electric disks, it inclines to the negative side, spreading itself out. With a certain strength of current it vibrates to and fro like a pendulum, and displays a peculiar stratification. These phenomena also occur the less the richer is the flame in oxygen. It is accordingly probable that carbon and hydrogen are attracted more to the negative, but oxygen more to the positive pole, perhaps—like every distinctively polar attraction—in consequence of a certain uni-polar conductivity of the substance in question. The retrogression of the flame is thus explained: the point of the flame loses more electricity by influence than it receives by conduction. A strip of paper, one end of which is pasted to a large ball, displays similar movements as soon as the free end is pointed and made more conductive. There are two causes why the negative becomes retrograde. Either the point of the flame has here an exceptional radiating power, or the foot of the flame is here an exceptionally bad conductor. The former supposition agrees with the experiments of Wiedemann and Rühlmann, and the latter with Erman's observation on the uni-polar conduction of flames. Other grounds speak in favor of the existence of a uni-polar conduction. The resistance observed by Hittorf at the negative electrode cannot explain Erman's experiments, since if negative electricity penetrates into the flame with more difficulty, positive electricity must have more difficulty in making its exit.

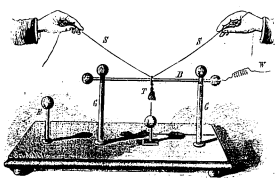
Herwig's explanation of the above resistance by the assumption of a negative specific electricity does not agree with the fact that the flame is drawn exactly to the negative pole. It may otherwise be concluded that the specific electricity of flame can play no essential part in the phenomena above mentioned.—*Wiedemann's Beiblatter.*

EXPERIMENT ILLUSTRATING DISCHARGE OF ELECTRICITY FROM CLOUDS.

Mr. Lomax gives the following easily performed experiment in the *Colliery Guardian*. It illustrates some of the phenomena of thunderstorms:

In the engraving, A is the base of the instrument, made of wood and brass. G G are glass legs supporting an arm of brass, B. The cloud is here represented by the moving tassel, T, pulled backwards and forwards by the strings of silk, S S. O is a ball provided with a point or lightning conductor. This ball is not insulated, that is, not supported by a glass leg. W is a wire leading to an electrical machine. On working the machine electricity is spread over the arm, B. The tassel consequently diverges, owing to each filament being charged with like electricity. On drawing the tassel (cloud) over the lightning conductor, O, an opposite kind is given off at the point and neutralizes the cloud and the hairs or fibers collapse. If we were to wholly detach the tassel and work the machine till we raised a large envelope of electricity around the arm, B, a vivid flash of light (lightning) would pass to uninsulated conductor, R. If the ball, O, was not provided with a point, on moving the electrified tassel along the arm, B, it would not collapse on passing the ball, except that a faint spark was given off. If this spark took place, you have what often happens in nature.

Persons ought never to stand near a tree nor a house, nor even a building provided with lightning conductors, for shelter. My reasons are these: Wood is a poor conductor, masonry worse, and if buildings provided with these conductors are not what they ought to be, they only invite destruction.



ILLUSTRATING DISCHARGE OF ELECTRICITY FROM CLOUDS.

Electric Discharges through Gases.—In a recent valuable paper on the thermal and optical behaviour of gases under the influence of electric discharges, Herr E. Wiedemann first studies the thermal phenomena in the case of discharges of the influence-machine, and indicates a different behaviour of the positive and negative electricity. He then describes an experimental attempt at numerical determination of the quantities which produce a change of the band-spectrum of hydrogen into the lime-spectrum. He further investigates the nature of the discharge from the negative electrode in greatly rarefied space. Then he discusses the applicability of other electrical sources, inductoria, large galvanic batteries, and Leyden jars, to spectrum-analytical researches, also the continuous and discontinuous discharges in gases. The paper concludes with theoretical considerations as to the phenomena of discharge in gases and the nature of spectra.—*Nature.*

Times. Sept. 11. 1881.

THE YELLOW LIGHT. 142

AN INTERESTING STUDY OF COLOR AS AFFECTED BY THE ATMOSPHERICAL PHENOMENA OF TUESDAY LAST.

To the Editors of the Boston Daily Advertiser:

So emphatic a lesson in color as the yellow light of Tuesday is rare enough to justify special notice from that point of view. Every day has similar lessons, but of such fine gradations that probably not two artists would agree on one and the same definition. But yesterday every one noted the prominent transformations. To every eye the gas lights were whiter than the daylight, and recalled the electric light to every mind. The startling hues of grass, trees, and flowers were an amazement even to the unobservant. It differed from a London fog in its purity of color and consequent logic in the strange changes it produced.

To follow these changes intelligently we need but keep in view that the yellow light (to an eye placed in the yellow medium) neutralizes yellow in all colors which contain it, and adds it to the others. Thus sunflowers seemed bleached, and linen on the line, while keeping a value of white, came near to gold. All yellow being eliminated from the grass and leaves, left them as nearly a pure green as we can ever hope to see. The eye turning from grass to hedge of box, or clump of pines, or row of cabbages, ran through a long scale of greens of marvelous purity. Distinctly not blues, as some have called them. White asters became yellow; the pink were intensified with gold, while the purple ones faded to a magenta color, the yellow light and the blue of the purple asters reducing each other to a white and leaving only the pale red shade.

I had no opportunity of observing a genuine blue but am confident it would have appeared either purplish or greenish as it leaned either way; or if without alloy, would simply have been bleached, like all yellows, though from different cause. Reds were everywhere intensified, both by the elimination of yellow and blue, and by the contrasts of green, which in the country framed all objects. In the same way all neutral tones, roads, rocks, plowed fields, became various hues of orange and red browns, partly from absorption, partly from contrast. The pure greens were confined to horizontal surfaces; all vertical masses, and the under surfaces of leaves were either so bathed in the light or so illumined by red reflections as to pass into hot browns. The distances as seen from here were unexpectedly green; perhaps owing to the nearness of the hills and consequent influence of the local color. A tone more akin to the sky, like a wash of sepia, is what with a more disturbed horizon would be looked for. It is further worthy of note that gold and brass were not like yellows bleached in appearance, but rather intensified.

Later the light deepened to a copper color, in which even scarlet geraniums began to bleach. And finally the yellow and red were withdrawn, and everything assumed a monotonous greenish hue, not agreeable, but more akin to usual foggy daylight. Indoors, with gas flames white and glaring at midday, the dark window-frames surrounding a space of gold, the changes of normal hues were as strange as those without. I note but one: In this double illumination the wonderful purity of a bunch of white flowers was a thing of which I never saw the like.

As to its cause, a light, high fog with light smoke behind it has a satisfactory sound among the various guesses propounded. But I wish to note as of importance that this effect in less perfection is by no means rare. I have wondered over it many times in the past, and have always seen it with a light and high fog at or oftener immediately after sunset, when yellow light seems in order without the need of superadded smoke, which is certainly not indispensable to this effect in its transient forms.

I am, yours very truly,

J. C. BANCROFT.

Milton, Mass., Sept. 7, 1881.

ESSAYS IN SCIENCE.

[CONTINUED FROM FIRST PAGE.]

parison we must be content with mere probabilities. Judge Henderson's work will be published by the Smithsonian Institution.

SELENIUM AND THE PHOTOPHONE.

Alexander Graham Bell upon the Production of Sound by Light—Researches by Sumner Tainter and the Inventor of the Telephone—A New Discovery.

In bringing before you some discoveries made by Mr. Sumner Tainter and myself, which have resulted in the construction of apparatus for the production and reproduction of sound by means of light, it is necessary to explain the state of knowledge which formed the starting point of our experiments. I shall first describe the remarkable substance selenium, and the manipulations devised by various experiments; but the final result of our researches has evidenced the class of substances sensitive to light-vibrations, until we can propound the fact of such sensitiveness being a general property of all matter. We have found this property in gold, silver, platinum, iron, steel, brass, copper, zinc, lead, antimony, German silver, Jenkin's metal, Babbitt's metal, ivory, celluloid, gutta percha, hard rubber, soft vulcanized rubber, paper, parchment, wood, mica and silvered glass; and the only substances from which we have not obtained results are carbon and thin microscopic glass. We find that when a vibratory beam of light falls upon these substances they emit sounds,—the pitch of which depends upon the frequency of the vibratory change in the light. We find farther that, when we control the form or character of the light-vibration on selenium, and probably on the other substances, we control the quality of the sound and obtain all varieties of articulate speech. We can thus, without a conducting wire as in electric telephony, speak from station to station, wherever we can project a beam of light. We have not had opportunity of testing the limit to which this photophonic influence can be extended, but we have spoken to and from points 213 metres apart; and there seems no reason to doubt that the results will be obtained at whatever distance a beam of light can be flashed from one observatory to another. The necessary privacy of our experiments hitherto has alone prevented any attempts at determining the extreme distance at which this new method of vocal communication will be available. I shall now speak of selenium.

SELENIUM.

In the year 1817 Berzelius and Gottlieb Gahn made an examination of the method of preparing sulphuric acid in use at Gripsholm. During the course of this examination, they observed in the acid a sediment of a partly reddish, partly clear brown color, which, under the action of the blow-pipe, gave out a peculiar odor, like that attributed by Klaproth to tellurium. As tellurium was a substance of extreme rarity, Berzelius attempted its production from this deposit; but he was unable, after many experiments, to obtain further indications of its presence. He found plentiful signs of sulphur, mixed with mercury, copper, zinc, iron, arsenic and lead, but no trace of tellurium. It was not in the nature of Berzelius to be disheartened by this result. In science every failure advances the boundary of knowledge as well as every success, and Berzelius felt that, if the characteristic odor that had been observed did not proceed from tellurium, it might possibly indicate the presence of some substance then unknown to the chemist. Urged on by this hope he returned with renewed ardor to his work. He collected a great quantity of the material, and submitted the whole mass to various chemical processes. He succeeded in separating successively the sulphur, the mercury, the copper, the tin and the other known substances whose presence had been indicated by his tests;—and, after all these had been eliminated, there still remained a residue which proved upon examination to be what he had been in search of—a new elementary substance. The chemical properties of this new element were found to resemble those of tellurium in so remarkable a degree that Berzelius gave to the substance the name of "Selenium," from the Greek word *selene*, the moon—("tellurium," as is well known, being derived from *tellus*, the earth).

Although tellurium and selenium are alike in many respects, they differ in their electrical properties; tellurium being a good conductor of electricity, and selenium, as Berzelius showed, a non-conductor. Knox discovered, in 1837, that selenium became a conductor when fused; and Hittorf, in 1852, showed that it conducted at ordinary temperatures, when in one of its allotropic forms. When selenium is rapidly cooled from a fused condition, it is a non-conductor. In this its vitreous form, it is of a dark-brown color, almost black by reflected light, having an exceedingly brilliant surface. In thin films it is transparent, and appears of a beautiful ruby red by transmitted light. When selenium is cooled from a fused condition with extreme slowness, it presents an entirely different appearance, being of a dull lead color, and having throughout a granulated or crystalline structure, and looking like a metal. In this form it is perfectly opaque to light, even in very thin films. This variety of selenium has long been known as "granular" or "crystalline" selenium, or, as Regnault called it, "metallic" selenium. It was selenium of this kind that Hittorf found to be a conductor of electricity at ordinary temperatures. He also found that its resistance to the passage of an electrical current diminished continuously by heating up to the point of fusion, and that the resistance suddenly increased in passing from the solid to the liquid condition. It was early discovered that exposure to sunlight hastens the change of selenium from one allotropic form to another; and this observation is significant in the light of recent discoveries.

EXPERIMENTS WITH SELENIUM.

Although selenium has been known for the last sixty years it has not yet been utilized to any extent in the arts, and it is still considered simply as a chemical curiosity. It is usually supplied in the form of cylindrical bars. These bars are sometimes found to be in the metallic condition; but more usually they are in the vitreous or non-conducting form. It occurred to Willoughby Smith that, on account of the high resistance of crystalline selenium, it might be usefully employed at the shore-end of a submarine cable, in his system of testing and signalling during the process of submersion. Upon experiment, the selenium was found to have all the resistance required—some of the bars employed measuring as much as 1400 megohms—a resistance equivalent to that which would be offered by a telegraph wire long enough to reach from the earth to the sun! But the resistance was found to be extremely variable. Experiments were made to ascertain the cause of this variability. Mr. May, Mr. Willoughby Smith's assistant, discovered that the resistance was less when the selenium was exposed to light than when it was in the dark.

In order to be certain that temperature had nothing to do with the effect, the selenium was placed in a vessel of water, so that the light had to pass through from one to two inches of water in order to reach the selenium. The approach of a lighted candle was found to be sufficient to cause a marked deflection of the needle of the galvanometer connected with the selenium, and the lighting of a piece of magnesium wire caused the selenium to measure less than half the resistance it did the moment before.

These results were naturally at first received by scientific men with some incredulity, but they were verified by Sale, Draper, Moss and others. When selenium is exposed to the action of the solar spectrum, the maximum effect is produced, according to Sale, just outside the red end of the spectrum, in a point nearly coincident with the maximum of the heat-rays; but, according to Adams, the maximum effect is produced in the greenish-yellow or most luminous part of the spectrum. Lord Rosse exposed selenium to the action of non-luminous radiations from hot bodies, but could produce no effect; whereas a thermopile under similar circumstances gave abundant indications of a current. He also cut off the heat-rays from luminous bodies by the interposition of liquid solutions, such as alum, between the selenium and the source of light, without affecting the power of the light to reduce the resistance of the selenium; whereas the interposition of these same substances almost completely neutralized the effect upon the thermopile. Adams found that selenium was sensitive to the cold light of the moon, and Werner Siemens discovered that, in certain extremely sensitive varieties of selenium, heat and light produced opposite effects. In Siemens's experiments, special arrangements were made for the purpose of reducing the resistance of the selenium employed. Two fine platinum wires were coiled together in the shape of a double flat spiral in the zig-zag shape, and were laid upon a plate of mica so that the discs did not touch one another. A drop of melted selenium was then placed upon the platinum-wire arrangement, and a second sheet of mica was pressed upon the selenium, so as to cause it to spread out and fill the spaces between the wires. Each cell was about the size of a silver dime. The selenium cells were then placed in a paraffine bath, and exposed for some hours to a temperature of 210° C, after which they were allowed to cool with extreme slowness. The results obtained with these cells were very extraordinary; in some cases the resistance of the cells, when exposed to light, was only one-fifteenth of their resistance in the dark.

Without dwelling farther upon the researches of others, I may say that the chief information concerning the effect of light upon the conductivity of selenium will be found under the names of Willoughby Smith, Lieutenant Sale, Draper and Moss, Professor W. G. Adams, Lord Rosse, Day, Sabini, Dr. Werner Siemens and Dr. C. W. Siemens. All observations by these various authors had been made by means of galvanometers; but it occurred to me that the telephone, from its extreme sensitiveness to electrical influences, might be substituted with advantage. Upon consideration of the subject, however, I saw that the experiments could not be conducted in the ordinary way for the following reason: The law of audibility of the telephone is precisely analogous to the law of electric induction. No effect is produced during the passage of a continuous and steady current. It is only at the moment of change from a stronger to a weaker state, or vice versa, that any audible effect is produced, and the amount of effect is exactly proportional to the amount of variation in the current. It was, therefore, evident that the telephone could only respond to the effect produced in selenium at the moment of change from light to darkness, or vice versa; and that it would be advisable to intermit the light with great rapidity, so as to produce a succession of changes in the conductivity of the selenium, corresponding in frequency to musical vibrations within the limits of the sense of hearing. For I had often noticed that currents of electricity, so feeble as to produce scarcely any audible effects from a telephone when the circuit was simply opened or closed, caused very perceptible musical sounds when the circuit was rapidly interrupted, and that the higher the pitch of sound the more audible was the effect. I was much struck by the idea of producing sound by the action of light in this way. Upon farther consideration it appeared to me that all the audible effects obtained from varieties of electricity could also be produced by variations of light acting upon selenium. I saw that the effect could be produced at the extreme distance at which selenium would respond to the action of a luminous body, but that this distance could be indefinitely increased by the use of a parallel beam of light, so that we could telephone from one place to another without the necessity of a conducting wire between the transmitter and receiver. It was evidently necessary, in order to reduce this idea to practice, to devise an apparatus to be operated by the voice of a speaker, by which variations could be produced in a parallel beam of light, corresponding to the variations in the air produced by the voice.

EXPERIMENT WITH LIGHT AS A PRODUCER OF SOUND.

I proposed to pass light through a large number of small orifices, which might be of any convenient shape, but were preferably in the form of slits. Two similarly perforated plates were to be employed. One was to be fixed and the other attached to the centre of a diaphragm actuated by the voice, so that the vibration of the diaphragm would cause the movable plate to slide to and fro over the surface of the fixed plate, thus alternately enlarging and contracting the free orifices for the passage of light. In this way the voice of a speaker could control the amount of light passed through the perforated plates without completely obstructing its passage. This apparatus was to be placed in the path of a parallel beam of light, and the undulatory beam emerging from the apparatus could be received at some distant place upon a lens, or other apparatus, by means of which it could be condensed upon a sensitive piece of selenium placed in a local circuit with a telephone and galvanic battery. The variations in the light produced by the voice of the speaker should cause corresponding variations in the electrical resistance of the selenium employed; and the telephone in circuit with it should reproduce audibly the tones and articulations of the speaker's voice. I obtained some selenium for the purpose of producing the apparatus shown; but found that its resistance was almost infinitely greater than that of any telephone that had been constructed, and I was unable to obtain any audible effects by the action of light. I believed, however, that the obstacle could be overcome by devising mechanical arrangements for reducing the resistance of the selenium, and by constructing special telephones for the purpose. I felt so much confidence in this that, in a lecture delivered before the Royal Institute of Great Britain, upon the 17th of May, 1878, I announced the possibility of hearing a shadow by interrupting the action of light upon selenium. A few days afterwards my ideas upon this subject received a fresh impetus by the announcement made by Mr. Willoughby Smith before the Society of Telegraph Engineers that he had heard the action of a ray of light falling upon a bar of crystalline selenium, by listening to a telephone in circuit with it.

It is not unlikely that the publicity given to the speaking telephone during the last few years may have suggested to many minds in different parts of the world somewhat similar ideas to my own.

Although the idea of producing and reproducing sound by the action of light, as described above, was an entirely original and independent conception of my own, I recognize the fact that the knowledge necessary for its conception has been disseminated throughout the civilized world, and that the idea may therefore have occurred to

...any circumstances. *The fundamental idea, on which rests the possibility of producing speech by the action of light, is the conception of what may be termed an undulatory beam of light in contradistinction to a merely intermittent one.* By an undulatory beam of light, I mean a beam that shines continuously upon the selenium receiver, but the intensity of which upon that receiver is subject to rapid changes, corresponding to the changes in the vibratory movement of a particle of air during the transmission of a sound of definite quality through the atmosphere. The curve that would graphically represent the changes of light would be similar in shape to that representing the movement of the air. I do not know whether this conception had been clearly realized by "J. F. W." of Kew, or by Mr. Sargent of Philadelphia; but to Mr. David Brown of London is undoubtedly due the honor of having distinctly and independently formulated the conception, and of having devised apparatus—though of a crude nature—for carrying it into execution. It is greatly due to the genius and perseverance of my friend, Mr. Sumner Tainter of Watertown, Mass., that the problem of producing and reproducing sound by the agency of light has at last been successfully solved.

RESEARCHES BY MR. SUMNER TAINTER AND DR. A. GRAHAM BELL.

The first point to which we devoted our attention was the reduction of the resistance of crystalline selenium within manageable limits. The resistance of selenium cells employed by former experimenters was measured in millions of ohms, and we do not know of any record of a selenium cell measuring less than 250,000 ohms in the dark. *We have succeeded in producing sensitive selenium cells measuring only 300 ohms in the dark, and 155 ohms in the light.* All former experimenters seemed to have used platinum for the conducting part of their selenium cells, excepting Werner Siemens, who found that iron and copper might be employed. We have also discovered that brass, although chemically acted upon by selenium, forms an excellent and convenient material; indeed, we are inclined to believe that the chemical action between the brass and selenium has contributed to the low resistance of our cells by forming an intimate bond of union between the selenium and brass. We have observed that melted selenium behaves to the other substances as water to a greasy surface, and we are inclined to think that when selenium is used in connection with metals not chemically acted upon by it, the points of contact between selenium and the metal offer a considerable amount of resistance to the passage of a galvanic current. By using brass we have been enabled to construct a large number of selenium cells of different forms. The mode of applying the selenium is as follows: The cell is heated, and, when hot enough, a stick of selenium is rubbed over the surface. In order to acquire conductivity and sensitiveness, the selenium must next undergo a process of annealing.

We simply heat the selenium over a gas stove and observe its appearance. When the selenium attains a certain temperature, the beautiful reflecting surface becomes dimmed. A cloudiness gradually extends over it, somewhat like the film of moisture produced by breathing upon a mirror. This appearance gradually increases, and the whole surface is soon seen to be in the metallic granular or crystalline condition. The cell may then be taken off the stove, and cooled in any suitable way. When the heating process is carried too far, the crystalline selenium is seen to melt. Our best results have been obtained by heating the selenium until it crystallizes, and continuing the heating until signs of melting appear, when the gas is immediately put out. The portions that had melted instantly recrystallize, and the selenium is found upon cooling to be a conductor, and to be sensitive to light. The whole operation occupies only a few minutes. This method has not only the advantage of being expeditious, but it proves that many of the accepted theories on this subject are fallacious. Our new method shows that fusion is unnecessary, that conductivity and sensitiveness can be produced without long heating and slow cooling; and that crystallization takes place during the heating process. We have found that on removing the source of heat immediately on the appearance of the cloudiness, distinct and separate crystals can be observed under the microscope, which appear like leaden snow-flakes on a ground of ruby red. Upon removing the heat, when crystallization is further advanced, we perceive under the microscope masses of these crystals arranged like basaltic columns standing detached from one another, and at a still higher point of heating the distinct columns are no longer traceable, but the whole mass resembles metallic pudding-stone, with here and there a separate snow-flake, like a fossil, on the surface. Selenium crystals formed during slow cooling after fusion present an entirely different appearance, showing distinct facets.

PHOTOPHONIC TRANSMITTERS.

We have devised about fifty forms of apparatus for varying a beam of light in the manner required, but only a few typical varieties need be shown. The source of light may be controlled, or a steady beam may be modified at any point in its path. The beam may be controlled in many ways. For instance, it may be polarized, and then affected by electrical or magnetic influences in the manner discovered by Faraday and Dr. Kerr. The beam of polarized light, instead of being passed through a liquid, may be reflected from the polished pole of an electro-magnet. Another method of affecting a beam of light is to pass it through a lens of variable focus. I observe that a lens of this kind has been invented in France by Dr. Cusco, and is fully described in a recent paper in "La Nature"; but Mr. Tainter and I have used such a lens in our experiments for months past. The best and simplest form of apparatus for producing the effect remains to be described. This consists of a plane mirror of flexible material—such as silvered mica or microscope glass. Against the back of this mirror the speaker's voice is directed. The light reflected from this mirror is thus thrown into vibrations corresponding to those of the diaphragm itself.

ARRANGEMENT OF APPARATUS FOR THE REPRODUCTION OF SOUND BY LIGHT.

In arranging the apparatus for the purpose of reproducing sound at a distance, any powerful source of light may be used, but we have experimented chiefly with sunlight. For this purpose a large beam is concentrated by means of a lens upon the diaphragm-mirror, and, after reflection, is again rendered parallel by means of another lens. The beam is received at a distant station upon a parabolic reflector, in the focus of which is placed a sensitive selenium cell, connected in a local circuit with a battery and telephone. A large number of trials of this apparatus have been made with the transmitting and receiving instruments so far apart that sounds could not be heard directly through the air. In illustration, I shall describe one of the most recent of these experiments. Mr. Tainter operated the transmitting instrument, which was placed on the top of the Franklin schoolhouse, in Washington, and the sensitive receiver was arranged in one of the windows of my laboratory, 1325 L street, at a distance of 213 metres. Upon placing the telephone to my ear I heard distinctly from the illuminated receiver the words: "Mr. Bell, if you hear what I say, come to the window and wave your hat." In laboratory experiments the transmitting and receiving instruments are necessarily within earshot of one another, and we have, therefore, been accustomed to prolong the electric circuit connected with the selenium receiver, so as to place the telephones in another room. By such experiments we have found that articulate speech can be reproduced by the oxy-hydrogen light, and even by the light of a kerosene lamp. The loudest effects obtained from light are produced by rapidly interrupting the beam by the perforated disk. The great advantage of this form of apparatus for experimental work is the noiselessness of its rotation, admitting the close approach of the receiver without interfering with the audibility of the effect heard from the latter; for it will be understood that musical tones are emitted from the receiver when no sound is made at the transmitter. A silent motion thus produces a sound. In this way musical tones have been heard even from the light of a candle. When distant effects are sought another apparatus is used. By placing an opaque screen near the rotating disk the beam can be entirely cut off by a slight motion of the hand, and musical signals, like the dots and dashes of the Morse telegraph code, can thus be produced at the distant receiving station.

We have made experiments with the object of ascertaining the nature of the rays that affect selenium. For this purpose we have placed in the path of an intermittent beam various absorbing substances. Professor Cross has been kind enough to give me his assistance in conducting these experiments. When a solution of alum, or bisulphide of carbon, is employed the loudness of the sound produced by the intermittent beam is very slightly diminished; but a solution of iodine in bisulphide of carbon cuts off most, but not all, of the audible effect. Even an apparently opaque sheet of hard rubber does not entirely do this. When the sheet of hard rubber was held near the disk interrupter the rotation of the disk interrupted what was then an invisible beam, which passed over a space of about twelve feet before it reached the lens which finally concentrated it upon the selenium cell. A faint but perfectly perceptible musical tone was heard from the telephone connected with the selenium. This could be interrupted at will by placing the hand in the path of the invisible beam. It would be premature, without further experiments, to speculate too much concerning the nature of these invisible rays; but it is difficult to believe that they can be heat rays, as the effect is produced through two sheets of hard rubber containing between them a saturated solution of alum. Although effects are produced as above shown by forms of radiant energy which are invisible, we have named the apparatus for the production and reproduction of sound in this way "*The Photophone*," because an ordinary beam of light contains the rays which are operative.

NON-ELECTRIC PHOTOPHONE RECEIVERS.

It is a well-known fact that the molecular disturbance produced in a mass of iron by the magnetizing influence of an intermittent electrical current can be observed as sound by placing the ear in close contact with the iron. It occurred to us that the molecular disturbance produced in crystalline selenium by the action of an intermittent beam of light should be audible in a similar manner without the aid of a telephone or battery. Many experiments were made to verify this theory without definite results. The anomalous behavior of the hard rubber screen suggested the thought of listening to it also. This experiment was tried with extraordinary success. I held the sheet in close contact with my ear, while a beam of intermittent light was focussed upon it by a lens. A distinct musical note was immediately heard. We found the effect intensified by arranging the sheet of hard rubber as a diaphragm, and listening through a hearing-tube. We then tried crystalline selenium in the form of a thin disk, and obtained a similar but less intense effect. The other substances which I enumerated at the beginning of my address were now successively tried in the form of thin disks, and sounds were obtained from all but carbon and thin glass. We found hard rubber to produce a louder sound than any other substance we tried, excepting antimony, and paper and mica to produce the weakest sounds. *On the whole, we feel warranted in announcing as our conclusion that sounds can be produced by the action of a variable light from substances of all kinds, when in the form of thin diaphragms.* We have heard from interrupted sunlight very perceptible musical tones through tubes of ordinary vulcanized rubber, of brass and of wood. These were all the materials at hand in tubular form, and we have had no opportunity since of extending the observations to other substances.

I am extremely glad that I have the opportunity of making the first publication of these researches before a scientific society, for it is from scientific men that my work of the last six years has received its earliest and kindest recognition. I gratefully remember the encouragement which I received from the late Professor Henry at a time when the speaking telephone existed only in theory. Indeed, it is greatly due to the stimulus of his appreciation that the telephone became an accomplished fact. I cannot state too highly also the advantage I received in preliminary experiments on sound vibrations in this building from Professor Cross, and near here from my valued friend Dr. Clarence J. Blake. When the public were incredulous of the possibility of electrical speech, the American Academy of Arts and Sciences, the Philosophical Society of Washington and the Essex Institute of Salem recognized the reality of the results and honored me by their congratulations. The public interest, I think, was first awakened by the judgment of the very eminent scientific men before whom the telephone was exhibited in Philadelphia, and by the address of Sir William Thomson before the British Association for the Advancement of Science.

At a later period, when even practical telegraphers considered the telephone as a mere scientific toy, Professor John Peirce, Professor Eli W. Blake, Dr. Channing, Mr. Clarke and Mr. Jones of Providence, R. I., devoted themselves to a series of experiments for the purpose of assisting me in making the telephone of practical utility; and they communicated to me, from time to time, the result of their experiments with a kindness and generosity I can never forget. It is not only pleasant to remember these things and to speak of them, but it is a duty to repeat them, as they give a practical refutation to the often repeated stories of the blindness of scientific men to unaccredited novelties, and of their jealousy of unknown inventors who dare to enter the charmed circle of science. I trust that the scientific favor which was so readily accorded to the telephone may be extended by you to this new claimant, the photophone.

Electric Storms.

Professor Tait explains the formation of the whirlwinds which occasionally sweep the Western America. Sixty are electrical storms, not wind storms. There was no wind attending a recent tornado at Marshfield. Among the evidence of the electrical nature of that storm he notes the fact that it destroyed every building which had a tin roof, or which had metal of any kind in its roof. In Marshfield it passed directly over several buildings with shingle roofs, and tore to fragments others, not more exposed, which had metal roofs. A mill situated over a quarter of a mile away from the centre of the cyclone, had its iron chimney torn out and carried a long distance, while the mill itself suffered very little damage. The cupola of the public school building at Marshfield, which had a tin roof, was wrecked, but the building, which was roofed with shingles, was not injured to any extent. Even more constructive and remarkable, he thinks, were the phenomena manifested in connexion with trees and shrubs. The bark was stripped from the trees and bushes, not alone on those sides exposed to the force of the cyclone, but on all sides. The ends of the branches were not only denuded of their leaves and bark, but were rifled into fine fibres, so that they presented the appearance of little brooms. The active agent in such cases, he insists, was not wind, but electricity. Under its influence the sap under the bark was instantly converted into vapour or gas, expanding 2000 times in volume, and as by an explosion, tore off the bark, shattered the trunk, and split the green twigs into fibres.

JAS. CROLL, F. R. S., makes mention of an article written by himself in *Phil. Mag.*, xxxii., 1866, pp. 213-216, which may not have been before presented to American public, in which he conjectured the annual fall of frost observed between a black-bulb thermometer exposed to the direct rays of the sun, and one shaded, *downwards*, to a second into the atmosphere. Mr. Croll deduces from this that radiation into stellar space is the medium for the production of snow in elevated places, and the protective action of aqueous vapor the cause of its melting in places where there is a greater snowfall, a remark in perfect harmony with Prof. Tyndall's important discovery regarding the influence of aqueous vapor on radiant heat.

AN ELECTRO-DYNAMIC PARADOX.

Dynamo-electric machines, like M. Gramme's *Alternate current* and can either generate a current from mechanical work, or, from continuous current magneto-electric machines do the same thing. But if the current from a dynamo-electric machine is sent into a magneto-electric machine, a very strange effect results. This effect is signalled by M. Gérard-Lescuyer, who calls it an electro-dynamic paradox.

Soon as the circuit is closed the magneto-electric machine begins to move, and tends to acquire a speed proportional to the intensity of the current actuating it. But suddenly its slackens speed, stops, and then begins to rotate in the contrary direction, only to arrest itself anew and begin again as before. In a word, it exhibits a regular alternative motion, lasting as long as the current which actuates it.

What, asks M. Lescuyer, is the cause of this phenomenon? Evidently the motive current changes its direction; and a galvanometer introduced into the circuit proves it. But how does it produce itself when the speed of the prime mover, be it steam or other engine, does not vary? The effect must be due to an exterior cause reversing the polarity of the inductors of the dynamo-electric generator so as to cause it to give birth to a reversed current. This reversal is proved by placing a compass near the inductors, and this reversal keeps time with the reversal of the current, as shown by the galvanometer in circuit with the machines.

Let us suppose that the magneto-electric receiver has periodic increases of velocity. These will give rise to a current of its own in the magneto-electric machine, which will traverse the dynamo-electric machine, and, as it will be a contrary current to that coming from the latter, it will tend to reverse the polarity of the inductors of the dynamo-machine. Hence a reverse current will proceed from the latter.

To test this hypothesis it is sufficient to prevent the increase of velocity in the magneto-electric receiver by means of a brake. As soon as the brake is put in play the paradoxical effect vanishes, and the receiver goes uniformly in the same direction, whilst the galvanometer and compass are unaffected. The experiment is well shown by a Siemens dynamo-electric continuous current machine for generator, and a small laboratory Gramme with ordinary permanent magnets, as constructed by M. Breguet, for receiver.

EARTH CURRENTS.

St. Leonards, Aug. 1, 1880

Several communications have appeared in our daily contemporaries, referring to aurora, seen by various observers on August 12th. In "Nature" will be found those inserted in *The Times*. Connected possibly with this phenomenon we have accounts of strong earth currents on and about this date. A most interesting statement describing the earth currents on various cable lines, has been sent to us by Mr. H. Sumner, electrician in chief to the Eastern Telegraph Company. The phenomena of earth currents are so universal, so important to science, and so little understood, that we hope some way will be found to accumulate facts from which data may possibly be deduced. Mr. Saunders, speaking of the electrical and magnetic disturbances of the 12th and 13th August says —

"The earth currents on those days were exceptionally strong and variable, causing great interruption to the traffic over all the English and Continental lines, so much so that the Director of Telegraphs in France gave notice in the papers of the cause of delay to telegrams.

"I have collected the following data as to what was observed on the Eastern Telegraph Company's system and the Eastern and South African Company.

"Between London and Porthcurno, and London and Marseilles and London and Liverpool, there were very considerable disturbances all day of the 12th, the maximum effects being observed between 11 a.m. and 4 p.m.

"The English Government and the Submarine Company's systems were also affected.

"The system upon which we work most of our lines, which is purposely intended to block earth-current disturbances, prevents them being noticed except when very strong and variable, so that on the cables from Porthcurno to Lisbon and Vigo nothing very unusual was observed; but upon a cable from Lisbon to Vigo, which is undergoing repair, and upon which an instrument is kept in circuit, strong and variable currents were observed on the 12th and 13th, the maximum being between 11 a.m. and noon, the weather being unusually calm and the sky thickly overcast.

"At Gibraltar very strong currents were observed on the cable to Lisbon at 10.25 a.m. of the 12th and the 12th being the strongest both on the Lisbon and Villa Real cable, maximum at 11.46 a.m., and currents on both cables during the 13th, but not so strong. Little or no current was noticed on the cable between Gibraltar and Malta on either of the days.

"Malta observed nothing unusual on the cables connected with Gibraltar, Marseilles, and Alexandria, nor did Alexandria observe anything on any of the cables connecting Malta, Cyprus, and Candia. In the Levant there was considerable disturbance on most of the lines. The Otranto Zante cable was violently disturbed between 10 a.m. and 4 p.m. the 12th, and the Zante-Candia line the whole of the day, rendering working very difficult.

"On the 13th the former section was free, but the latter still slightly disturbed. Candia did not have anything unusual either on the Syra or Alexandria cables. The Syra-Candia line was very strong. The cables connecting Syra with Pentedeo, and Pora and Tenedos and Salonica, as also on the Turkish lines, both on the 12th and 13th. The currents were not observed on the cable at Cyprus connected with Alexandria, but were on the land lines on both days, strongest on the 13th, and on the Larnaca-Limassol section. Nothing exceptional was observed on the cables between Suez, Aden, and Bombay. African cables between Zanzibar, Mozambique, Delagoa Bay, and Natal. It is all the more curious that, as a rule, these lines are very free from earth currents.

"This is, of course, very imperfect record, owing to the fact that cables are direct-reading machines in the first place, so that when there is trouble on the lines the first thing we do is to get the staff are deadred to getting the traffic through, and have little time for accurate recording.

"However, the salient points are sufficiently determined, viz. —

1st. The extent of the disturbance extending over Europe, as far as Constantinople, down to the extreme points of the southern coast of Spain, and also over the extreme points of the northern near the Red Sea, but turning up again at Zanzibar and along the east coast of Africa.

2nd. The remarkable coincidence as to the time of maximum effect at different places being separated.

"These disturbances are generally accompanied by displays of the aurora borealis, and I see from a letter in *The Times* of the 14th that a vivid display was seen from Hitcombe, on the night of the 12th, extending over a great part of the horizon beyond the Welsh coast. The aurora was visible at Suez on October 24th, 1870, and again on Feb. 8th, 1872, when it was seen there were great electrical disturbances over all the lines. During the last I measured earth currents equal to 120 Daniell cells upon the Suez and Aden cables. The aurora was preceded in each case by electrical disturbances on the line, and in the present case earth currents have been unusually strong for some days before, although during the actual time of the greatest disturbance on either lines the Suez-Aden section was clear."

THE MAGNET IN PARALYSIS.

Professor Nothnagel relates (Virchow's *Archiv*, May, 1880) some experiments he made on rabbits with the Leyden jar. He found that sufficiently powerful sparks produced a localised anæsthesia of transient nature. The extent of the anæsthesia was proportional to the density of the charge. He found that, to its quantity divided by the diameter of the brush. At the same time the motor fibres were almost unaffected, the duration of the paralysis being about the same as that of the loss of sensation. The faradic excitability was not destroyed nor even diminished. The latter was also the case where a man was struck by lightning on his right side, which became completely paralysed and remained so for ten weeks. The recovery was sudden and rapid; in two days the hand became quite normal again and remained so for six years, when suddenly both hands and feet were paralysed. Professor Three months after the occurrence he was admitted into the hospital. He was subjected to the usual electrotherapeutic means, without any benefit. Professor Nothnagel, who had read of Burq's experiments on a case of hemi-anæsthesia, tried the magnet [illegible] hand. His astonishment was great on finding that within three quarters of an hour sensation and motility were returning. Further applications of the magnet were followed by a complete recovery, and a few days afterwards the patient resumed his work. No return has been observed.

EFFECT OF MAGNETISM IN TOUGHENED IRON.

The *Lumière Electrique* states that M. Piazzoli has just undertaken a series of interesting experiments to demonstrate that magnetisation increases the toughness of iron. Holmhoeff had already proved as far back as 1866 that such must be the case by showing that a piece of magnetized iron requires a heavier greater than that of tempered steel, and that it also will have no effect on it; but it was interesting to know whether this limit was at the same time accompanied by a condition of toughness. M. Piazzoli's experiments were performed with iron wires about fourteen inches in length, stretched over supports, and covered with four magnetic spirals through which long currents were sent successively in two directions. Silent [illegible] the magnetic effects ceased to be produced or annulled in the iron wire without changing the thermic effects developed at the same time by the action of the current. The following are the results obtained with the specimen of wire employed, the weight of which was 0·209 gramme per metre (1.) When the wire had been annealed with charcoal the breaking weight was found to vary from 1,900 to 1,950 grammes, under the influence of magnetisation, and the wire had been reduced in cable of carbon these weights were 2324·4 to 1726·8 with magnetisation, and from 1761·92 to 1719·87 without magnetisation. (3.) Finally, when the wire had been annealed in hydrogen the weight necessary to break it when magnetised was from 1293·6 to 1210·1, and from 1208 to 1209·2 when unmagnetised.

Although the difference between the larger and smaller figures of each of the two series are at times contradictory to the conclusions announced at the beginning of this note, the summary of the eighteen series of experiments has shown that the breaking weight of the magnetized wire was from one to three per cent. greater than that of non-magnetized iron.

Interesting Experiment.—A simple and interesting experiment in magnetism has been introduced by Prof. Thompson. A thin plate of hardened steel is written upon, with a magnetized [illegible] pencil, is preserved by the steps in [illegible] which [illegible] to read what has been written, things are sprinkled on the plate and the plate is then gently tapped a few times. The particles of which the [illegible] fall off except those which [illegible] magnetic part of the plate marked by the [illegible] having the writing in relief.

The Earth's Magnetism.

The great physical problem of terrestrial magnetism has engaged the attention of numerous physicists lately, and it is well known that several ingenious solutions of it have been proposed. Professors Ayrton and Perry, for example, conceived the happy [illegible] which was adopted with much electricity, which being carried round on the surface of the globe, [illegible] the magnetism of the earth. It occurs now to doubt to this [illegible] however, by the mathematical criticism [illegible] Professor Perry has since found out that the surface charge required was sufficient to send a spark from earth to moon. A theory based upon the existence of electric currents flowing in the atmosphere around the earth was propounded later; and now we have another supposition, which has a better claim to serious attention than any of the rest, because it is supported by direct experiment. Starting from the idea of M. Edlund that an electric current is really an ether current flowing in the circuit, and that electrostatic effects are due to accretions and condensations of the ether, M. Selim Lemström considered that he might produce like ether current by mechanical action. He therefore made a paper tube having two concentric walls and mounted on an axis. A core of soft white iron was placed within the tube, and an exciting the latter the core was found to be magnetic, as demonstrated by two magnetometers. On now throwing the rotation reversed the magnetic polarity; and M. Lemström concludes that the relative motion of the ether in the revolving tube and the stationary core was the cause of the polarity. It follows that if the tube be stationary and the core revolved a similar effect will be produced; and hence, if a magnetic body like the earth be rapidly rotated round its axis in an insulating medium like the air, it will exhibit magnetism. Pursuing this idea into mathematics, M. Lemström arrives at an expression for the magnetic moment of the earth which agrees very well with the formula of Gauss.

Nouveau moyen de reproduire l'expérience du magnétisme de rotation d'Arago.

On peut, suivant M. Bailly, au moyen d'électro-aimants dont on fait varier l'intensité, faire tourner une plaque de cuivre, et si les variations sont assez rapprochées, la rotation semble continue comme dans l'expérience d'Arago. « Plaçons, en effet, dit M. Bailly, deux pôles magnétiques au-dessous d'un disque conducteur mobile autour d'un axe vertical, et faisons l'un des pôles ponctuel, en posant réaliser les combinaisons suivantes

Journal

Pôles [illegible] même sens [illegible] de magnétisme.

Pôles de noms contraires [illegible] Universelle

« Dans le premier cas, l'action des pôles variable par les courants induits est perpendiculaire au plan du disque, mais l'autre pôle reprenne ce disque vers le premier; dans le second cas, le disque marche vers le pôle constant; dans le troisième et le quatrième, les effets sont les mêmes tant que la rotation est de sens contraire; mais si l'un des pôles augmente d'énergie alors que l'autre en perd, les actions s'ajoutent, et, comme ces extrêmes, on peut prendre des aimants qui commencent à s'aimanter ou qui finissent. Or, supposons une série d'aimants rectilignes P, Q, R disposés en cercle de manière que leurs pôles soient sur le même plan, et réunissons dans deux les aimants placés aux extrémités d'une même diamètre du disque, en faisant passer en P et Q des courants tels que les pôles voisins soient de même nom. Supprimons le courant en P, et rétablissons-le en Q, et ainsi de suite : la rotation reconra une série d'impulsions, toutes dans le même sens, et si le nombre des électro-aimants est infini, on atteindra une rotation uniforme du champ magnétique comme un aimant tournant.

« On peut, toutefois, produire cette rotation au moyen de deux pôles seulement d'électro-aimants ab, a'b' et de deux piles, par les combinaisons ci-dessous.

1 2 3 4 5 6 7 8 9
NN ON NN SS SS ON SS NO NN
SS SO SN ON NN NO NS OS NS

« O indique que le pôle est inerte, et quand cela a lieu, le disque tourne dans le sens ab, a'b'; mais il en renverse les polarités de manière à rendre suffisante une impulsion. Au moyen d'un commutateur, on peut produire les interruptions convenables pour faire tourner le disque dans un sens ou dans l'autre.

« On augmente l'effet en plaçant au-dessus du disque des électro-aimants disposés d'une manière inverse par rapport à ceux qui sont au-dessous et dont les pôles doivent toujours être de noms contraires... »

Positions conjuguées de deux hoônes circulaires.

D'après M. W. Grant, si on dispose en face l'une de l'autre deux hobines électriques dont une jouie le rôle d'inducteur, l'autre d'induit, et qu'on déplace l'une d'elles latéralement par rapport à l'autre tout en maintenant les axes

no bearing on the subject of the high temperatures obtained by breathing through warm material on the bulb of a thermometer, for no one has yet observed that ventilets clothing will develop a less greater than that of the body it covers, viz., 98°·5.

The hygroscopic properties of different materials offer no explanation of the phenomenon, for the power of materials to imbibe moisture will not account for an increase of their temperature by becoming moist themselves.

Are my conclusions right or wrong; Mr. McNally has not shown them to be either. My facts are not the less true from being incompatible with "ascertained physiological truths," for ascertained physiological truths are only true so long as they are not controverted by other ascertained physiological truths.

My experiments show that the temperature obtained by breathing on the thermometer in the manner described is higher when his exhale is obstructed from the surface of the body, lower when the surface of the body is losing more caloric. Thus on a warm surface of my breath raised the thermometer to 108°, whereas to-day (a cold wet day) it only raised the thermometer up to 103°. Does not this seem to show that respiration is a means of getting rid of the superfluous caloric generated in the body, and that when the means of caloric cannot be got rid of by the skin it passes off by the breath?

October 9 H. E. DUDENEY

Selenium

As the only chance of being able to transmit images of reflexion through a conducting wire, in the way sound is repeated to a distance by telephone, appears to lie in the preparation of a finely transparent sheet of metallic selenium; it may tend to advance the subject if the difficulties experienced in dealing with this substance are mentioned.

Selenium in its vitreous condition melts about 220° Fahrenheit, and can be drawn out between side plates over a lamp, to a thin transparent red film. But heated for some time it turns black and granular, apparently dissolving hydrogen, then melts only at 473° F., and is brittle and intractable. Unfortunately it is only in its crystalline state that its power of conducting electricity appears, and varies with the light under which the crystals are placed.

Procured in the usual way, electrically conducting selenium is an opaque mass of the hardness of brass, with the shiny appearance and surface of graphite. Heated, it is reduced with a sufficiency to any degree of transparency in vapour to be deposited, it is of a dull red colour, and unless in the ideal solution from hydrogenic pressure between flat polished steel plates, the deposit is always slightly profound. Selenium also dissolves freely in chloride of selenium, $SeCl_4$, and precipitates slowly in a butyrated mass of black lustrous plates. It also separates in the crystalline form from concentrated solutions of caustic of potassium or sodium.

There is some uncertainty as to whether a transparent sheet could be more easily obtained by the method of precipitation, than by some mechanical treatment. But the investigation is one that requires to be carried out with the aid of a fully equipped laboratory, and is beyond the power of an ordinary amateur's means.

To develop a successful mode of making a black substance like graphite at all moderate, requires a distinct under-standing of the reason why selenium can expose. Something more than an explanation in general terms is needed before camera pictures can be resolved into their electric currents, and again integrated upon a receiving plate.

Perhaps some of the readers of NATURE may be able to suggest a method of dealing with selenium that will produce this transparent sheets capable of conducting electricity.

London, October 16 A. T. F.

Dynastes Hercules

The reviewer of Oley's "Camps in the Caribees" (NATURE, vol. xxii. p. 529) appears to doubt the story of the habits of the large Hercules beetle, *Dynastes hercules*, told by Oley on the authority of Sprigle. If the description perfectly true, and I have myself often seen the occurrences described in the neighbourhood, where the beetle is not uncommon. In the first instance I noticed it on a branch of *Ochroma lagopus*, and the second time on a species of *Bombax*, both very soft-wooded trees. The branches in each case were about three-quarters of an inch in diameter, half an inch being formed by the wood. In both cases I saw the performance of the animal most distinctly, just as described by Oley's guide, and I took not only a piece of the severed branch with me, but secured also the severed animal. The noise is not so much produced by the cutting of the branch as by the open wings passing rapidly through the air during the motion of the beetle. I do not believe there is anything of a sexual call in the manœuvre. The beetle wants to get at the abundant juice of the young leaves. It is called in this country *corrocoyo*, or *corocoro*. Sloane, Leroy, an effect insect of the same family as *Geotrupes* and *Scarabæus* in a similar way, but chooses of course thinner branches.

Carúpia September 9 A. ERNST

What is Alrese?

In the large *Encyclopédie* published by Didrot and d'Alembert, vol. xii. p. 224 (edit. in folio) there is mentioned amongst the substances used for poisoning water to catch the fish, *l'herbe qu'on appelle* ALRESE. Littré has no such word, nor anything like it, nor indeed any other lexicographer I am able to consult here. I should be much obliged for any information on this name, or the plant referred to. A. ERNST

Caracas, September 9

Rainfall of Sierra Leone

As I believe there is little account taken of this climate at home, and as perhaps it might interest you, I send you an account of one day's rainfall this month, which is an excessive amount even for Freetown, and equal to one-third the whole year's rainfall for Dublin, I believe :—

Rainfall registered in the Colonial Hospital, Freetown, 50 feet above level.

		inches.
From 6 a.m. to 4 p.m. September 11	... ...	6·35
From 4 p.m. to 6 a.m. September 12	... ...	4·65
Total in 24 hours	... ...	10·9

Care-on House, Freetown, September 16 W. HUME HART, Colonial Surgeon

An Octopus

I ENCLOSE an account of an enormous octopus which was thrown on the shore at Killare, Co. Clare, in the last great storm. As I suppose my uncle's hand very hard to read, I have copied his letter.

Ardanaile Fuynes C. G. O'BRIEN

"*Saturday, October 9, 1880*

"I am sorry you were not at Killare when a great fish was stranded on the side of the Duggerna reef on Thursday last. Its arms last long certainly broken : there were eight of them, each as thick as a strong man's upper arm, and beneath each were two rows of suckers like saucers—one row more than a shilling size in circuit. When perfect, each of the 2 arms must have been from twelve to fifteen feet long, and from the point of one arm to that of its opposite was a length of nearly thirty feet. The animal's length from the insertion of its arms to the end of its body must have been nearly twenty feet, perhaps more. Its mouth, like a parrot's beak, was as large as two joined hands of a large man with the fingers outstretched. It weighed about 4 cwt. Its head was 24 inch in diameter, about three feet long : its eyes of the size of the inner circuit of a breakfast-plate. A monster. The under colour first of the under side of a turbot."

—(*From a letter of the Rev.* R. J. GARRETT.)

SYNTHESIS OF CITRIC ACID

AS we intimated last week, another brilliant synthesis has recently been accomplished in the domain of organic chemistry. Messrs. Grimaux and Adam have succeeded in building up the characteristic acid of lemons from glycerin. Glycerin may be regarded as trihydroxypropane, $C_3H_5(OH)_3$, and citric acid as hydroxypropane-tricarboxylic acid, $C_3H_4(OH)(CO_2H)_3$. To convert glycerin into citric acid it was therefore necessary to replace two (hydroxyl) groups, and one hydrogen atom, by the group CO_2H (carboxyl). This was done as follows :—By the action of hydrochloric acid on glycerin, dichlorhydrin,

AN ACCOUNT OF EXPERIMENTS IN PHOTO-ELECTRICITY.

Telegraph Journal.

By C. H. MINCHIN, M.A., Professor of Applied Mathematics in the Royal Indian Engineering College, Cooper's Hill.

(Read before the British Association, Aug., 1886.)

Ref. 1871

(*Continued from page* 326.)

18. CASE OF INVERSE CURRENTS.—Several experiments, made at various times, led me to conclude that when cosine is in the cell, and not on the plate, the photo-electric current is in the direction opposite to that of the current produced when the cosine is on the plate and not in the cell. The observed phenomenon were not, however, marked enough to prove this decisively; and, indeed, the difficulty of determining the point is obvious, because if a clean plate is dipped into a cell containing a solution of cosine, the plate will at once take up a layer of cosine, however thin, and we shall necessarily have the two cases combined.

An experiment which seems to me to have a bearing on this question is the following :—I took a large glass cell and filled it with distilled water containing a very small quantity of cosine. The liquid became brilliantly coloured. The cell was completely covered over with black paper pasted to the faces, with the exception of a rectangular strip of one face, opposite to which was placed the plate on which the light was to fall. Two clean silver plates were immersed in the cell, and connected with the galvanometer in a loop-room. The cell was at the top of the house, and the light used was sunlight. No light being admitted, the D. C. happened to be from the shaded plates to that which was about to be exposed, and after five minutes this current had so far died out that the spot came to rest at 40 divisions from its zero position.

Now, when the screen in front of the cell was suddenly removed, the spot answered over the 80 or 90 divisions of the scale in the direction *opposite to that in which it moved by the light*, and after this initial deflection it moved slowly in the opposite direction, just as it would have moved if the plate had been dipped with an ordinary gelatine film, and its motions then appeared to answer the variations of light intensity as usual. This latter (or normal) motion was much greater than the initial impulsive motion.

Again, when the screen was suddenly replaced in front of the cell, the spot, instead of going suddenly back towards the zero position (as we should expect it to do on the withdrawal of the light) *took an impulsive forward motion over 80 or 90 divisions of the scale*, after which it moved backward to zero.

The same experiment was tried with fluorescine—a different cell being, of course, used. The same results were observed, so that the impulsive motions of the spot took place over only 4 or 5 divisions instead of 80 or 90.

It would seem to me that these observations are consistent with the supposition that the action of light on cosine and fluorescine is a cause of the production of electric current exactly opposite from those which it may generate by effecting chemical action between these bodies and metallic plates.

19. NAPHTHALINE RED.—A silver plate was coated with a layer of gelatine, and was soaked up in a testtube with a very small quantity of naphthaline red, this latter having been previously dissolved in alcohol. The layer was allowed to set thoroughly on the plate, and, when dried in a cell containing tap water, no discoloration of the water took place, however long the plate was left immersed.

Apparently, for photometric purposes, this is the best plate that I have found. A naphthaline red plate which was made last April, and which has been used several times since, is found to answer quite as at least as well as those given by it eighteen months ago.

Though these experiments are not quite so exact as those given by cosine plates, Moreover, some experiments with coloured glasses show that currents in opposite directions are produced by the red and the blue rays.

I quote the records of two experiments :—

Tune 28.—Naphthaline red. D. C. from U. to L. in cell. Spot steady at 30 divisions to right of zero. Sunlight.

No glass in front of cell. Motion from 30 to right, each opposite to 70 to left ... ... from 30 right.

Blue	...	...	...	180, ...	... 30 ...
Red	...	...	...	∞ ...	... 30 ...
Red	...	...	...	∞, right, ...	... 30 ...
Blue	...	...	...	180, ...	... 30 ...
Green	...	...	...	0 ...	... 30 ...

"The opposite results of the red and blue rays do not appear to be accidental, but this may be due to the comparative sensitiveness of the effect of the red and, and to impurities of colours in the glasses.)

Tune 28.—Same plate, same cell. Magnesium light. Spot steady, at 45 divisions to right of zero.

Red glass ...	Motion from 45, right, to ∞, left	Same direction as D. C.
Yellow, dilute ...	Motion from 45, right, to 60, to left	Opposite to D. C.
Yellow, strong ...	Motion from 45, right, to ∞, to left	Same direction as D. C.
Blue, dilute ...	Motion from 45, right, to 60, to left	Opposite to D. C.
Blue, deep ...	Motion from 45, right, to ∞, to left	Same direction as D. C.

The opposite effects of the coloured glasses were observed only when magnesium light was used. With sunlight, these opposite effects were not produced in any experiments of which I have records.

With the plate prepared nearly three months previously, I observed that the D. C. usually disappeared in about one minute after the completion of the circuit; and that on the withdrawal of the light the spot returned to the zero position in about a minute.

As a general rule, I have observed that for the production of maximum effects a very small quantity of the colouring substance (cosine, naphthaline red, &c.) must be used in the gelatine layer.

The use of sunplates will (in virtue of the comparative insolubility in water) was suggested to me by Mr. Wilson, of South Kensington.

20. INVERSE CASES.—In examining the photo-electric qualities of the Aquilles Dyes, I found that very strong currents are produced by the action of light on a silver plate coated with iodine green and gelatine. Dissolve a very small quantity of iodine green in water and shake, pour it in a dish large enough for use, and when the plate has become thoroughly dye, pour over it a layer of collodion. Then dip it a few times in a tumbler of water. After the first dip a little of the iodine green will come into the water—probably from the edges of the plate; but subsequently no visible amount will come off.

Placed, in the usual way, in a cell containing tap water, this gave a strong D. C., which died out completely in about twenty-four hours.

Tune 17, to 8, in the cell,

and this current kept the needle right against the stops. In order to bring the spot back to the edge of the scale, it was necessary to place three yellow glasses and a violet one in front of the cell.

21. MEASUREMENT OF THE E. M. F.—Twelve of the small cloisite cells with blue glass faces were employed for the measurement of the E. M. F. produced by the action of sunlight on a silver plate coated as above with iodine green. Exposed to very oblique sunlight in a window of the Physical Laboratory at University College, London, the plates of the battery were connected with a Thomson Quadrant Electrometer. The deflection varied with the intensity of the light; it did not wholly disappear when the light was withdrawn, but became steady at a definite value, and, closed for five minutes, gave no deflection. The E. M. F. so permanently been allowed to disappear by closing the circuit of the battery, and tested by it after closing the previous night. In this observation the reading was E. M. F. 0·1 single cell observed was about the $\frac{1}{200}$th of the E. M. F. of a Daniell's cell.

The battery was left covered up in charge of Mr. Grant, the Assistant, and he kindly made further measurements whenever better conditions of sunlight offered. The sunlight in one of his observations brought up the E. M. F. to $\frac{1}{40}$th of that of a Daniell.

22. OTHER SUBSTANCES.—Although I have now described the most striking of the results obtained, several other substances have been used. Foremost among these I may mention Fuchsine, an exceedingly unstable body, a trial of which was recommended to me by Professor E. Wiedemann. The ease with which it is soluble in water renders it objectionable for coating a plate. But when dried on a thoroughly clean plate, which is then dipped into a solution of iodine, a film is formed on the plate (silver), and gives good currents by the action of sunlight.

Fluorescine, used like cosine, with silver or platinum plates, gives poor results.

Of course the action of light on a silver plate, coated

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INFLUENCE OF THE GALVANIC CURRENT ON BACTERIA (P. Cohn and B. Mendelsohn).—The authors carried out their experiments to verify the assertion of Schiel, that the galvanic current prevents the development of bacteria. The results were that a feeble current from one pair of elements had no perceptible effect; a current from two elements rendered the solution inactive at the positive pole; a current from five, sustained for twenty-four hours, completely sterilised the whole solution, and deprived it of its power to infect another solution. The solution at the positive pole was first bleached; with the stronger current the liquid became acid at the positive and alkaline at the negative pole. The induction current had no perceptible effect on the bacteria.—*Ind. C.*

Science N. 196

An Explosion of Electrical Phenomena.

Mound, Iowa, Oct. 9.

To the Editor of the Journal of the Telegraph: I S

Last evening a noise very distinctly resembling the reverberation of distant thunder was heard in my office. Upon investigation I found that it came from my telegraph table, although I could not discover that my instruments had anything to do with it. Opening the key did not cause the sound to cease, and putting my ear to the table I could distinctly hear our night train despatcher calling offices on circuit No. 2, I telling on No. 1. Circuits Nos. 1 and 2 have no apparent connection with each other or at all, although both instruments are on the same table, one being on one end of the table and the other at the opposite end. We tried it several times and it always worked the same. Will you please explain how the sound could be carried in that way?

My office is situated twenty-one miles south of the train despatcher's office, and he was working south on circuit No. 2.

W. E. F.

Lisbon.—It may have been caused by short circuiting of main and local connections in one of the relays, by defective insulation between bells and coil, the latter touching the armature.]

SCIENTIFIC PROGRESS.

Seeing by Electricity.

A correspondent of the *Scientific American* says that the description of "seeing by electricity" is not altogether new. The correspondent, W. E. Sawyer, of New York, writes as follows: "Early in the fall of 1879, I constructed, from principles and even the apparatus described, visible objects at a distance through a single telegraphic wire were described at No. 21 Cortlandt street, New York, to James G. Smith, Esq., formerly superintendent of the Atlantic and Pacific Telegraph Co., and now of the Continental Telegraph Co., and to Messrs Shaw & Baldwin, telegraphic constructors, now connected with the Clectic Telephone Co. At that time the writer was engaged in perfecting an autographic telegraph by which many characters were daily transmitted by telegraph over a single wire.

"The correct consciousness of this discovery in these different directions, each undoubtedly independent of my own experiments, show how the same idea often arises in separate minds. There is no likelihood of any of the rights ever being refused to grant, for none of the difficulties in the way of all of the plans are insuperable, as will be apparent from the following reasons:

"1. The action of light upon selenium in changing its electric conductivity is slow—although now discoveries may remedy this fact.

"2. To convey with any accuracy an image, one even as small as to be projected upon a square inch of surface (I am speaking now of his apparatus you describe), would necessitate that this inch surface should be composed of at least 10,000 insulated selenium points, connected with as many insulated wires leading to the receiving instrument, for the variation of the 10th of an inch either way will 'throw a line out of focus.'

"3. The most delicate apparatus would not indicate a change in resistance by the projection of light upon merely a selenium point.

"4. Isochronism is unattainable, as required. The method I proposed involved the isochronous movement of the separate instruments. The transmitter consisted of a coil of fine selenium wire in a darkened case, having a diameter of say three inches. Light from the image to be transmitted was to be let into the transmitter and upon the selenium coil by a fine tube which, starting at the periphery of the circle, would draw concentric imaginary spiral lines until reaching the center of the circle. The light emitted or reflected from the image to be transmitted would effect the selenium just in proportion to the brightness of the image at the different points within the compass of the circle traversed by the imaginary lines drawn by the opening in the tube.

"The receiver consisted of a darkened tube, having an inside diameter of three inches (corresponding to the transmitting circle) with its sides and bottom absolutely black. In this tube, drawing exactly anything lines just as the tube in the transmitter, was a blackened index carrying two fine insulated platinum points very close together connected with the secondary wire of a powerful induction coil, the primary wire of which constituted a part of the main wire leading to the transmitter.

"The transmitting ray of light and the invisible index in the darkened receiving tube were to start at the periphery and describe their spiral motions in exact synchronism. The center should be reached, and the synchronism sufficiently great it is obvious that as the intermittent spark between the receiving platinum points could not have ceased to affect the retina until the last spark, with the index at center, would have been produced, an exact image of the object before the transmitter would be reproduced before the eye of the observer placed at the darkened chamber of the receiver.

"But the trouble is to make the selenium sufficiently active, *and to get the isochronous motion.*

Science July 20. 1881.

A curious thing occurred lately in the works of M. Fleury, at Cette (Herault). The feed-water of the boiler giving much incrustation, M. Fleury was advised to put into the boiler some fragments of zinc as a de-incrustant, and did so. In a few days, spite of filling, the steam-boiler began to work very badly, the piston catching a great deal, and it soon became necessary to stop and make examination. The piston was found to be covered with a thick adherent layer of copper. It was put on the lathe, and at certain convex projections, the metallic layers were so thick that the tool worked in copper alone. The explanation given by M. Fleury is this. The boiler was connected with the engine by copper pipes. Particles of zinc carried off by the steam would form with the copper a multitude small galvanic couples; hence the transport of copper to the piston, which would principally attract them by reason of its motion, and of the heating produced. It is remarked in *Les Mondes*, that the eminently electric properties of expanding steam may have helped in development of the phenomenon.

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instrument, but to a lever, n, on which it works stiffly, so as to retain any position in which it is placed. Lever n works contiguous has a limited range of motion, to one end of which it is elevated by a spring; slight pressure with the finger, moves it and its attached mirror, so as to throw the light to and off the object in a succession of long and short flashes by which letters and words may be indicated. Flashes may also be given by moving the thumbpiece H held in the hand.

The above instrument answers well for all positions of the sun except when very low behind the observer's back, for this case another mirror is provided by which the light is reflected on to the mirror, A. Messrs. T. Cooke & Sons, York, are sole makers of this instrument.

AN ACCOUNT OF EXPERIMENTS IN PHOTO-ELECTRICITY.

By G. M. MINCHIN, M.A., Professor of Applied Mathematics at the Royal Indian Engineering College, Cooper's Hill.

(Read before the British Association Aug. 18th.)

1. TWO OBJECTS OF PHOTO-ELECTRICITY.—In the study of the electric currents produced in various ways by the action of light, I have had two objects in view, viz.:—

(1.) *The production at a distance of effects due, in the first instance, to photographic action of light;* and

(2.) *The continuous daily registration of the intensity of sunlight of any selected wave length.*

It is at the outset evident that for the solution of the latter problem the action of the light, whose intensity is to be measured and registered, must be received on some substance whose chemical composition is either unaltered by the light, or so slowly and slightly altered during the period of observation, that the magnitude of the change may be neglected.

For the solution of the former problem it occurred to me, in the first instance, to receive the photographic action on plates coated with the silver salts in ordinary use among photographers; but I do not now think that it would be necessary to work exclusively with these substances, and if the use of them can be to any extent dispensed with, a corresponding gain in sensitiveness would, since they are permanently and very rapidly decomposed by luminous action.

2. LUMINOUS ACTION A SOURCE OF ELECTRICITY.—In 1873, Professor Young, from the experiments of Hesehyel and Clarke, that electrical currents can be produced by the action of light, discovered each two clean silver plates exposed one to the vapour of iodine, plunged both into a cell containing a conducting liquid, and completed the circuit through a galvanometer. The cell being completely covered in the moment the circuit was completed, a strong current was set up. This current disappeared after about 24 hours. Then, on illuminating the sensitised plate, an intense current was generated by the light.

Grove used a prepared daguerreotype plate inclosed in a box filled with water, having a glass front with a shutter over it. Between this glass and the plate was placed a gridiron of silver wire, and, on completing the circuit through a galvanometer, a current was generated by the action of light on the daguerreotype plate. (See the *Correlation of Physical Forces.*)

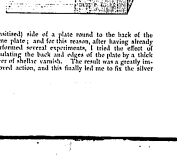
Grove also found that when two clean platinum plates were immersed in a cell containing acidulated water, and one of them was exposed to light, a current was produced. On the light was allowed to fall on the plate three days or of course, the current which is always produced by the immersion of two plates, however similar on each, ceased in making them, in any liquid. This current I am in the habit of speak of as "the disturbing current," since it is produced by some other agency than that of light; and I shall frequently refer to it as the "D. C." for shortness. The current produced by the action of light on one of the platinum plates was found by Grove to be always in the same direction as that of the D. C.; and he found, moreover, that the current produced by the rays was greater than that produced by red.

Currents of this latter kind may be produced by the agency of light in several different ways. For instance, the two platinum plates will give the current in question if they are immersed in common tap water. Again, the two clean platinum plates may be replaced by two clean silver plates, and we shall obtain still stronger currents by the action of light on one of them. No doubt several other metals would be found to give similar results.

In such currents—viz., those generated by the action of light on any unoxidised metallic plate immersed in a liquid, in presence of a similar plate unexposed to the light—I shall be at present designate as "Grove's currents." They are exceedingly small compared with the photo-electric currents which we shall be occupied.

3. PLATES EMPLOYED.—Since the substances to be acted upon by light were, in my first experiments, those of silver, I chose silver plates in order to obtain as much interference action in the cells as possible. At first the plates were simply stiff pieces of silver foil, about two or three inches long, and one or two inches broad. But it appeared at least possible that much of the current was lost by passing from the excited (or

Fig 4.



sensitised) side of a plate round to the back of the same plate, and for this reason, after having already performed several experiments, I tried the effect of insulating the back and edges of the plate by a thick layer of shellac varnish. The result was a greatly improved action, and this finally led me to fit the silver

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Magnetic Attraction in Iron Ships.

THE South Australian *Advertiser* prints the following interesting communication from a correspondent:

Before the *Hecate* left England, Captain Wild read in a paper a suggestion to nullify the local attraction on board iron vessels by means of an earth compass, the simplicity of which is its chief recommendation. It was claimed that a complete envelope of earth would so far protect the attraction of the compass by the addition or absorption of local magnetism, that deviation tables would be unnecessary. The *Hecate* was fitted with binnacle and standard compasses on same, both of which varied from one and a half to three points, according to the direction of the ship's head, before leaving, the master furnished himself with the necessary earth to form a mound about an ordinary ship's compass. Accordingly this half cask was procured, directly over the compass and the compass was buried deep in the soil, so that the direction of the needle might be accurately observed. During the voyage the most careful attention has been paid to the compass, and the result has proved the complete efficacy of the plan adopted, and that a compass so fitted is as much to be depended on in an iron vessel as though it were in a wooden ship. The experiment was deemed of sufficient importance to attract the attention of Captain Blanche, the inspector of compasses, who devoted some part of Monday to making experiments, and has since verified the Captain's statements. Sailors alongside the wharf the standard compass—one and a half points wrong, and the binnacle compass two points out; that on the earth box was true as the needle to the pole."

Dec 30. Nature
1875

ANOTHER new property of selenium is claimed as the discovery of M. Blondlot. He states that when selenium is rubbed upon platinum, each metal being connected with a terminal of a capillary electrometer, a current is observed. This current, which is observed to pass through the electrometer from the platinum to the selenium, appears therefore to differ from the thermo-electric currents discovered by Becquerel, and which were always in the same direction at the thermo-electric contacts which would have been produced had the surfaces of friction been suitably heated. The term thermo-electric current of a selenium-platinum pair is, according to M. Blondlot, from selenium to platinum at the heated junction. One curious point stated by M. Blondlot is that its deflection whatever is obtained upon the capillary electrometer, whether the connection be made between two tenderers, between a vessel and an insulator. The electrometer in the selenium-platinum circuit indicates a diminution of potential about equal to that of one Daniell's cell.

Engineering Jan 7 1876

"It is a familiar fact that some ordinary kinds of paper, well heated and rubbed, show distinct electrical properties. Mary Wickamora has shown that Swedish filtering-paper, after a certain preparatory treatment, presents much more intense electric properties. A strip seven centimetres long, &c. It is proper to mix into a mixture of nitric and sulphuric acids (equal volumes), as for making gun-cotton. Then it is washed well with water and dried. It should be rubbed on wax-cloth to develope the electric charge. (Jour. f. p. C. [2] 7, 127.)

Eng Mech Jan 21 1876

A CONTRIBUTION TO THE ANALYSIS OF ELECTRIC DISCHARGES. W. Holtz.—The electrodes (tin-foil points) between which the sparks of an induction apparatus were striking were made to revolve up to 2,000 times per second in an electric field of 12 c.m. diameter. When the distance traversed by the sparks is very small the electrical image of the sparks is greatest. It is reduced by diminishing the capacity of the exciting elements and the number of turns of the two wires in the induction coil, or by increasing the resistance of the air. The image consists of a great number of parts separated by intervals, and is of a violet light anterior coil, followed by white violet tints, reddening in length. On connecting the poles of the induction apparatus with Leyden jars the longer the jars the greater the total extinct of the image of the spark and of the layers is shortened; the violet tints disappear, and the red tints become brighter. This shows that the intermittent luminous phenomenon does not depend on an intermittent excitation of molecules within the coil, but merely on an intermittent discharge of its end-surfaces: for with increase of the polar surfaces, and with production of the distance traversed by the sparks, the quantity of electricity of the reversal discharges is increased at the cost of their number. Exactly similar phenomena as observed on discharging Leyden jars with the intercalation of moist cards when the ends of the cards are connected each with a smaller Leyden jar just before the tracks of the sparks. The length of the entire image increases with the size of the surface of the layers.—*Göttingen Nachrichten*, iv., p. 315.

ON THE ELECTRIC DISCHARGE AS A CONTRIBUTION TO THE EXPLANATION OF THE PHENOMENA IN GEISSLER TUBES, AND TO THE REFRACTION OF THE PHOTOMETRIC RAYS. Dr. Oberbeck. (Pogg. Ann.—Jubelband.)—Tubes of 10—20 c.m. in length and 1—2 c.m. in width were closed at each end with cards, through which were passed copper wires. Bronze-powder was introduced; other finer powders which were tried adhered to the sides of the tube under the influence of the discharge in consequence of static charges. One wire was connected with the positive conductor of an electric machine, whilst the other permitted the supply of electricity to escape into the air. In certain cases the electricity was furnished by a charged Leyden jar, and the pressure of the air was that of the atmosphere. The bronze-powder displayed three very beautiful stratifications, which differed in their arrangement according to the original position of the powder. Around the positive pole there was formed a large space of air at first free from the powder, which was later collected at the negative pole. If the current had been allowed to pass for a time and the poles were then changed the strata disappeared and the chief part of the powder collected in the middle of the tube, probably owing to its static charges. The phenomenon agrees closely with Quincke's.

The author compares these distributions of the bronze-powder with the stratification of gases, showing that both are influenced by the same circumstances, such as the quantity of electricity passing at each discharge, the width of the tube, the charge of the outer sides, &c. With a repulsion of the particles similar to one the electrode could here be directly observed, the author considers that the stratification in Geissler's tubes depends on mechanical causes, as is assumed to be the case in Faraday's dark space. Hittorf has observed that the condensed strata are luminous. He explains the stratification from the fact that the electricity enters the tube, the sides and the gaseous molecules become saturated, and are repelled from the electrode and from the sides. The electrode moves the gas to the negative pole, and the sides of the tube impel it more or less towards the axis of the tube. From the reciprocal action of these forces results a strata like the disc-figures bronze-powder is chiefly accumulated at the negative pole, the author concludes that the maximum density of the gas in Geissler's tubes is found at the negative pole. He seeks to explain the stratification in flames, the figures of Lichtenberg, &c., on the same principles. The author appends some remarks on Crookes' experiments, which he explains in accordance with his views, and thus refutes the hypothesis of the fourth state of matter, but without submitting it to any thorough discussion.—*Beiblätter* (Wiedemann's), iv., No. 12.

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EXPERIMENTAL INVESTIGATIONS OF CHANGES IN THE ABSOLUTE TENACITY OF IRON WIRES PRODUCED BY THE ELECTRIC CURRENT.—G. Hoffmann.—An increase of tenacity was observed in iron wires after being traversed by the current. Wire which in its original state was able to support 68 grms. after a three hours' passage of the current supported 230, showing an increase of 238 per cent. With the elongation of the section of the current the increase of tenacity became greater till it attained a maximum which was reached earlier in some wires and later in others. Thus wires of 0·19 millimetre in diameter after a three minutes' passage of the current showed an increase of tenacity of 58 grms. after 12 hours' passage, 24 hours 50, another wire of 0·31 millimetres diameter after three hours showed a gain of 12 grms., after 6 hours 23 grms., and after 24 hours no further increase. The gain chiefly concerns the increase of tenacity in equal time-elements proportional to the strength of the current. The stronger currents this law is no longer realised, owing to the heating of the wires. Thus in the case of a wire of 0·19 metre diameter a 12 hours' passage of $0·07$ units of a deviation of 4° gave an increase of strength of 56 grms., one of $0·28$ grms., and one of $0·56$ grms. During the actual passage of the current the increase was greater. The author considers that the increase of cohesion is favoured by the heat evolved by the current, but that the current itself plays an essential part.—

THE polar difference in luminous phenomena of the discharge of electricity through gases were considered by Wiedemann and Rühlmann as possibly due, in part at least, to a gas layer (more or less condensed) on one electrode. Supposing that other kinds of envelopes with like action would essentially affect the phenomena, Herr Holtz has been able (*Wied. Ann.* No. 11), by covering one electrode, e.g. with silk, or (indirectly) sensitised silk dried before it, to verify the, and (since both solutions, in some cases, the other phenomena.

IN a series of experiments recently re-searches, by Herr Geissler, of Bonn, Herr Hittorf has more investigates the phenomena which take places in a space of the transmitted that the green phosphorescence of glass appears with the discharge from the cathode, there are, not only, two general cathodes. He has met with a new form of electrical illusion, not to be classified either with the mechanical repulsion in collision of pendentic masses, or with electrostatic or *elektrodynamic* repulsion. (An abstract of the memoir appears in *Wiedemann's Beiblätter*, No. 11.)

Manchester Guardian Jan
April 19, 1876

THE TIMES OF ELECTRICITY.—Mr. Alex. Adams, one of the officers of the British Post-office Telegraph Department, has discovered the existence of electric tides in telegraph circuits. By long continued and careful observations he has determined distinct variations of strength in these earth currents, which are invariably present on all telegraphic wires, following the different diurnal positions of the moon with respect to the earth.

80 New York Times, September 9th 1881.

A SAFFRON-COLORED SKY

A CURIOUS PHENOMENON AND ONE WIDELY EXTENDED.

BEGINNING IN CANADA ON MONDAY, IT SPREADS OVER NEW-ENGLAND AND PART OF NEW-YORK ON TUESDAY.

From the Toronto Globe, Sept. 6.

The one topic of conversation all over the city yesterday afternoon and evening was the wonderful appearance of the sky. Early in the forenoon the mercury had risen above 90° in the shade, and although the sky became clouded the heat was maintained long after darkness had commenced, the mercury in the city at midnight still being as high as 80°. At 3:30 o'clock in the afternoon the whole northern heavens assumed a rich orange hue, and the rest of the sky a yellow. The orange deepened and extended as the day advanced, till at 5 o'clock the heavens presented the appearance of an orange dome of extraordinary beauty. The streets and buildings wore an orange tint; in fact, nearly everything looked as though viewed through an orange glass. The gas was now lighted, and instead of its usual yellow, burned a brilliant white—almost as white as the electric light. As sunset approached the orange hue deepened on city and sky alike, and the streets were filled with an interested population gazing at the strange, weird glory of the scene, and indulging in all sorts of speculations—some of them terrifying—as to the cause of the unwonted spectacle. Bush fires were held responsible by some. Others said it was a solar eclipse. Orangemen jocularly claimed it as an Orange display a little late in the season, and thousands took a more serious view, and predictions of Mother Shipton's prophecy that

"The world to an end shall come
In eighteen hundred and eighty-one,"

mingled strangely with Grimmer's terrible predictions, and produced a dread in the breasts of thousands that the end of the world was come. Of course many knew that the phenomenon was simply due to the interception of the orange rays of old Sol, but between the anxious fears that the spread of bush fires throughout the Province was about to culminate in a whirlwind of flame which might destroy the city, and dread that the last trump was about to sound, a feeling of tremulousness prevailed, the like of which has not been known in Toronto for very many years. As a matter of fact, there was weeping and wailing in some homes, so great was the fear of disaster produced. With the lightness of the sky, which was lit up as with one uniform conflagration reflected through dense clouds, was a degree of darkness which compelled the lighting of gas and lamps all over the city long before the sun went down. Within half an hour after sunset the last trace of orange or red had disappeared, and the usual darkness of a cloudy, moonless night had set in.

From the Bangor (Me.) Commercial, Sept. 6.

Superstitious people when they looked out of their windows this morning thought the crack of doom had come and Mother Shipton's prophecy was about to be fulfilled. After the dark and rainy night the sun rose through a bank of yellow fog, and the sky had the appearance of an inverted drum of brass, the air was close and oppressive, every one felt dull and depressed in spirits. Every object assumed a yellowish tinge, and the fairest complexion was changed to a tawny hue, as if all persons were suddenly afflicted with jaundice. After a few hours the fog changed to a gray color and the sky to a leaden hue, and toward noon the sun burst forth with a burning heat. At noon the mercury had risen to 8° in the shade, which figure did not, however, indicate the degree of heat felt by human beings. In the afternoon the sky assumed a smoky aspect, and the air was oppressive and sticky.

From the Portland (Me.) Press, Sept. 7.

The citizens of Portland experienced a genuine London fog yesterday, or as near that as we ever came in Portland. The air was filled all the morning with a heavy fog mixed with smoke. Until noon people were unable to read easily, either print or writing, without the aid of gas. The gas was lighted in this office and the principal stores until 11 o'clock. The light was of a yellow tint, the heavens being the color of old gold. When the gas was lighted the flame looked white like that of the electric light. In the schoolhouses the children had to be dismissed, as they could not see to study. Some people thought the light was ominous, betokening the dissolution of the President; others that the globe was passing through the tail of a comet. Later the yellow in the fog brought out the entire landscape to its utmost intensity. Every separate spear of grass and every green twig stood out in bold relief against the sickly yellow background. In the afternoon the atmosphere became natural in color, but the fog continued and the air was very close and hot.

From the Boston Journal, Sept. 7.

The famous Black Friday of 1780 will no longer stand alone in the history of New-England. Yesterday was a companion day and will be as long remembered. Its gloom did not strike such terror into the hearts of the people as did that of May 19, 1780, but it found its way into timorous souls to a considerable extent, and there were probably more people filled with wonder and dread than would be willing to confess to the fact. The day was an exceedingly uncomfortable one, although the mercury did not climb to an extraordinary height, the oppressiveness arising from the extreme humidity of the atmosphere combined with an ordinary Summer temperature. At an early hour in the morning a very peculiar appearance was to be perceived in the air. No fog or haze was perceptible, except when looking off toward the horizon from an elevated position, but the sun was thoroughly obscured and the atmosphere was pervaded with a yellowish light which lent a strange appearance to every object. There was a weird lustre to the surface of the streets and the fronts of the buildings. The aspect of the sky was such that some timorous people's minds were directed by it to the Scriptural prophecy concerning the brassy appearance of the sky, which is to be one of the features of the "last day." The interiors of buildings grew dark as the day advanced, and the outer air as viewed through a window seemed to be pervaded with the reflected light from some vast conflagration. It became necessary to light the gas in stores and offices, and the jets emitted a white flame that strongly resembled the electric light. The faces of people in the street were of a deep saffron color, as if jaundice had begun to show its work in complexions tanned by a Summer of exposure to wind and sun, and some skins even displayed the tint of those yellow beach shoes which have of late come into fashion. A few buff dresses seemed as yellow as dull gold, and the grass took on a rank and metallic hue like verdigris. The phenomenon became more marked in the afternoon than it was during the forenoon. As late as 1 o'clock it was possible for a person sitting near a window to see to read or write without the aid of artificial light, but after that hour the gloom deepened rapidly. The sky grew still more brazen in appearance, and the gloom was that of late twilight. The front windows of stores on Washington-street were illuminated as at night, and there was not a single usual aspect of the daytime to be seen in any direction. There was something terrible in the scene, and it is not to be wondered at if some weak minds allowed themselves to be tormented by fears of what the extraordinary event might presage. The climax was reached at about 3 o'clock, and after that light began gradually to return, although perfect daylight was not restored. At 5 o'clock the ruddy glare had disappeared from the sky, and the light, such as it was, seemed more natural than during the day. Before 8 o'clock the moon had come out, the clouds had disappeared, and the atmosphere had resumed its normal condition.

Dispatches received last evening show that practically the whole of New-England experienced the same visitation. It is reported from Block Island, Cape Cod, and Hartford, to the south and west, and from nearly all parts of New-Hampshire and Vermont. Business was in a great many instances suspended, and schools were dismissed because of the lack of illuminating facilities. Among the ignorant there was considerable fear of terrestrial catastrophe, while others foresaw a tornado. A Hanover (N. H.) dispatch says: "Prof. C. F. Emerson, Professor of Natural Philosophy and Astronomy at Dartmouth College, says it must be something in the atmosphere which absorbs the shorter and longer wave lengths, leaving only those which give the color of yellow and green. He thinks it may be owing to the pollen from fir and pine trees, together with smoke from the forest fires in Canada."

Of course there were many inquiries as to the cause of the strange phenomenon. Sergt. B. M. Pursell, who has had charge of the United States Signal Office here during more than two years past, expressed the opinion that it is smoke resulting from forest fires, and he finds a basis for this opinion in the fact that there has been a severe drought in the West this Summer. He also thinks it possible that decaying vegetation may have something to do with the matter. At the Harvard Observatory, while disclaiming any professional knowledge of the origin of the phenomenon, the astronomers are inclined to attribute it to the Canadian fires. They think that smoke may have been carried up and caught by the upper current of the air, and that the darkness was intensified by the excessive moisture of the lower atmosphere.

From the Fall River (Mass.) News, Sept. 6.

A phenomenal day, such as the present generation has hitherto never seen. It is a peculiar day, for the barometer is normal, (29.75,) and very nearly stationary; yet the smoke creeps the ground. The atmosphere is in a state of nearly complete saturation, fully 90°; thermometer, 76°. The wind was moderate, say eight miles per hour, from 7 to 11 A. M., but since then (now 2 P. M.) it has been two miles per hour. The color of the light is a greenish-yellow one, which makes the gas-lights look like the incandescent electric lights. It is a day to remember as phenomenal, and when we hear of the dark day early in this century we now have one to nearly match it. The probable cause is the bush fires in Canada. Yet it is a different light entirely from that of last Thursday. The water that fell then was sooty in its taste, indicating the mass of smoke above.

From the Providence (R. I.) Journal, Sept. 7.

Yesterday's strange cloud was not confined to this city and its vicinity, but seems to have extended over a large area. Travelers from various points in New-England arriving here last evening reported that it had been ever present above them during the day. One peculiarity in the appearance of things, and which was naturally most prominent in the country districts, was the unusual hue given to grass, foliage, and all green things. The green seemed to be very much deepened and brightened, at the same time giving off the faintest suggestion of a bluish tinge. Well-authenticated instances of hens going to roost, as in 1780, of birds seeking their nests, of the appearance of bats and the chirping of crickets are related. Up to the hour of sunset the appearance of the sky remained about the same as it had been throughout the day. In the early part of the evening, however, the clouds lightened up and in a brief space of time had entirely disappeared, the darksome day being followed by a bright moonlight evening.

From the Poughkeepsie Eagle, Sept. 7.

The intense heat of yesterday was the subject of general remark, the mercury reaching 95° in the shade. The peculiar color of the atmosphere in the early morning attracted attention, the yellowish tinge being caused no doubt by smoke from burning forests. In the afternoon there was a southerly breeze, which at times was quite refreshing, but generally speaking the heat was very oppressive.

From the Utica Herald, Sept. 7.

From daylight to 9 A. M. yesterday the sky was covered with a deep mist of a dull, yellowish hue, which shut out the effects of the sun's rays almost completely. The sky brightened, however, about the middle of the forenoon, and the sun made up for the peculiar action by sending its rays with redoubled force. In the eastern part of the State this phenomenon continued throughout the day, and in a greater degree than in this vicinity. The grass was made to appear as of a dark green color, and the general appearance of the surrounding atmosphere was such as to alarm the superstitious. In Schenectady the schools were closed, and in Troy work was suspended in many places. The *Herald's* Boonville correspondent says: "Yesterday morning the sky in this neighborhood presented a most unusual and striking appearance. About daybreak it was crimson, changing later to an orange, and then a lemon hue. This continued until after 9 o'clock. It was also up to 9 o'clock so dark that lights were quite necessary in-doors."

Passengers from the St. Lawrence report that the peculiar condition of the atmosphere was more marked on the Canadian side of the river than further south. The description given in the telegraphic reports from Boston corresponds with the appearance of the Canadian skies. The ghastly lines of the electric light came to mind at once, and are mentioned in the reports of nearly all observers. Superstitious people were greatly frightened, and some people are said to have prayed who have not paid much attention to their devotions of late.

At Glendale the entire face of nature assumed a yellowish hue, and all were enveloped in darkness up to 9 o'clock. At 8:30 lamps had to be used in all the houses here. At Lowville, where later in the day the thermometer was 94° in the shade, the same general appearance was noticed, and at Watertown it was a subject of remark. At Syracuse and Oswego and all along the St. Lawrence it was very noticeable. A ghastly yellow and pale sickly green were the colors which seemed to fill the heavens.

From the Boston Advertiser, Sept. 7.

The hypotheses of an approaching cyclone, of the realization of the Apocalyptic vision, and of the fulfillment of the beldame's prophecy having been dismissed, the theory of the learned is accepted on all sides. In brief that theory is, that the saffron curtain that hid the sky was composed partly of fog, but mostly of smoke; that it passed along at great height above the earth's surface, which explains the absence of any smell of smoke; that this smoke originated in the extensive forest fires which for several days past have been raging in parts of northern New-York and in Canada; that the intense heat of these great fires produced a volume of hot air which reached a great altitude; that the smoke thus gained a lofty atmospheric stratum, and, quietude prevailing in the strata below, its mass was undisturbed, and it floated slowly toward the sea in one dense cloud, overspreading all New-England, being propelled to its oceanic destination by the ruling atmospheric current of high altitudes in this section of the country, which moves from west to east, deflecting somewhat southerly; that the thin edge of the cloud passed over Albany and the Long Island Sound region, the denser part of it being on the northern side, so that while it is chronicled as fog at Portland and Eastport, it was doubtless the density of it in that section, a density which the sun's rays could not penetrate, that relieved it of the yellowish cast it wore in central and southern New-England. By 5 P. M. it began to show a thin edge at Boston, and by 8 P. M. the stars were visible in the zenith.

the Albert Dock pass into an expansive basin 500 ft. in front, and 650 ft. wide. The bottom is firm bowlder clay, into which are driven two marine locks with buoys attached, for the purpose of swinging vessels into or out of their berths. Beyond this wide space there are two open basins 1,000 ft. each in length and 200 ft. in breadth, separated by a jetty 250 ft. in width, and entered from the west side. The west end of the jetty is pierced in the center by a fine graving dock, 300 ft. in length, 48 ft. wide at the bottom, which is paved with 4 ft. of concrete, and 70 ft. wide at top cope, which is reached by five altar courses. There will be 20 ft. of water on the sill, and the dock will be opened and closed by means of four crab winches, worked by hand. The dock can be rapidly emptied of water by a centrifugal pump at the engine-house near the gates, in which are two small sluices, as well as a large one, 4 ft. square, by means of which the dock can be filled with equal expedition. At the east end, there are two flights of steps from top to basement, with timber slips on either side. The graving dock is built of Craigmillar stone, with copings of Aberdeen granite. The total amount of masonry is over 100,000 cubic yards; the facework, 26,000 superficial yards; copings, 40,000 cubic feet; ashlars in foundations of swing bridge and entrance to graving dock, 50,000 cubic feet. The north and south quays are each 1,500 ft. in length. These, together with the accommodation afforded by the jetty, bring up the total quayage in connection with the new dock to 6,775 ft. All round the quay, 50 ft. apart, there are mooring bollards, and the walls of the dock at similar distances are strengthened by counterforts, hidden buttresses having 10 ft. of additional masonry. The walls faced with Craigmillar stone are 15 ft. thick about the base, narrowing in two tiers to 8 ft., inclusive of the above-mentioned additional buttresses. Between the walls and embankment there is a bed of from 5 to 7 ft. of clay, which is calculated to keep the works perfectly water-tight. The walls of the dock have been built throughout with blue lias lime, brought from Lyme Regis, in Dorsetshire, the stone being burned at the works, slaked, and mixed in mortar mills under heavy rollers. The new dock will cost altogether about £350,000. The works have been under the superintendence of Mr. Alexander Clark, C. E., engineer for the contractors, since their commencement.

MARVELS IN ELECTRICITY.

A correspondent of the *Parisian* thus describes some of the notable features of the Paris Exhibition of Electrical Apparatus, now in progress:

The immense nave of the Palais de l'Industrie is filled with all important material of electric science. It may be reached by a small electric railway, on the Siemens' system, starting from the Chevaux de Marly, on the Place de la Concorde, and entering the palace near the Pavillon de l'Horloge. The road runs parallel with the avenue, and drops its passengers in the center of the building. The trains consist of two saloon carriages, of the usual dimensions, and a small electric motor, which takes from the rails the fluid supplied by generators at the end of the line. In the nave is a small pond, several square meters in area, in which a miniature steamer will lay a miniature submarine cable on the Colas system. In the basement of the building will be illustrated all varieties of such cable and wire manufacture, adjoining, but not forming part of, the official part of the exhibition, which will comprise all forms of governmental electric apparatus, manipulators, receivers, piles, telegraph posts, isolators, switches, and a thousand other matters of necessary detail in the complicated system of commercial or military telegraphy. Towering above the whole nave is an immense lighthouse, the perfected result of the Serrin system, the style adopted by the State of La Hève, and to be employed in the constructions planned by M. de Freycinet.

By daylight the spectator may watch the operations of a whole army of telegraphists, machinists and other electric specialists, each in his own niche, while at night this swarm of operators and motors is lighted by the blaze of a thousand electric lights streaming from the roof—a grand composite of all known systems—Jablochkoff, Werdermann, Jamin, Siemens, Gramme, Lontin, Nouillon, Maritens, Suisse, Wilde, Brush, Swan, Edison, Maxim, Arnaud, Crompton, Brockie, etc.—some in globes, others diffused by enormous Balestriori reflectors. Force is supplied by magnetic and dynamo-electric generators amounting to 1,500 horse-power. The Pavilion of the city of Paris is adorned as for an art exhibition. Statues and hangings are replaced by fire alarms, electric dials, municipal and police calls, etc. Prominent rivals of the government are the five great railway companies, with their systems for stoppage and signaling, their electric brakes, train registers, calls and alarms, besides a singular carriage, at work on the Eastern Line, and invented by Messrs. Deprez and Napoli, for observing the running of trains, and registering velocity, traction, force of wind, consumption of steam, etc. The basement region offers also the surprising and novel results obtained by the recent labors of Messrs. Cabanellas, Hospitalier and Deprez, in the matter of electric division, transportation and distribution, a department in which the French school has been successful.

So much for the basement, the region of science and practical utility. The upper story has been devoted by the chief Commissioner to scientific curiosities and fanciful inventions for the delectation of the curious but untechnical observer. Two telephonic auditoriums have been arranged to connect, one with the Opéra and the other with the Théâtre Français, richly furnished, and supplied with some 50 telephones each, where the auditor, calmly seated in his arm-chair, may listen to the sonorous recitative of M. Villaret, or the bright dialogue of Croizette and Coquelin. In adjoining rooms the visitors may talk through the Herz telephones with distinct cities like Lyons, Orleans, Dijon, or a dozen others. Next comes a series of eight rooms, literal copies of a Parisian apartment of the present day, where everything will be, so to speak, run by electricity. The kitchen is to be lighted by electric lamps; the range heated by electric currents passing through water; a half-dozen electric cooks, by means of incandescent platinum wires, turn out "electric waffles," and electrically heated metallic plates serve for braziers and chafing dishes. The dining room is fitted out with all the wondrous new apparatus which already threatens our peaceful firesides with its novel blending of science and comfort. The central sunlight, in place of a chandelier, may be lighted by the pressure of a button or the opening of a door. The dishes will be brought up on an electric dumb-waiter; doctors, errand-boys, firemen and servants can be summoned by the familiar New York system of dials and calls. The only thing left to do would seem to be to eat by electricity, and, in view of the wonders accomplished, even that seems not so very improbable.

The third room—the parlor—is furnished with electric chandeliers, mantel clocks going by electricity and adorned with electrical groups and figures, telephonic speaking tubes and electric fire-places. In the billiard room adjoining, an electrical billiard table enables the player, if not to make his carroms, at least to mark them by an electrical indicator. It would be a pleasant policy to add to these rooms an electric chair for the extinction of the persistent bore. You take the idea? Your bore is comfortably seated, smoking and talking you to death. A light touch on a knob. Crack! your bore is wrung with internal convulsions and set upright on his legs. *Exit ex necessitate.* Seriously, however, the parlor has an electric piano, to be played by "some other fellow" at a distance, and having a Carpentier melograph to make electric record of improvisations. The bedroom, besides all sorts of electric calls, has on the toilet table a set of electric brushes. You turn a commutator, offer your head to the gentle caresses of the brushes, and your hair is brushed—if you have any. The series of rooms closes with a family theatre—stage, auditorium, flats and all—lighted by the Werdermann electric lamp, which allows the footlights to be instantaneously raised or lowered, filling the room with a blaze of illumination or leaving it in total darkness at will. In this pleasant room noted Parisian musical artists will give concerts, to more completely electrify the audience. Finally, a room is devoted to electric views, projections and toys; miniature telegraphic apparatus, trick boxes, magic lanterns, railways, telephones, dolls and automata, for the amusement of Parisian youth and their elders as well.

One of the important industrial inventions which Americans have sent is the electric middlings purifier, the most perfect method known of separating the bran from the middlings. This is usually done by air blast, which blows out the bran. The defects of this system are that much of the fine flour is blown away, and the mill is filled with the fine dust that sometimes causes an explosion. Mr. Kingsland Smith, an American miller, first devised an electrical separator. When a bit of hard rubber is rubbed with a brush it will attract any light sub-

Menlo Park Scrapbook, Cat. 1029

No. 19. "Phonograph"

This scrapbook covers the period April-July 1878; there is also one clipping for June, 1877. Most of the clippings relate to the phonograph, but the book also contains material about the telephone, microphone, and electric pen. There are also several articles about Edison and Menlo Park and, on page 110, copies in Edison's hand of two telegrams. The book contains 182 numbered pages.

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THE TELEPHONE—THEORY AND PRACTICE.

[14251.]—I HAVE, almost from the first, read the articles and letters appearing upon the telephone in your invaluable journal, and derived much useful information from the various hints and suggestions from time to time made. In common with so many of your readers I have made numerous experiments with a view to improving the efficiency of this most interesting instrument; but so far, it is scarcely necessary to remark, with very little success. As the result of some of these efforts has seemed to throw light upon certain matters previously unnoticed in your columns, the facts may, perhaps, prove of interest. There has been, and perhaps still is in some minds, a doubt as to the cause of the sounds produced in the receiving instrument. In fact, a sort of molecular vibration and mechanical vibration theory controversy seems to have arisen. While admitting that there is some foundation for the former, the latter theory will, doubtless, be eventually adopted as the real explanation of the phenomena.

Experiment conclusively proves that magnets affected by even the weak induced currents, sufficient to produce sound in the telephone, also make a very faint effect upon the receiving magnet itself. A convenient means of proving this is to suspend a bar magnet, with its bobbin attached, in a cigar-box, from which the lid has been removed. The thread holding the magnet should be tied to thin bars of wood, having their ends resting on either side of the box. On passing a current from a very weak cell, filled with pure water only, a faint but unmistakable tick will be heard every time contact is made and broken. This sound is much increased on attaching a piece of iron or steel to the magnet. So much for the molecular theory. Mechanical vibration of the plate seems so probable from the facts already brought to light that a short résumé of them can scarcely fail to prove convincing. Experiment has proved that increased thickness of plate does not lead to augmentation of sound, and diminution of same makes but a slight difference. If the vibration were actually molecular, the thick plate should give the best result, owing to the larger number of particles in a given exposed surface, all of them influenced by the induced currents passing along the wire. A reasonable explanation of the action of the telephone, however, lies in a very narrow compass—proportion of thickness of plate, implying as a necessary consequence a certain natural elasticity capable of resisting up to a certain point, and within limits to be at some future date accepted as a law of the magnet, to overcome this inherent power of the plate, the most satisfactory results being obtained when these opposing forces are in a state of equilibrium.

This is readily proved by using plates of various thickness with the same magnet, the distance of diaphragm from magnet, remaining constant. It will then be found that, provided the magnet is of sufficient power to obtain good results from the stoutest of the series, its distance will have to be gradually increased to produce a like effect upon substituting the members of the series until the thinnest is used—the distance of magnet having been increased on the substitution of each diaphragm.

Quantity of wire on bobbin must also be varied for strength of magnet; but this, the actual source of power, is subject to infinitely greater variation than relative strength of magnet to thickness of plate—fifteen yards of No. 30 wire producing a sound equal to 250 yards of No. 36. Power of bar magnets compared with horseshoe form:—The best of the former are only capable of holding—say, twice their own weight. All lengths and diameters leave little to choose. After testing all those sold by best London makers, some cheap horseshoe magnets at 2d. each were procured. One of them sustained a weight of 8 ounces—length of magnet 1¾in. Three of these were bound together with thin No. 36 copper silk-covered wire, and compactly cemented, after winding, with gutta percha. Lifting power of this combination ¾ of a pound; on trial with ordinary 1¾in. diaphragm at distance 1-32in., no distinct sound was obtained; on distance of magnet being doubled, ordinary conversation could be heard, but not so well as with bar magnet. On increasing distance better result was obtained. Substituting a 4in. plate of ordinary tin, a splendid sound was obtained, the distance from magnet in this case being 1-32in. This points to another law regarding the transmission of speech—that the diameter of the magnet of a certain strength bears a proportion to size and thickness of plate exposed to its influence. These facts all point to the verification of the theory of mechanical vibration of the diaphragm. Another step in the same direction is gained by the combination of electrical and string telephone to which attention was directed by M. Brequet in the ENGLISH MECHANIC some weeks since.

Material for diaphragm seems to be of little consequence provided iron, steel, ferrotype, and tin plates are made use of, and the conditions of distance from magnet, &c., previously noticed, are carefully observed. The material of which the case is formed is again unimportant, provided means for holding plate firmly by its circumference and of adjusting and holding magnet are observed. Shape of mouthpiece is, however, a matter of first importance. The ordinary form of Bell's telephone is faulty as not possessing a sufficient aperture to include all vibrations arising from the utterance of the infinite variety of sounds comprising articulate speech. The exposed surface of the plate must be at least 1¾in. A cone of this diameter next the plate, ¾in. long and 2in. at greatest diameter, will render even reading at ordinary rate perfectly clear—a result to be looked for in vain in Bell's most perfect instruments. Augmentation of sound:—It being allowed that very minute, in fact almost imperceptible vibrations of diaphragm will produce an effect upon the ear sufficient to give the effects of quality and timbre of voice. It is prudent that unless by some means not yet discovered, the amplitude of these vibrations can be increased, no greater sound can be obtained. Power of current:—This, as is already known, is almost inappreciable by any previously-known tests, but by a remarkable coincidence the telephone has proved itself a most delicate galvanometer.

The very small electro-motive force developed by two thin wires, one of iron the other copper, immersed in pure water for a depth of half an inch, producing a sound in the diaphragm on breaking and making contact, showing the passage of a current so feeble as scarcely to affect a delicate reflecting galvanometer, but yet audible in the telephone. Practical difficulties seem to have beset the path of many correspondents who have asked questions on the construction of the telephone. Attention to a few points necessary to be observed in the construction of all electrical apparatus would have prevented the occurrence of cases of disheartening failure. A most essential point is care in the winding of coils, more particularly when very thin wire is used. This may break, and the point of fracture pass unnoticed. Joints in wire should be carefully soldered, and wires soldered to binding screws. A small spoon of tin, holding half an ounce of solder melted over a spirit lamp, will be found the most handy appliance. Wires should be scraped clean and rubbed with powdered resin. When solder is melted, insert the point of junction of wire and move gently about until the wire is just covered; a little practice will determine the proper moment for withdrawing it. Wide bobbins ¼in. inside width seem best—cardboard will do as well as wood for the material of which they are composed. Best material for plates seems to be ferrotype, carefully cut to a true circular form. Varnish on both sides left untouched. Line wire for short distances may be any size from No. 40 (thin) to No. 16 thick. It is, of course, to be borne in mind that thin wire offers a resistance to the passage of currents increasing with smaller diameter; thus a wire ¼in. thick and one hundred yards long will offer no more resistance than 25 yards 1-16in. thick, insulation being equal. Earth wires instead of double line wire may be used with advantage in most cases. Good earth connection may be obtained by thrusting an old knife in the ground in a damp place, and soldering end of wire to same. Distance of magnet from diaphragm, as already noted, must be determined by experiment in each case, and no particular rule can be safely adhered to.

The question of size of instruments is again one in which wide limits may be observed. Plates one inch in diameter, fitted in the top of small boxwood boxes, give satisfactory results, especially in the transmission of whispers; louder sounds are beyond their capacity. As curiosities, for carrying in the pocket, they are, however, very interesting. Magnets should be made to take out, and adjusted by a collar of cardboard glued round them.

It is hoped these items, the result of a long series of experiments, may prove of interest and save the time of fellow-workers in this most interesting field of research. That the telephone is destined, when brought to perfection, to effect a revolution in the employment of telegraphic instruments, and, in our means, social enjoyment, there can be little doubt. There is, however, a great scientific value attached to the discovery of so delicate an instrument for the detection of exceedingly weak currents of electricity. Besides this the telephone opens a wide field of speculation, and the facts it has brought to light may at no very distant future date lead to the adoption of other instruments capable of assisting other senses besides that of hearing.

R. W. J.

PHONAUTOGRAPH.

[14252.]—NOTHING better than Swedish pitch for your slides; it will hold very tenaciously. I take this opportunity of thanking "J. R. H." for his kindness. I have shown the slide to a few scientific gentlemen who have been much pleased with it.

Edison's carbon telephone has been eclipsing the performances of its rivals by carrying spoken messages from New York to Philadelphia in perfectly clear and distinct tones. The new telephone derives its name from a small circular cake of carbon fixed in the mouth-piece between two metallic plates, to which the positive and negative poles of a small battery are respectively connected. Complete details of the apparatus have not yet been published, but it appears to have answered remarkably well at the first practical trial.

The Phonograph has been exhibited at the Crystal Palace, and the newspapers give descriptions of its performances. In most of the reports it is said that the action of the machine "is reversed" to reproduce the speech. Of course, the action is exactly the same as when the indentations in the foil were made by the vibrations of the point connected to the diaphragm spoken against. It is only when a different diaphragm is used to reproduce the sounds that any change in the motion is required, and it is obvious that the reproducing point must traverse the foil in exactly the same way and at the same speed as the point of the transmitting instrument.

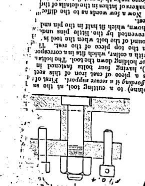
THE ELECTRIC PEN AND THE BLIND.

[14265.]—I HAVE lately had occasion to use the patent electric pen, and the idea has occurred to me that this instrument could be very suitably used by or for blind persons. I mean that the punctured writing (at present used as a stencil, from which numbers of copies are printed) could be used as an original communication. Any one acquainted with the electric pen will understand this. The pen, while writing, makes about 150 punctures per second, and these punctures naturally make raised surface lines on the paper of the shape of the letters formed.

I think that such outlines could be easily felt and traced by the delicate and practised touch of a blind person. Thus any communications may be intelligibly conveyed to and from the blind.

Jib.

(To be continued.)



Washington Evening Star Apr 19-78

1029

National Academy of Sciences.

AN INTERESTING SESSION YESTERDAY—EDISON, THE MODERN MAGICIAN, UNFOLDS THE MYSTERIES OF THE PHONOGRAPH.

At the scientific session yesterday a paper on "The Effective Force of Molecular Action," was read by Prof. Norton, and discussed by Professors Peirce and Alexander. Next came a paper entitled "Remarks on the Value of the Results Obtained for the Solar Parallax from the English Telescopic Observations," by Prof. Peters. This paper caused a lively discussion among the astronomers on the subject of the varying estimates for the parallax of the "great gas ball fluctuating within narrow limits," called the sun. Prof. Newcomb, in referring to the "black-drop" theory, said that at one time the question of the nature of the black-drops on the sun was almost an international one, and that many Englishmen thought that speaking disrespectfully of the black-drops was almost as bad as speaking disrespectfully of the Queen. It looked, at one stage of the debate, as if the "black-drop" controversy would be repeated in the academy. After Prof. [illegible] had read an essay on "The Vertebrate Fauna of the Permian Period of the United States," pointing out their similarity to specimens found in the Ural mountains,

MR. THOMAS A. EDISON,

the celebrated inventor, appeared by invitation before the Academy, and with him came the phonograph and carbon telephone, which have made his fame world-wide. The secretary's room and the adjoining halls were now crowded with an interested and excited gathering of ladies and gentlemen. The doors, which led to the room adjoining the hall where the scientists have regaled themselves daily with salmon and other brain food, were taken from their hinges in order that there might be "room for one more" to get a peep at the modern magician and his wonders. The eyes of grave academicians, fair ladies and eager children were all turned curiously on one man. The occasion was a tribute of science, culture and beauty to inventive genius.

EDISON IN PERSON.

The inventor sat at the secretary's desk twisting a small rubber band nervously in his fingers. His shaggy brown hair stood out at all angles in defiance of comb rule. His forehead was broad rather than high, and between his eyebrows, which were somewhat lighter in color than his hair, a crease appeared, which deepened when he spoke. He had no beard. His eyes were light gray, his nose prominent, and his complexion of moderate clearness. He looked the mechanic straight from his workshop, plainly dressed and cuffless. Prof. Geo. F. Barker introduced Mr. Edison, referring to the fact, that the members of the French Academy had lately been thrown into extraordinary excitement by the presence of the phonograph, and adding, that this Academy had now before it, not only the phonograph but also its inventor. After a few remarks of welcome by Prof. Marsh, the presiding officer, the wonders of the phonograph were unfolded by Mr. Edison's assistant.

WHAT THE PHONOGRAPH IS LIKE.

The instrument was placed on the president's desk. It is composed of a cylinder, on which appear spiral grooves, and which is connected with a crank by which it may be turned, and a diaphragm over the cylinder, showing on the outer side a mouth piece, and on the inner a steel point. The cylinder was covered with tin-foil and set in motion. If no words had been spoken, the steel point would merely have pressed the tin-foil into the grooves of the cylinder and formed a regular indentation. But words spoken in the mouth piece caused vibration in the steel point as it indented the tin-foil. When the machine was reversed and the steel point placed where it commenced its journey, as the cylinder again revolved, the same vibrations were produced in the steel which originally caused the indentations, and were translated into sound waves and spoken from the mouth piece. When words were uttered in the mouth piece, the sound waves caused vibration in the needle or steel point and indentations in the tin-foil. When the steel point was again passed over the indented tin-foil, precisely the original vibrations were produced, which by a reverse process were converted into sound waves and faded from the mouthpiece as speech. Thus the process was entirely mechanical. Into the mouthpiece of the instrument Mr. Edison's assistant sung and shouted and whistled and crowed, and in a few minutes the same sounds floated out upon the air faint but distinct. "I declare," said one who had heard it before, "it sounds more like the devil every time." There was something weird and uncanny about the little machine as it expressed itself in articulate language, and more than one little girl in the audience crept up closer to her protector as the awful hush that preceded the phonograph's remarks was broken by its far off utterances. The impressiveness of the scene was heightened by the appearance of two pallid faces without any visible support over the top of a large photographic picture in one corner of the room. A second look revealed the fact that the eyes, which were glaring down on the marvelous phonograph, belonged to two young men whose curiosity had caused them to perch in a window partially concealed by the large photograph. Just as the assistant was remarking in a bass voice to the phonograph on the subject of Uncle Ned that "he had gone wh—," the tin foil gave out and the line remained unfinished. One of the audience, not a member of the Academy, however, suggested that the line be completed by adding the words "where tin foil fuses."

Prof. Barker then told in a picturesque way

THE STORY OF THE TELEPHONE.

The peculiar point about Mr. Edison's invention is a little plate of carbon in the instrument, on which its efficiency depends. Carbon is susceptible to a difference in conductivity by a change in pressure. Mr. Edison has succeeded in discovering a kind so suitable for his purpose that pressure of the most extreme delicacy, even the slightest breath may be detected. He is the discoverer of the principle on which his telephone operates, and not simply an inventor. Examples of the different telephones were shown, and the members of the Academy by their means carried on a conversation with some one in Philadelphia.

"A report of Progress on the subject of Oxygen in the Sun," by Dr. Henry Draper, brought the scientific session to a close.

A TALK WITH EDISON.

The inventor is shy and shrinking, and did not show off at all ornamentally in the kind of reception which he was compelled to hold after the exhibition was over. His deafness is an embarrassment to him in this connection. As Prof. Barker said of him, "He is a man of deeds not words." In reply to a remark of a representative of THE STAR, referring to the number of people who had been pressing upon him for an introduction, he said: "Yes, I don't like these crowds. I can't hear for one thing. Now, when the president welcomed me in the academy hall I didn't hear a word he said. So, if I had wanted to, I could not have replied." Referring to the fact that Mr. Ford had invited him to attend the theater in the evening, THE STAR man asked: "Is it impossible for you to hear at the theater?"

Edison.—"Oh, no! I have invented an instrument, a sort of improved ear trumpet, with a large air chamber, and a tube which gradually decreases in size, whose end is inserted in the ear, with which I can hear perfectly well. I sat as an experiment once as far back in the the theater as I could get, and yet I heard with perfect distinctness. I can hear more plainly

THROUGH MY TEETH

than through the external ear. A stick touching a music box and placed between my teeth enables me to enjoy the music. By touching the telephone receiver to my teeth I can understand a message."

Star.—"Have you ever been in the city before, Mr. Edison?"

Edison.—"Oh yes! I was here for several weeks once. When I am here I am around the Patent Office, principally. I have a whole case there to myself, containing 138 models of my inventions. Many of these, however, are only protective of those of importance."

Star.—"For what purposes is the phonograph practically available, Mr. Edison?"

Edison.—"The instrument I have here is only useful as showing the principle involved. It reproduces words only one-third or one-fourth as loud as one I have in New York. But I expect to have my improved phonograph ready in four or five months. This will be useful for many purposes. A business man can speak a letter to the machine, and his office boy, who need not be a shorthand writer, can write it down at any time, as rapidly or slowly as he desires. Then we mean to use it to enable persons to enjoy good music at home. Say, for instance, that Adelina Patti sings the "Blue Danube" into the phonograph. We will reproduce the perforated tin-foil on which her singing is impressed and sell it in sheets. It can be reproduced in any parlor."

Star.—"Will the voice be reproduced with equal fullness?"

Edison.—"With about one-half the original volume, sufficient to fill a parlor. It would be about three times as loud as the reproduction by the phonograph which you heard to-day. Then in the same way the tones of a great elocutionist can be preserved and heard. I saw the president of the American Philological Society the other day, and he had a conversation with a Portuguese who was in the room through the phonograph. He wants one of my improved phonographs to preserve the accents of the Onandagas and Tuscaroras, who are dying out. One old man speaks the language fluently and correctly, and he is afraid that he will die. You see, one man goes among the Indians and represents the pronunciation of their words by English syllables. Another represents the same words differently. There is nothing definite. The phonograph will preserve the exact pronunciation. The president of the Philological Society means to travel with it among all of the North American tribes."

Star.—"Your improved phonograph substitutes a disc, for the cylinder, does it not?"

Edison.—"Yes, the tin foil is stretched over a rim of straw board soaked in alum, like the head of a drum. One thing that I have got to discover is how to send the indented tin foils by mail, in such a way that they will not be injured, and yet will not make a cumbrous and [illegible] package. I do not see yet exactly how this is to be done, but it will be possible, I think."

Star.—"Is it impossible that a way may be devised by which the indented tin foil can be translated by the eye or fingers, so that the deaf may profit by the invention?"

Edison.—"I do not think that it can be done. The same word even when pronounced by the same person, presents at different times an entirely different appearance to the eye. You say 'phonograph' naturally, and then put your hand to your cheek and say 'phonograph,' and the indentations have no resemblance."

Star.—"How many words can you get on a tin foil that would cover the cylinder of the instrument you have with you?"

Edison.—"It is possible to put 48,000 words on a tin foil of that size."

Star.—"Have you made any recent improvements or discovered any new applications of your instruments?"

Edison.—"Well, nothing recently, so far as the phonograph is concerned. Night before last I found out some additional points about the carbon which I use in my carbon telephone. It may be used as a heat measurer. It will detect one fifty-thousandth of a degree Fahrenheit. I don't know but what I can make an arrangement by which the heat of the stars will close the circuit at the proper time automatically and directly. It is a curious idea that the heat of a star millions of miles away should close a circuit on this miserable little earth, isn't it? But I do not think that it is impossible."

Star.—"Will you go to Paris this summer, Mr. Edison?"

Edison.—"No, I will be busy in getting out my improved phonograph. But I expect to go next year. I have an exhibit there. I will send over the quadruplex, the phonograph, the carbon speaking telephone, the musical telephone, the electric pen, the automatic telephone and possibly the aerophone. The French are very enthusiastic in the matter of these discoveries."

In conversing at his ease and on subjects in which he is especially interested, Mr. Edison's eyes light up, his chin becomes firmer, his whole face grows more animated, and he speaks forcibly and impressively.

In the evening many of the members of the Academy visited the United States Observatory, and gazed at the stars through the "big telescope." They were hospitably entertained by Admiral and Mrs. Rogers. Mr. Edison came late in the evening, after exhibiting the wonders of the phonograph to a large gathering of newspaper men at the *Philadelphia Inquirer* office. Rather more levity characterized the remarks of the phonograph to this assemblage than to the Academy of Sciences. Mr. H. C. Ford, of the National Theater, was present with a cornet player, who tooted into the mouth piece of the instrument. The audience were highly pleased with the phonograph's performance.

AT THE SCIENTIFIC SESSION TO-DAY

a paper on the "Photometric Comparison of the Components of the Close Double Stars," was read by Prof. E. C. Pickering, Cambridge, Mass. An apparatus was described by which the comparative brightness of the two stars which under the telescope are found to constitute a double star, can be measured. Profs. Peters, Alexander, Newcomb and Hall discussed the paper. Next came an essay on the "Duplication of Geographical Names," by Dr. F. V. Hayden. This interesting subject was ably, extensively, and in some instances humorously discussed by Profs. Guyot and Haldeman and Mr. G. K. Gilbert. Several other papers were read, and the Academy then adjourned. It will meet in New York on the second Tuesday in November for a scientific session, and will re-assemble in Washington again next April.

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CONDENSED MYTHOLOGY.

VULCAN.

Vulcan was the village blacksmith, about whom Mr. Longfellow has written some very clever verses. He was god of the fire and the forge, and earned his bread by the sweat of his brow. He was a rapid workman, but back files of the Norristown *Herald* make no mention of the number of horses he could shoe in an hour. The local news was not gleaned so closely in those days.

Vulcan was lame and ugly. When, at a military or a firemen's fair, a gold watch was voted to the handsomest man and a leather medal to the homeliest, Vulc. always got the medal. He was so lame and ugly that his mother, in shame, cast him from heaven into the sea.

And she was not arrested!

A couple of Oceanids, named Eurynome and Thetis, took pity on Vulcan and tended him for nine years in a deep grotto of the sea. How he escaped catching a fearful cold and dying of pneumonia, living in such a damp place, is little short of a miracle. He must have had wet feet pretty much all the time. For their kindness to him, Vulcan made the Misses Thetis and Eurynome many ornaments and bric-a-brac things, some of which the girls stuck full of Keramic pictures and placed on the parlor mantel.

Becoming reconciled to his mother Vulcan returned to Olympus under the guidance of Dionysus.

Another account says it was his father who treated Vulcan so cruelly. One day Jupiter and his wife quarrelled over the question who should get up first and make the fires—or something that way—and when Vulcan came to the assistance of his mother, Jupe seized him by the foot and hurled him from Olympus. Vulcan, we are told, fell for a whole day, but alighted at sundown on an isle, with but little breath in his body.

We should think so. The wonder is that he was not killed outright. If he fell head foremost he must have lost all the money out of his pockets before reaching terra firma.

Some writers say it was from this fall that he became lame. And we can readily believe it. Nowadays a man can't fall from the roof of a four-story house without being lamed for life. And if he were to fall a whole day, the only thing that would be of any service to him after alighting would be a funeral.

Vulcan was supposed to have his forges in the fiery mountains, and the smoke and flame which broke forth from the chimneys of his shops. This may be true, but we shouldn't think he would secure much custom by setting up business in such an out-of-the-way place. His principal employment was forging thunderbolts. Ancient writers don't inform us where he found a market for such bolts. If he were still in the business, he might dispose of large numbers to our politicians, who often yearn for red-hot thunder-bolts to hurl into the ranks of the opposition.

Vulcan built himself a gorgeous brazen palace on Olympus in which was a huge workshop with twenty cunningly devised pairs of bellows. It is to be presumed that he worked all these himself, for it is not on record that his journeymen ever stuck for higher wages. Vulcan was the Prof. Edison of the gods. He constructed tripods which moved of their own accord into the banquetting chamber, and then returned to their places after the meal was over. Such tables were marvels of ingenuity, but they had their objections. Guests who imbibed too freely of the nectar of the gods, and retired under the table to sleep off their weariness, would have their weakness and bodies exposed when the tripods meandered off.

But more wonderful than the walking tables were the golden statues of maidens, which Vulcan made to assist him in walking and bestowed on them speech and motion. They were worth their weight in gold. Edison's phonograph is an insignificant invention alongside of these talking maidens.

Despite Vulcan's deformity and ugliness, the beautiful Venus became his wife. She had several other husbands, however, and evidently believed that variety was the spice of married life. Vulcan was short in the left leg, but that wasn't as inconvenient as if he had been "short" in the pocket-book. He was lame and homely and only a blacksmith, and yet the Romans worshiped him. This warm regard for the deformed god will be understood when we state that he was not a member of the 45th Congress and never wrote humorous paragraphs.—*Norristown Herald.*

THE SUN, SUNDAY, APRIL 21, 1878.

ECHOES FROM THE PHONOGRAPH.

What Mrs. Barstinglow Heard After Three Days' Absence from Home.

From the Burlington Hawkeye.

It happened that Mrs. Barstinglow was going down to Keokuk for a few days, and Mr. Barstinglow was inconsolable. At one time he protested that she should not go; he could not endure the lonesome house during her absence. And then again he declared that if she must go, he would neglect his office, and let his business go to the bow-wows, and he would go with her. At length, however, she persuaded him to be reasonable, and on her repeated assurance that she would not remain away longer than three days, he consented to let her go. He even bought her ticket, and ordered the carriage and paid for it two days ahead, lest his resolution should give way, and he should forbid her going from him. And from that time till the morning of her departure Mr. Barstinglow spoke in subdued tones, and moved about with the air of a man whose heart was buried under mountains of grief.

Before she left the house, Mrs. Barstinglow set the phonograph in the sitting room, behind the clock. Then she kissed her disconsolate husband, and begged him to preserve his precious life for her sake while she was away, and then she was gone.

Every day, during her three days' visit in the Gate City, she received a letter from her mourning husband, begging her to come back and telling her how lonesome he was without her, and how like a grave the empty house seemed, and how the hours dragged over his aching heart with leaden feet. And in three days she came home, and filled the solemn house with sunlight and laughter again.

The evening after her return to Burlington, she took down the phonograph.

"I wonder," she said, "what we said last in its hearing? It must have been something while we were discussing my visit. Or may be it has caught some of your poor, longing moanings while I was away."

And then she turned the crank.

"Lord, no," croaked the phonograph, in tones of hearty reassurance, "no danger of that; she's safe in Keokuk for three days; saw her safely off, myself, this morning. Light your cigar while I light another lamp and make the room look cheerful."

"Why," exclaimed Mrs. Barstinglow, in a countenance of amazement, "what on earth is it saying?"

"Oh, some nonsense some of your visitors have talked into it some time or other," replied her husband, nervously, "people talk all kinds of stuff into a phonograph, you know. They say anything for talk."

Mrs. Barstinglow, looking only half convinced, gave the crank another turn.

"This is devilish good whiskey, Barsty," ejaculated the machine, very earnestly. "You don't get it in Burlington, do you?"

Mrs. Barstinglow gave a little shriek.

"My dear," said her husband, looking now quite as worried as he had looked when he was begging her not to go to Keokuk, "put it away; somebody has had it out in the stable, and it might say something perfectly shocking, you know. Put it away."

But Mrs. Barstinglow, upon whom the spirit of investigation had descended with great power, ground away, and the phonograph, in a voice marvellously like her husband's, went remorselessly on.

"Not much; they don't make this kind now. It's some old Monongahela, copper distilled, that Mrs. Barstinglow's mother gave her for medicinal purposes three years ago. Fill up, there's plenty of it, and I can replace it with any kind of beverage when it's gone. The old girl won't know the difference."

Mrs. Barstinglow felt herself turning to stone, but the next turn of the crank brought out an uproarious

"Ha, ha, ha! Here's to thee, gal!"

That fanned her cheeks into a flame.

"For mercy's sake, Malachi Barstinglow," she shrieked, "what does this mean?"

Mr. Barstinglow now looked as though he really did wish she had never gone to Keokuk.

"It's just as I tell you," he said, with an effort to look unconcerned that was like a humorous book, a colossal success, so far as its utter failure was concerned. "Somebody has been talking all sorts of nonsense into it just for talk's sake. How else could it get hold of such dreadful stuff in our dear little home, lovey?"

Mrs. Barstinglow didn't say, but she turned away and the phonograph asked carelessly:

"Throw around for the deal?"

She thought she would faint, but she didn't, and the pitiless machine proceeded to remark, with a variety of voices:

"It's my age."

"You'll have to straddle that blind if you come in."

"Give me two cards."

"Chip one."

"I'll see your little one and raise you a couple."

"Push the bottle this way, Ben."

"Ain't you going to stay in, Harry?"

"Can't stay in on a pair of sixes."

"Call you."

"Two small pair, kings to head."

"Tens and deuces. Take the pot."

"Barsty, get us something to eat. Old girl left the cupboard keys, didn't she?"

"Lord, yes; told her I was going to keep bach at home to save expenses and keep out of bad company."

"Ha, ha, ha!! Ho! ho!! ho!!!"

"Oh," yelled Mr. Barstinglow, unable to contain himself any longer, while his wife, more dead than alive, leaned over the phonograph and ground away at the crank in a dazed kind of a way. "Oh, keep it up! That's right! Keep her agoing! Grind it all out! Dog gone the diabolical piece of black art and the vile assassin that invented it! Keep it up! That's right! Believe a senseless diabolical piece of monstrous mechanism rather than your husband. Keep her a going. Keep it up!"

And Mrs. Barstinglow did keep it up. She kept it up, and listened to that phonograph swear and shout and howl; she heard it shriek "Oh, my eye; my eye!" She heard it tell some one to let some one else "have it again in the same place;" she heard it warn somebody to "hold his head over the stove hearth, and not let his nose bleed on the carpet," and at last, as it assured her very thickly and with some difficulty, that it was "a ban' of jorry goof fuf-fuf-follows," and that it "won'-hic-won' g' ome till morning," she ground it into silence, and sunk back, speechless and breathless, while Mr. Barstinglow took the phonograph out into the back yard and smashed it into so many and such small fragments that it couldn't reproduce even a steamboat whistle.

Apr 21 Baltimore Gazette

[Special Dispatch to the Baltimore Sun.]

The Wonderful Phonograph in Washington.

WASHINGTON, April 19.—Mr. Edison, the inventor of the phonograph, gave a number of interesting illustrations with his instrument today in the rooms of the Senate and the House committees on patents. A large number of Senators, members, ladies and others were present, and were much entertained. The phonograph repeated with wonderful precision every tone of the voice. Mr. Edison talked into his phonograph lots of little ballads, ditties and quaint sayings, and after a while he would turn the crank and they would come out again a perfect mimic of his voice. A Western member of Congress, from one of the backwoods districts, came into the room as the phonograph was repeating the following:

There was a little girl
And she had a little curl
Right in the middle of her forehead;
When this little girl was good
She was very, *very* good,
And when she was bad, she was horrid.
Ha! ha! ha! ha! ha!
Well I do *de*-clare.

The Western member listened, with his mouth opening wider and wider as the words came out with marvelous distinctness from the little instrument. Finally, he clapped his hand down on his side, and said, "Well, I'm agin that; it would never do in my deestrick; it would frighten every woman and gal around." The horrified member then walked out of the room amid the laughter of all who were present.

[General Dispatches.]

Nature Apr 4 '78

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Elements of Articulate Speech

As a corollary to the interesting observation with the phonograph recorded by Prof. Fleeming Jenkin and Mr. Ewing in the last number of NATURE, will you allow me to point out that every capital letter of the Greek alphabet except Γ and Ρ is actually (either as written or when turned through an angle of 90°) a reversible or a reduplicate symbol.

With regard to gamma, although the capital is not, the small letter (γ) *is* reversible; and as to Ρ (or R, which is another ancient Greek form of it), many facts seem to show that by itself it does not as a rule represent a complete part of articulate speech; witness its frequent reduplication in Greek, the aspirate so often employed with it both in Greek and Latin, and the way in which it is frequently omitted, as if of no importance, from Latin words ordinarily spelt with it. The French or Italian pronunciation of this letter amounts to a reduplication in the English ear, while the English pronunciation of it amounts to its omission altogether in the ear of a Frenchman, an Italian, or a Scotchman.

In the Roman alphabet F, G, L, P, and R, are the exceptions; much might be said about each of these, but I will content myself by saying that L is obviously only an apparent exception, as it is easily derived from A. W. H. CORFIELD

10, Bolton Row, Mayfair, March 30

Phoneidoscopic Representation of Vowels and Diphthongs

I HAVE just obtained the two following results with the phoneidoscope[1]:—

1. If a vowel be steadily sung on a single note, a constant colour-figure is produced; but if the vowel be spoken in the ordinary conversational tone, a change of figure occurs before the sound ceases. The slurring alteration of pitch which takes place in pronouncing a single vowel is thus rendered perceptible by the eye.

2. When a diphthong is slowly intoned, two distinct figures successively present themselves, which are found on trial to be those corresponding to its constituent vowel-sounds. The twofold nature asserted in the word "diphthong" receives by this experiment a visible illustration. SEDLEY TAYLOR

Trinity College, Cambridge, April 1

Scientific American Apr. 20, 1878

Telephone Notes.

It is now well known that if the wire of a telephone be extended parallel to telegraph wires, and supported on the same posts, the clicking of the telegraph instruments will be distinctly heard in the telephone, so that messages passing can be read. This opens a new war utilization of the telephone, as it will be necessary simply to carry its wire near an enemy's telegraph line to read his dispatches, without tapping his wires.

Another new use of the telephone is in the Norwegian herring fisheries. The fishing season takes place when the herrings come into the shoals to deposit their eggs; but it often happens that the fish accomplish their purpose and go back into deep water before all the fishermen can be warned. Some 120 miles of submarine cable have been laid and telephones connected with it, so that all the fishermen on the coast can be immediately notified.

The telephone is a very simple contrivance, and it would seem that nothing could be more direct than the transmission of the voice to the ear of a listener; yet no less than eight transformations take place. The muscular effort of the speaker is transformed (1) into air vibrations; (2) into metallic vibrations; (3) into magnetic waves; (4) into electric induction; (5) into magnetic induction; (6) into metallic vibrations; (7) into air vibrations; (8) into vibrations of the auditory apparatus of the hearer.

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Iron Apr 6. 78

THE AEROPHONE.

A new instrument has been produced in America. According to the published description, its function is that, "placed upon a locomotive, it will raise its voice when desired, and announce, in giant tones that can be heard for miles—'I am the the engine, Marmaduke, and will stop at Boonton Station,' or whatever other warning or information it chooses." This instrument might be usefully employed in this country, and on our most cherished railroads. Thanks to advertising enterprise, it is rarely possible to read the name of the station. One is impressed with the virtues of various articles of domestic use, but remains profoundly ignorant of where one is. The inarticulate howl of a railway porter is of no assistance whatever, inasmuch as by the exercise of fiendish ingenuity he invariably produces a sound utterly unlike the name of the place to which he is attached. An aerophone would be a vast improvement on the inarticulate porter. The name of the place approached by the train would be welcome, even in "giant tones," to the hapless voyagers, who crane out of the carriages, and, confronted by the "Lion, the Net and the Mouse," shriek their enquiries to a lout who, if he answers at all, barks out a series of unintelligible sounds.

Boston Weekly Globe Oct 19

THE MAN WHO INVENTS.

TOM EDISON'S TALK WITH A "POST" REPORTER.

The Wonderful Phonograph and Its Eternal Voice—Description of the Man of Genius—What he has Accomplished—The Key of Silence Only Touched.

Hearing that Mr. Thomas A. Edison, the world-famous discoverer of the phonograph had arrived at the Smithsonian Institution yesterday, with a specimen of his instrument, The Post reporter, then on duty there, hurried from the monologues of the savants to have an interview with the most wonderful inventor of the world. Catching a glimpse of him, the reporter followed him to the outside, where the great discoverer was found looking intently around him, apparently interested in a study of the trees, the shrubbery and the blue sky. Suddenly he darted off, as if determined to more closely examine specimens of the white pine that springs from the covered point of one of the walks. As he reappeared, coming slowly back, the reporter noticed he was rather under the medium size; about five feet seven or eight inches high, and marred with a kind of listless gait, as if tired or meditating. His forehead is round, not very high, moderately full in the temporal regions, indicating a prominence of the organs, yet not especially noticeable for expansion. His hair is thick, but white, his eyes, of a decided brown hue, and the face is bare of beard. His eyes are grayish-blue, clear and bright, and in conversation brighten wonderfully. The nose is large, standing out boldly from the face, but as it is was looking into the future for its success—an inquisitive member, could not an encounter—one. A large mouth where smile is a pleasure see, a square rather prominent chin and a white skin, complete the facial description. His manner is quiet, modest and retiring, exhibiting a lack of egotism or presence at once refreshing and marvellous in a man who has reason to be so justly proud of his fame and his achievements. Yet while he is talking you are conscious that there are tremendous potencies in the plain-mannered gentleman before you. "Can I interview you, Mr. Edison?" said the Post reporter, timidly.

"Yes. What an interview with the phonograph wins without a report," he said, pointing to the not words of wins that ran high in the cylinder. "Mr. Edison, I have been told that when the combination, 'I have been told' occurs in a newspaper report, but when I went over to this lecture I found you could see no more than I could hear. Naturally enough the inventor has no eyes for trees or flowers, and I suppose you are quite as oblivious when are concerned.

"Let me, like all the rest of the world, congratulate you on your discovery of the phonograph, Mr. Edison." The Inventor shook the reporter's hand, blushed like a girl and modestly acknowledged the compliment.

"Can you a long time in perfecting the discovery?"

"Oh, no; I had thought of the idea vaguely many times, long before I undertook to work it out. The idea is fascinating, one, and this, too, fascinates my way had probably occurred to many people perhaps for centuries. But when I undertook to realize it, and make it a success it came out pretty right very easy. It is a very simple idea when you stand to look at it, and the wonder is it wasn't discovered before."

"It walked for Edison, and walked in," suggested late talking the sleeve of his coat.

"Experiment was doubtless pleasing, but the fascinating tendency of the men caused him to shrink from pursuing his own project.

"What a pity you hadn't invented it before. Then is only a matter of interesting her and her age, she would have liked the invention of Edison, their failing voices again, a miracle your phonograph makes possible."

"No, I don't think the world was ripe for it before. Why, I wanted to get it patented in South America, and my agents spoke to consuls in Mexico, Peru and other places, but were advised not to go there. The people were too ignorant, they deemed generally to receive it. I would destroy the whole system of the machinery of the civilized and such the agents as the regular line."

"Had you any thought of coming to Washington?"

"Not until yesterday, when I got a telegram requesting me. They are a pleasant set of fellows in Washington. Some don't think full of clothes, though."

"They don't really seem to care for the tailor, don't they?"

"O, they've got on their good clothes now. But see them at work, or they come into my laboratory, they don't look as nice as they do to-day, but they have lots more fun in them. I remember when Senator Thompson, when he came to see me, had on a suit of clothes, I told you. He removed his coat, vest and collar, his cuffs and shirt and greasy, the collar that I gave his glove his cuffs, and he looked as if he had boiled eggs for it. And that was his business suit, too."

"When do you give an exhibition on your phonographs?"

"Not to the public. Have you ever seen it? Well, come in and I'll show it to you." And leading the way, he entered the laboratory, followed by the secretary, editor, uncovered phonograph "Sound Writer," and began to explain:

"Here the phonograph, you see, is a thin disc or diaphragm of iron, beneath which is this fine steel point, which moves up and down in the vibrations of the disc. Beneath this is the revolving cylinder, on which is this spiral groove. As the disc vibrates the cylinder is a screw, the distance between the grooves being the same as the distance between the vibrations of the disc. Now, when I speak into the mouthpiece the vibrations of the voice send with a sheet of tin-foil — just will see it operate by and by—and when the cylinder is revolved the steel point presses into the tin-foil and the spiral groove. If now the diaphragm is thrown back by the voice the steel point will make a series of indentations in the tin-foil grooves, corresponding to the sounds uttered. On coming over again the same groove with the steel point, by the indentations in the tin-foil cause the diaphragm again to vibrate precisely as at first, thus reproducing the sound originally made. The vibrations of the voice you first used is returned to you in whatever shape you may desire. Your words, for example, are preserved in the tin-foil, and will come back upon the application of the needle. Now, you see, the whole process is exactly the same tone of voice you spoke them in."

"Are you ready, Sirs?"

Seeing as the tin-foil lacks. This tongue-less, toothless, gumless instrument, having no other power, deems voiceless matter, nevertheless utilizes your tones, and centuries after you have passed away, and centuries after you have mouldered into dust will repeat your words again, your very tones, your very voice. You, your very little thought, every fond fancy, every calm thought that you chose to whisper against the thin iron diaphragm.

"Ready, Sirs?"

"Ready, you, Mr. Edison?"

"Very ready."

"I am glad for this; and I hope to astonish the world yet with things more wonderful than this. I think the world is on the eve of grand and immense discoveries, before which the discovery of Columbus pales the record of the past will be insignificance. This is a very poor invention of the phonograph. You see how simple the invention of this idea, and how simple the idea itself; and yet, after all, is useless."

And the reporter, turning away to record the utterances of the sage in the room, suggested, thought of that passage of Holy Writ which, with very little thought and every rule, would Judgment Hour. Does the Recording Angel still hold a Deleted Phonograph, against whose spiritual diaphragm some mysterious other presently record a human life?

Scientific American
Vol. XXXVIII. No. 16. [Reprinted from Sept. 19, 1877.]

Marvels of the Phonograph.

(San Francisco Post.)

The phonograph is the latest lunkhead thing directed by science against the whole inconsequence of society, and this paper would deem itself remiss in its duty if it did not warn the public against the fraud. Mr. Edison, who is the inventor of this instrument of this fact and dastardly nefarious invention. Everybody knows how the world wonder the strange process that is useful and beneficent discovery has been under. We are all familiar with the fact that instead of being received with the kind welcome which scientific inventors must who wisely consecrate their lives and efforts with a suspicious has usually received similar tests the condemnation of ostracism, and the fact that Mr. Edison has made a development of his kind because a halt and shown upon the ludicrous runs known enough to be a warning to all who are tempted to imitate. Edison's invention is a very simple affair, consisting of a cylinder covered with tin-foil, on the outer of a cylinder, and the result intercommunication that "baby has cried" into a mouthpiece, or that the hymn singer hasn't a voice, or that the preacher is a bore, is recorded on the cylinder, whereupon the machine can be set in motion and the instrument can be obtained at ten minutes interval. Now, it is evident that such an instrument is useless and other mechanical contrivances have been invented which are of real value. Take the telephone, for instance. But the absurdity of this phonograph is not to be realized upon unless the phonograph is actually put in operation. Then the fraud of Mr. Edison's device for the manufacture of machines is as instrument which automatically records and reproduces the human voice, and also other mechanical sounds, such as the whistle of a steam engine, the whistle of a locomotive, the whistle of a steamboat, the whistle of a steamboat, the whistle of a steamboat

6, 1878. Boston Sunday Herald Dec. 14, 1878

A WONDERFUL GENIUS.

Interesting Reminiscences of Thomas Alva Edison.

One of the Greatest of American Inventors.

A Life of Eccentricity, Study and Usefulness.

The inventions of Thomas A. Edison are the wonder of the world; he has done more than any other to perfect and advance the various systems of telegraphy; he is still at work with indefatigable zeal for the accomplishment of other inventions and improvements. Sketches and reminiscences of his life therefore are interesting to all connected with the use of electricity, and not only to these, but to the world at large, which he has so greatly benefited.

His ancestors came to this country in 1730. Thomas Edison was a prominent bank official on Manhattan Island during the Revolution, and his name appears on the Continental money. The race is long-lived. Edison's great-grandfather lived to be 102, and his grandfather 103 years old. His father, Samuel Edison, is now living, aged 74, and in perfect health. His mother, Mary Elliot Edison, was of Scotch parentage, but born in Massachusetts. She was finely educated, and for several years taught in a Canadian high school. She was an industrious, capable, literary and ambitious woman. She died in 1862 at 67 years of age. Thomas Alva Edison was born Feb. 11, 1847, at Milan, Erie county, Ohio, but his parents removed to Port Huron, Mich., when he was seven years old, which has since been their home. Edison never went to school over two months in his life. His mother taught him spelling, reading, writing and arithmetic. She was a fine reader, and often read aloud to the family. Edison acquired his love of reading from her. At ten years old he had read "The Penny Encyclopedia," "Hume's England," "Gibbon's Rome," and other books of like character and value. In his reading he passed over nothing superficially, and to this concentration is due the accomplishment of

MANY ASTONISHING RESULTS.

While disliking mathematics, he was constant in experiments while yet a boy. At 12 he became a train boy on the Grand Trunk Railroad, and soon after acquired an exclusive newsdealers' right, having four assistants. This he held for four years, earning about $1 a day, which was given to his mother. While running to Detroit he attempted to read the "Library" through, but gave it up, and systematized his selections when he had read everything on the shelves to the height of fifteen feet. His favorite is Victor Hugo. His mind is so retentive that he quotes long extracts from volumes and pages of abstruse authors, so that he is something of an encyclopædia himself. In an untenable freight car which had been intended as a smoking car, he fitted up a laboratory, where experiments were common while running on his route, until his bottle of phosphorus fell and set the car on fire. He purchased 300 pounds of the old type of the Detroit Free Press, and for six months printed the Grand Trunk Herald, filled with railroad gossip and other information of interest on the road, and had a "list" of several hundred. While running to Detroit he became acquainted with the telegraph operators and began telegraphing the newspaper headings to stations in advance of the train. He became impressed with the value of the telegraph, and determined to learn the business. He purchased a work on the electric telegraph, and, in conjunction with James Ward, one of his assistants, constructed a line between their residences in Port Huron, using stove-pipe wire, insulated with bottles placed on nails driven into trees and crossed under an exposed road by means of a piece of abandoned cable, captured from the Detroit River. The first magnets were of wire, wound with rags for insulation, and a piece of spring brass was used for a key. The first attempt to generate a current was by means of cats rubbed vigorously together at each end. This failing, they soon after purchased some old instruments and other materials, and a success was accomplished. About two months afterward, as the railroad train was switching some cars on to the side track at Mt. Clements station, the agent's little boy, 2 years old, crept upon the track in front of the approaching cars. Edison, seeing the danger, sprang to the ground, seized the child and barely saved his life. J. A. McKenzie was the agent and operator, and, in gratitude for the act, volunteered to assist Edison

TO LEARN TELEGRAPHY.

Thereafter, on reaching the end of his route, Edison would go back by freight train to Mt. Clements, and worked nights to perfect himself in operating. In five months he was sufficiently accomplished to secure employment in the telegraph office at Port Huron. The office was in a jewelry store, and Edison had an opportunity to indulge his mechanical inclinations. He worked night and day for six months, and next went to Stratford, Can., as night operator. The operators were required to report "six" every half hour to the circuit manager. Edison indulged his ingenuity in making a wheel with Morse characters cut in the circumference in such a way that when turned it would write the figure six and sign his office call. This the watchman turned for him while Edison slept. He was discharged from here by the train dispatcher for an error, and soon after obtained a situation at Adrian, Mich. Here he had a small shop and a few tools, where his spare time was used in repairing instruments and making such experiments as he had the means to accomplish. He lost his situation through a violation of a rule. Two months later, he went to Indianapolis, where he invented his first successful automatic repeater, which is an arrangement for transferring the writing from one telegraph line to another without the medium of a sending or receiving operator. Being unable to take "press" reports without frequent breaks, he rigged two more recording registers, one to receive and one to repeat the embossed writing at slower speed so it could be copied. When this was done he told the sending operator to "rush him," which gave him a brief reputation, for the "copy" was so slow in reaching the press it caused complaint, and he was suspended. He next went to Cincinnati, and on account of his achievement in dispatching business one night during a strike of operators, had his salary raised from $65 to $105 per month, and was given the Louisville wire with Bob Martin, one of the fastest senders in the country at the Louisville end, and his experience here made him a first-class operator.

Edison's utter negligence of dress and appearance, his willingness to work at all hours, night or day, his insatiable thirst for reading, and his enthusiastic attempts to solve what appeared to his companions impossibilities, earned for him the name of "luny" or crazy man, which clung to him a number of years. He retained, however, the personal good will of his associates.

At Memphis, in 1864, he made and put into operation his automatic repeater, so that Louisville and New Orleans could work direct. The idea of duplex transmission had taken possession of him, and he was perpetually advocating and experimenting to accomplish it. These efforts were looked upon with disfavor by the management, and in the changes resulting upon the transfer of the lines from the Government to the telegraph company he was dismissed.

Afterwards in the Louisville office, where Edison was required to report on a fine worked from the blind side of a repeater, where there was no chance to break, he was in the habit of arranging three sets of instruments, each with a different adjustment, so that, whether the circuit was strong or weak, or no matter how rapid the change, he was able to receive the signals accurately. He remained in Louisville for nearly two years, and then got

THE SOUTH AMERICAN FEVER

but was cured after a short sojourn there, and returned to Louisville, where he began to save his earnings more than ever, and invested them in additions to his library, apparatus, printing office and shop. He started to publish a work on electricity with his own office, but the task proved too much for his facilities. He went into a most elaborate series of experiments, as was his custom when investigating any subject, to determine the most rapid and best adapted style of penmanship for an operator's use. He finally fixed upon a slightly back-hand, with regular round characters, isolating the letters from each other, and without shading. This beautiful penmanship he became able to produce at the speed of 45 words per minute, which is the extreme limit of a Morse operator's ability to transmit. The result of one of his experiments earned for him another discharge, and he went to Cincinnati, where his experiments, and his absence in the Mechanics' Library, rendered him so unpopular that he returned home to Port Huron.

He had a warm personal friend, M. T. Adams, in the Boston office. An expert was needed to work a heavy New York wire. Several candidates had failed, as the New York end was worked by "York and Erie" operators, who, as a class, had the reputation of writing anything but the "Morse" alphabet. G. F. Milliken, the manager, offered the situation to Edison by telegraph, and he accepted. His reception at the telegraph office, on account of the prejudice inspired by his uncouth appearance, was scarcely flattering. The table at which he had been placed was in the centre of the room, for the better enjoyment of his discomfiture. He noticed the arrangement, and says he would have died rather than made a break. He arrived in Boston in 1868, and in the person of Mr. Milliken found the first superior officer who could appreciate his character. Mr. Milliken was an accomplished gentleman, a thorough master of his profession, and an inventor of merit. He made allowance for the gawky and hungry look of his subordinate, and in the secret excitement under which he seemed to labor

RECOGNIZED THE FIRE OF GENIUS.

Edison's stay in Boston was congenial. There is a vein of humor running through his character, and he played a practical joke on the cockroaches, which infested the office in great numbers. He placed some narrow strips of tin-foil on the wall, and connected them with the wires from a powerful battery. Then he placed food in an attractive manner to tempt them. When those clammy individuals passed from one foil to the other, they completed the battery connection, and, with a flash, were cremated, to the delight of the spectators. Edison started a shop in Boston, and gave all his spare time to it. His ideas here began to assume practical shape. He invented a dial instrument for private line use, and put several into practical operation. He made a chemical vote-recording apparatus, but failed to get it adopted by a Massachusetts Legislature. He commenced his experiments on vibratory telegraph apparatus and made trial tests between Boston and Portland. He matured his first private line printer, and put eight into practical operation. At one time he was invited to explain the operation of the telegraph to what he supposed was a girl's school. He forgot the appointment, and when found was putting up a line on a house-top. He went directly from his work, and was much abashed to find himself ushered into the presence of a room full of finely-dressed young ladies. He was actually timid in ladies' presence, but his subject was understood, and the occasion passed pleasantly. He was introduced to a number of the young ladies, who always recognized him on the street, much to the astonishment of his fellow-operators not in the secret. Edison is a strong believer in the Boston girl.

His idea of a duplex system constantly burned in his brain, and in 1870 he went to Rochester, N. Y., to try his apparatus between the two cities. Mr. F. L. Pope, the present patent adviser of the Western Union Telegraph Company, assisted in New York. The effort was a failure, although Edison has always claimed it ought to have succeeded. He then went to New York, arriving there dead broke and discouraged. He hung around the office of the Gold Indicator Company for several days. Their apparatus was cumbersome and imperfect, and frequently out of order. One day, when there was an unusual excitement in the gold market, the apparatus failed. Edison happened in, and stood watching the confusion. He volunteered to fix the machinery. The president looked upon him with amazement, but, being in the mood to catch at straws, gave him permission to try. He speedily found the defect, and the next day was engaged to fill a responsible position with the company. He immediately began to improve the apparatus, and soon invented a gold printer.

THE POPE AND EDISON PRINTER

was brought out, and a private line system was put in active operation. This was soon sold to the Gold and Stock Company, and Edison has for many years been retained in the service of that company and the Western Union Telegraph Company at a large salary, they having the first option to purchase his inventions pertaining to telegraphy. Edison's inventions pertaining to the gold and stock telegraphy soon replaced the old apparatus, and that system is interwoven with his inventions and improvements. At the formation of his intimate connection with the Gold and Stock Company he established an immense electrical manufacturing establishment at Newark, which was divided into three large shops and two laboratories for experiment. He employed upwards of 300 men, and was himself the busiest man in America. He gave himself scarcely any time to sleep. An idea of his determination and persistence can be gained from the following incident: He had been given an order for $30,000 worth of improved printers. The sample instrument had worked an experimental circuit, but the first instrument for practical use proved a failure. In vain he sought to remedy the defect, till finally, taking four or five of his best men, he went to the top floor of his factory, remarking that they would never come down till the printer worked. They labored continously for sixty hours, and he was so fortunate as to discover the fault, and made the printers operate perfectly at an expense of $5000. Such severe and protracted labors are common with him. He says after going without sleep more than the ordinary hours he becomes nervous, and the ideas flow in upon him with great rapidity. His sleep after these efforts is correspondingly long, sometimes lasting 30 to 36 hours. As a manufacturer he did not prove a success. The more resources at command, the greater his efforts at invention. At one time he had 45 distinct inventions and improvements under way. All the large sums received for his patents and the profits arising from manufacturing to the amount of nearly $400,000 have been expended in inventive efforts. He finally became excessively annoyed at the tax upon his powers arising from regular business, and concluded to remove to some small place inconvenient to reach, where he would be free from curiosity seekers, and have opportunity to put into practical shape his conceptions. In 1876 he sold his machinery, and moved his family to Menlo Park, N. J., on the Pennsylvania Railroad, 24 miles from New York. Here, on the crest of a hill, remote from other buildings, he built a laboratory 28x100 feet, two stories in height. In one room on the ground floor he has a machinery apartment, in which is located a ten-horse-power engine and a collection of expensive tools, so that any appliance, however intricate, can be made under his own inspection. In another room are ranged on shelves and in cases the models of a large number of his experiments and inventions. Here are also to be found many instruments of precision which he has purchased at great cost to assist in his investigations.

HIS LIBRARY IS ENTIRELY SCIENTIFIC,

and costly, but not large. On his upper floor he has ranged upon shelves thousands of bottles of chemicals, and he makes it a rule to purchase some of every known chemical or mineral, to have at hand in case of need. Here he conducts his experiments under his personal supervision. He has always with him three or four assistants, whom he has selected on account of their skill as draughtsmen or workmen, willingness to comply with his wishes, and their physical endurance, which, with him is an important consideration. Sometimes he has fifteen men employed exclusively in developing his inventions, if of importance and near completion. Edison has been granted 112 patents in this country, and has some 20 applications pending in the office. His most valuable inventions have been patented in many foreign countries. Of his American patents, 35 pertain to automatic and chemical telegraphs, 8 to duplex and quadruplex telegraphy, 38 to printing telegraph instruments, 14 to Morse telegraph apparatus proper, and the remainder relate to fire alarms, district and domestic telegraphy, electric signals, the electric pen, the speaking phonograph, and a variety of electrical and non-electric apparatus.

The printing telegraph instruments, the automatic or chemical system, by which 1000 words a minute can be transmitted on a single wire for medium distances; the quadruplex system, by which four messages at a time are sent on the same wire by the Morse method; the electric pen; the carbon telephone, which exceeds all others for its loudness and distinctness; the speaking phonograph, and the aerophone are among his most valuable productions.

He is sharp at a bargain, and has been styled a Talleyrand in negotiating for the disposition of his inventions. His peculiarities and the great value of his inventions have led to severe struggles for the possession of some of them. He keeps a careful record of each day's experiments, properly witnessed, and has numerous volumes of such statistics. He was married to Miss Mary Stillwell of Newark in 1873. The

MEDALLION ON THE NEW SILVER DOLLAR

is an excellent profile likeness of her. Their honeymoon was eccentric, as Edison, although in the same city, could not leave his work for more than a few hours two or three times a week, the remainder of his time being used at his factory. The influence of his wife has greatly improved his habits and appearance of recent years. They have two children—a little girl five years and a boy two years old—who are nicknamed "dot" and "dash," after the characters in the Morse alphabet. He is affectionate and generous in his family, but rides rough shod over the ordinary mannerisms of life, and gets down to what he calls solid business. He has a large and comfortable residence near his laboratory. He says the existence of a God can be demonstrated in a thousand ways to an absolute certainty, but he has no religious convictions in the ordinary sense. His attention has heretofore been largely turned to electricity, but his knowledge extends over a wide field. He feels confident of being able to produce one or two things equally good as the quadruplex, telephone, electric pen, or phonograph, a year. His income from his inventions the present year will probably reach $50,000, all of which will undoubtedly be spent in pushing his inventions to completion. His personal tastes are very simple. When invited to dine recently at Delmonico's, he satisfied himself with a piece of pie and cup of tea, greatly to the astonishment of his host, who wanted to do the handsome thing. When tendered a public dinner he declined, stating that $100,000 would not induce him to sit through two hours of personal glorification. He dislikes personal notoriety, and says a man is to be measured by what he does and not by what is said of him.

When a success is reached it rapidly loses interest for him, and he must find some fresh impossibility upon which to expend the fuel of his genius and burn out his life. Examples are few of men who have done more in their own sphere than Thomas A. Edison to promote knowledge and bring the secrets of nature under the useful control of man.

Chro. Record Apr. 20

TALKING THROUGH SPACE.

Testing the Telephone Between Philadelphia and the Capital.

From one of the upper stories of the Western Union building, at Tenth and Chestnut streets, a party of gentlemen spent Thursday afternoon in conversing with a notable gathering in the Capital. The Academy of Sciences of the United States, an association comprising among its members some of the leading scientists of the country, was in session at the Smithsonian Institute, at Washington, and it was determined to make the meeting memorable by subjecting the telephone to the severest test which it has ever yet experienced. The trial was not a difficult one on account of distance, the length of the wire being only about 135 miles, but it was rendered important from the fact that sound would have to be conveyed not only through the switch-board at Baltimore, but also the cables of the Susquehanna, Gunpowder and Bush rivers, and it was feared that the immense electrical disturbances which would be occasioned by the presence of the vast number of wires in close proximity to that used for the experiment would produce such a quantity of induction as to destroy the hopes of the expectant scientists. Fortunately, however, the fears were not realized, and when Mr. Bentley opened the trial by shouting "halloo, halloo" into the transmitter the cheering and brisk response which came back from a voice which was readily recognized as that belonging to the great inventor himself demonstrated the fact that the success of the experiment had exceeded the anticipations of the telephone's warmest friends. From noon until sundown a continual exchange of sentiment, interspersed with prose and poetry, serious and humorous, went back and forward over the wire, every syllable being distinctly heard at either end. "It has been a perfect success," said Mr. Edison through the wire at the close, and Professor Barker tarried a moment to observe that "with that statement I perfectly agree."

Volkszeitung, Dienstag, den 12. M

Eine geisterhafte Erfindung.

Vor etwa 3 Wochen brachten wir den Lesern des Sonntagsblattes eine humoristische Skizze über die Verpackung von gehaltenen Reden, vorgetragenen Liedern in photographischer Treulichkeit, in der ganzen Eigenthümlichkeit der Stimmen der Sprechenden oder Singenden, wie sie das bereits allgemein bekannte Telephon empfängt, aber anstatt auf irgend welche Entfernung mit elektrischer Schnelle sofort zu befördern, in sich für spätere Ablieferung zu beliebiger Zeit verschließen kann. Mit dieser neuesten fast großartigen Erfindung ist es aber völliger Ernst. Sie nennt sich Phonograph, und ist, wie dies gewöhnlich der Fall, von mehreren Seiten zu gleicher Zeit gemacht worden. Der Amerikaner Edison hat im Beisein mit einem Herrn Cheever dieses Wunderding, die Vervollständigung des Telephons, in Amerika construirt, ein Engländer und Franzose zu gleicher Zeit in ihrer betreffenden Heimath das gleiche Resultat erreicht. Wir behalten uns eine eingehende Beschreibung des Instrumentes auf später vor. Die Idee der Erfindung ist folgende. Was man in dies Instrument hineinspricht oder hineinsingt, theilt genau dieselbe Bewegung, die jene Schallwellen in der Luft beschreiben und dadurch ihre Klangwirkung erzielen, einer für den geringsten Eindruck empfindlichen Metallplatte mit, die sich am Besten mit dem Trommelfell des Ohres vergleichen läßt. Während nun bei dem Telephon eine dem entsprechende Platte am anderen Ende der Leitung sofort genau dieselben Schallwellen der empfangenen Wortbotschaft dem horchenden Ohre mittheilt, stereotypirt die schnell empfangende Platte des Phonographen ihre Eindrücke auf ein mit gleicher Schnelligkeit rotirendes Zinnblatt, gemäß den verursachten Luftschwingungen in telegraphischen Tonzeichen, Wort für Wort, Klang für Klang. Was nun in den offenen Trichter des Apparates hinein gesprochen oder gesungen, anscheinend lautlos verhallt ist, ist thatsächlich „conservirt", wie man etwa Früchte in Flaschen einmacht. Man darf nun getrost das Zinnblatt, welches die Schalleindrücke aufbewahrt, herausnehmen, es irgendwo aufheben, auf Jahrhunderte für kommende Geschlechter einsargen, wenn man will. Sobald man die Platte nämlich in einen gleich construirten Apparat setzt, genau in derselben Lage auf den inneren Cylinder legt, und den Apparat in Rückwärts-Bewegung setzt, macht die vordere Metallplatte des letzteren genau dieselben zusammengesetzten Schwingungen, welche den auf dem Zinnblatt stereotypirten Worten oder Tönen entsprechen, und bringt letztere genau wieder zu Gehör. Die damit angestellten Experimente sollen überall die größte Sensation hervorgerufen haben. Eine Sprechmaschine in der wahrsten Bedeutung des Wortes, kann der Apparat in allen Sprachen, in jeder Tonhöhe, in allen Stimmen und Zungen, reden, singen, schreien, pfeifen, krähen u. s. w. Welche Aussicht in die Ferne, die Tragweite der Erfindung! Die Stenographie wird aufhören, der Zeitungsschreiber phonographische Reporte zu seinen Ohren reden lassen; ebenso wird sein Manuscript aufhören, an dessen Stelle den Setzern seine Artikel durch den Phonographen mündlich dictirt werden. Die kostspieligen Engagements von Primadonnen und Heldentenöre werden sich dem Impresario insofern glänzend rentiren, als er aus ihren Kehlen ganze Opern in den Sprechkasten conserviren lassen kann, um diese auf Bestellung nach irgend einer Stadt zur Reproduction derselben Oper zu versenden. Und die traditionelle Schwiegermutter wird bei Zeiten Sorge dafür tragen, recht viele ihrer liebenswürdigen Sermone für den Herrn Schwiegersohn in den Phonographen zu verpacken, damit, wenn sie selbst nicht mehr am Leben, die hülflose Tochter gegen etwaige freiere Uebergriffe des erlösten Gemahls diesen gespensterhaften Nachlaß der Mama hörbar in Requisition setzen kann. Die Einbildung zur Vervielfältigung und Ausdeutung dieser möglichen Erfindung darf sich hier freiesten Spielraum gestatten, obwohl sie selbst nicht so riesenschrittlich weiter geht, immerhin aber diese Ziele nach so wunderbaren Errungenschaften nicht für unmöglich halten läßt.

7

Telephone mixed with Phonograph

Die Indiscretionen des Telephons.

Eine Humoreske nach dem Französischen.

Das Telephon ist noch immer der Held des Tages.

Nach den jüngsten Ankündigungen soll die neue Wissenschaft im besten Zuge sein, ein Mittel zu erfinden, um Töne zu verpacken, Worte einzumachen, derart, daß eine im Jahre des Herrn 1878 gehaltene Rede nach Belieben erst ih 1880, selbst in 1900, gehört werden könnte.

Das ist gewiß wunderbar, aber ich zweifle, daß unser veränderliches Menschengeschlecht sich an eine solche Methode gewöhnt, die bei etwaigen späteren Widerrufen große Verlegenheit bereiten würde. Denken Sie sich die schrecklichen Folgen dieses Systems! Wie unklug wäre es, das Zeugniß der Vergangenheit gegen die Zukunft aufzubewahren, anzurufen!

Ich ließ in meinem Geiste die möglichen Resultate einer solchen retrospectiven Telephonie vorüber ziehen. Und schrecklich sind sie, man glaube mir. Da ist z. B. Herr X., ein Musterpolitiker. Er ist Candidat für ein Amt. Man hat sein stark liberales politisches Glaubensbekenntniß seiner Zeit im Telephon aufbewahrt. Jahre vergehen, der nämliche Herr X. ist zu der Ueberzeugung gelangt, daß seine liberalen Gesinnungen seinen Interessen im Wege stehen, geschickt hat er umgesattelt.

Wir begegnen ihm auf der Rednerbühne einer politischen Versammlung, wo er ohne alle Umstände seine früheren Ueberzeugungen aufopfert und Phrasen fabrizirt, die seine Principien als reactionärer Neophyt vollkommen decken.

Plötzlich läßt sich in einer Ecke des Saals ein Geräusch hören. Welch' merkwürdiges Geräusch. Man könnte sagen, es sei das Echo der eigenen Stimme des Herrn X.... welches dort widerhallt. Es sind in der That dieselben gerührten Ausrufe, derselbe Nachdruck der Ueberzeugung. Nur ... wie soll ich das Phänomen erklären? ... Wenn der Ton auch derselbe, das Thema ist ja ein ganz anderes.

Und während Herr X. redet, ergeht sich das teuflische Echo in vollstem Behagen.

— Ja, meine Herren, sagte der Redner, die sogenannten Freiheitshelden gefährden die öffentliche Ordnung.

— Nein, meine Herren, läßt sich die andere Stimme vernehmen, welche immer die seinige bleibt, lassen Sie sich nicht von den feilen Reden Derjenigen bethören, welche behaupten, daß unser Land nicht für die Freiheit geschaffen sei!

— Utopien, meine Herren, fährt Herr X fort, Utopien sind diese sogenannten Reformen in der Verwaltung, mit denen man das Volk ködert.

— Chimären, meine Herrn, fährt gleichzeitig das akustische Echo fort, Chimären sind diese Kinderschrecken, mit deren Hülfe man den Fortschritt zu hemmen sucht.

Es hält nicht schwer, sich diese Scene unter schallendem Gelächter der Anwesenden ob dieses selbsteigensten Antagonismus weiter auszumalen. Man ahnt die Ursache davon.

Ein boshafter College hatte sich das grausame Vergnügen gemacht, in die Sitzung einen alten telephonischen Kasten mitzubringen, in welchem die stolze Sprache des Herrn X, als er in den Reihen der Opposition saß, aufbewahrt war. Und jenes unwillkürliche Duett eines einzigen Mannes war das Resultat.

Doch nun erst in der Liebe.

Was für Verwirrung dürfte darin das teuflische retrospective Telephon stiften.

Das Stück spielt in einem Haushalt, welcher seit zwei, drei oder vier Jahren je nach dem Temperament der Betheiligten und der Ereignisse besteht.

Ein heftiger Zank ist ausgebrochen, man wirft sich grobe Wahrheiten an den Kopf.

„Ach, wenn ich es vorher gewußt hätte," ruft Madame aus, „hätte ich mein Leben an ein Ungeheuer gekettet, das mich nur meines Geldes halber geheirathet?"

„Dein Geld! ich rathe dir, nicht davon zu sprechen. Du hast mich wie einen Räuber im Walde, angefallen."

„Du gestehst es also, Du hast mich nur aus eigennützigen Motiven geheirathet?"

„Glaubst Du, daß in dem Alter in welchem Du damals standest, nach zehn auf einander folgenden Verlobungen ...."

„....Er beleidigt mich, er beleidigt mich auf gemeinste Weise! ... Um deinen Grobheiten zu entgehen und in der Erwartung, daß das Gericht bald die Scheidung zwischen uns verfügen wird, flüchte ich mich zu meiner Mutter, mein Herr.... Aber vorher will ich Sie mit den Beweisen Ihrer Schurkerei confrontiren ... Warten Sie einmal."

Darauf stürzt Madame in ein anstoßendes Gemach und holt einen kleinen hölzernen Kasten heraus.

— Warte, Elender, und höre!

Darauf läßt sich der geöffnete Kasten in geschwinder Satzfolge also vernehmen:

„— Theuerste Adolphine, Du weißt, daß ich Dich liebe, Dich, Dich allein. Ich gehöre nicht zu den Männern, welche äußere Rücksichten vor den Herzensfragen walten lassen. Seit ich Dich gesehen, habe ich begriffen, daß keine andere Frau in der Welt mich glücklich machen könne. Ich werde daher bei Deinen Eltern um Deine Hand anhalten. Erwirke deren Einwilligung, ich bitte Dich, theuerste Adolphine; ich kann diese Qual der Ungewißheit nicht länger ertragen."

Man stelle sich nun das Gesicht des Ehemannes vor, dessen Frau diese alte telephonische Depesche, welche aus der Zeit seiner Rolle als seufzender Liebender datirte, bewahrt!

Nein, nein, mißtrauen wir uns selbst, gedenken wir unserer Unbeständigkeit, lassen wir die gesprochenen Worte verfliegen. Es ist schon zu viel für unsere menschliche Schwäche, daß die geschriebenen bleiben.

NEWBERRY, SOUTH CAROLINA, FRIDAY, APRIL 19, 1878.

WONDERS OF THE PHONOGRAPH.

How the Talking Machine Works—The Possibilities of its Usefulness—The Aerophone—Personal Traits and History of the Inventor.

[From the News and Courier.]

NEW YORK, April 6.—The othe day I went out to Menlo Park, Ne Jersey, and spent the afternoon the workshop of Thomas A. Edson, the magician, who is makin machines that talk. His laborat ry is as interesting as Monte Chr to's cave, and his achievemen make the tales of Arabian sorce seem credible. I saw the talki machine, talked to it, and it tall back. You have heard about it course, but the story can not be old one for years to come, and though the phonograph is as si ple as a jack-knife, it excites t awe of the beholder as a telegra wire stirs up an Indian's supers tion.

Menlo Park is about an hon ride from this city towards Phi delphia. It is a mere station, a has no houses except Edison's lar laboratory and the houses of l chemists, machinists and assistant The former is a great building, hundred feet long, the lower floo occupied by machinery for work ing in iron, and the upper as chemical and electrical laboratory A quiver of wires enter the roof, connecting with a wide circuit of American cities, and there are nine lightning rods over the peak of the building. It is filled with a clatter like a rolling mill.

I found Edison up-stairs talking with the mouth-piece of a phonograph, which hears and speaks with the same organ, a thin sheet of iron, which is a tympanum when it is spoken to, and a diaphragm when it talks. He was bent over it, and repeated in a solemn voice the sage apothegm, "Intra, mintra, cutra, corn, apple seed and apple thorn, wire, brier, lim ber, lock, three mice ran up th clock."

"That's wrong," somebody sai and he looked up and laughed an said he had forgotten it. He th greeted us cordially, but with diffident manner, as if not accu toined to society, and turned describe to us the talking machi Thomas A. Edison is rather abo the medium height, unshaven a unshorn, slightly shabby, with pair of bright, aggressive gray ey illuminating an otherwise uninte esting face. He is an Ohio man, and is only thirty-one. His conversation has a strong Ohio flavor. Indeed, in some respects, he is provincial, for, if puzzled about a thing, he resolutely exclaims, "I'll git it yit."

THE PHONOGRAPH.

has no electricity and no magnet about it. It is a very simple piece of mechanism. It consists of a brass cylinder three inches in diameter and eight inches long, mounted on an iron frame, and turned with a crank (Edison has substituted steam power.) The cylinder is reamed with a fine spiral groove, like the thread of a screw. Upon it is laid a sheet of smooth tin-foil, against which rests the needle which is vibrated by the voice of the speaker. The sound waves shake the tympanum; the tympanum shakes the needle, and the needle makes small corresponding indentations in the tin-foil, as the cylinder revolves. So now we found the tin-foil encircled by lines of minute dots, which Edison said were "a photograph of the atmospheric waves put in motion by the voice."

"Now see," he said.

And he lifted the mouth-piece and needle, turned the cylinder back to the point of beginning, replaced the mouthpiece till the needle was in contact with the foil, shifted the belt on, and immediately from the mouth-piece came, in a high, clear voice, "Intra, mintra, cutra, corn," &c., down to "three mice" that ascended the household timepiece. The articulation was perfect. The inflections and emphasis were precisely preserved. It was evidently a human voice.

Then he tore off the sheet and put on another.

"That sheet is uninjured, you see," he said. "It might be made to repeat that hundreds of times; it might be sent to foreign lands or kept to future ages, and it would say it just as well, if put on a cylinder like this."

Then he talked poetry into it, whistled, shouted, whispered, barked, neighed, stuttered, crowed.—Everything was returned with perfect modulation, the only difference being that something more than half of the volume had been lost. Then your correspondent tried it satisfactorily.

A lady and gentleman sang a round into it by use of a double (forked) mouthpiece, "Scotland's burning, Scotland's burning! Look out! Look out! Fire! Fire! Fire! Fire! Pour on water! Pour on water!" and the machine sang it over after them three times with great spirit, sending the bars upon each other's heels in the most amusing hurry. The two tones of a bass and a contralto voice were also perfectly distinguished. They had a little metallic sound, but Edison said, "I can remedy that easily enough. I must substitute a membrane for that piece of iron, and a sapphire for this steel needle."

He then informed the machine about "three blind mice" and about the aspiration and misfortunes of Jack and Gill, and various other matters which it repeated, with all the peculiarities and original utterance.

The phonograph is very provocative of eccentricities of utterance, for to hear it crow, stammer and hiccup as if it were inebriated, is funny enough.

Edison began a serious sermon, in a very slow and drawling voice:

Ladies and gentlemen, I have come—before you this evening—to deliver for your—benefit—a discourse on travels—in Bible lands. Allow me—before commencing—to sta-a-ate—"

Then he turned back the cylinder, and, moving the stylus over the same space, shouted into the mouth-piece: "Oh, give us a rest! Oh, dry up! Sit down! Put him out! Hire a hall! Oh, that'll do! Bah!"

The cylinder was again adjusted, and both speeches came out together, the latter impudent exclamations almost drowning the quiet drone of the sermon. This represents their reproduction.

Ladies and gentlemen—I have—[*oh—give us a*]—come before you this evening—to [*rest!!—oh, dry up!*]—to deliver for your—benefit—a—[*Sit down!—put him*]—discourse on travels—in —[*out!*]—[*Hire*]—Bible lands. Allow—me, be—[*a—Hall!*]—fore commencing—to state"—[*Oh—that'll—do!!—Bah!*]

The inventor now exhibited

THE AEREPHONE

which makes the human voice perfectly intelligible four miles distant. He will fix one at the entrance of the Paris Exposition grounds, which will shout "A greeting to the Old World from the United States of America, yours truly, Uncle Sam!" or anything else the operator chooses to say. This, he anticipates, will be of great value to warn vessels off shore to enable steamers to hail each other and exchange news at sea, and enable locomotives to shout, "All out for Columbus—twenty minutes for dinner!" and, in short, to enable anybody to address large masses of people for any purpose, stump speaking, for instance.

This monster Python is as simple as a toy whistle, far simpler than the phonograph. The same tympanum is used, but it creates a voice by opening and closing the valves of a steam whistle, instead of by photographing the sound-waves. In the phonograph, however, it seems incredible how the insignificant cause can produce the tremendous effect.

"What do you expect to do with the phonograph?" I asked Edison. "What is it good for?"

"I expect, he replied, "that it will be used exclusively by bankers and business men instead of a short-hand amenuensis. They can thus save hundreds of dollars a year. They can speak their letters into it as fast as they can talk at the rate of a page of foolscap a minute, and an office boy hired for three dollars a week can copy and send them, for it can be made to speak at any speed. To such correspondents as have a phonograph he will dispatch the sheet of tin foil, untranscribed, and he will thus address them in his own voice.

"It will be used as a reader in families. I can produce a plate on which an elocutionist can deliver the whole of one of Dickens's novels; I can duplicate the impression at the rate of twenty cents a copy, and every family that has a phonograph may lay the sheet on it and hear the whole novel read in the very voice of the elocutionist. And all for twenty cents! What a relief it will be for weak eyes! What a boon to blind asylums! What a blessing to the millions who have never learned to read!

"It will be used to teach music, and to enjoy music, too. Any family may hear Louise Kellogg's own voice at a cost of a few cents. It will be used to teach languages. Philologists will use it to compare different tongues. You see that its articulation is perfect. Your own mind will suggest important uses to which it may be put."

"What will the machine cost?"

"A hundred dollars, I expect."

Mr. Edison proposes to apply his discovery to many other practical purposes. It is claimed that at the coming Christmas there will be a thousand and one novelties in toys; dolls are to speak in any language that may be desired; the animals in Noah's ark are to give forth their natural notes of voice, and there are almost every kind of self-acting musical instrument, in every size and shape. The great use of the instrument is expected to be found in commercial life. It can be used in connection with the telephone, and messages may be recorded by the person sending and also by the one receiving, thus preserving a fidelity in business transactions that hitherto has been unattainable by any telegraphic progress.

ABOUT EDISON HIMSELF.

Edison's ancestors came from Holland in the last century. When he was eight years old his parents

suffered "to every amount," amongmany and about this time the boy left home to earn his own living. He had never been to school more than a few weeks, but he was enterprising and imitative, and he "picked up" a great deal and very fast. His business was that of a butcher, and when the war broke out, at fourteen, he became a newsboy on the railway. Stimulated by the eagerness of the public for news, he conceived the idea of printing their appetites for his papers, so he erected large bulletin-boards at the principal stations, and telegraphed the news headings of his papers in advance of the train. The result was a largely increased sale, and his plan was followed by others. This interested him in the telegraph, and he determined to make one himself. He strung a wire a mile long between his house and a neighbor's and constructed the instruments of iron, tin and wood;

but he was too poor to buy it, and they would not make one. So he obtained some cats one Sunday when he had leisure enough, he thought, to generate a current, and he fastened a wire to their legs and then massed up their backs, and waited for the result. The machine did not respond, and he blamed the rude instrument for his failure. "This incident," says his associate of many years, Mr. Edward H. Johnson, who relates it, "is perfectly characteristic of the man. He will to-day undertake elaborate experiments and conduct them with great care and marvellous patience and perseverance, although his person points to their utter futility. It is this trait, however, which led him into lines of original discovery and inventionunattempted by others."

While a newsboy Edison started a newspaper, editing, printing and selling it himself. He had a small press on the train, and on this he printed the little sheet, and he showed the most marked ability in obtaining a circulation of four hundred and fifty subscribers. A son of Robert Stephenson, connected with the Grand Trunk Road, sent back to England two hundred copies of Edison's "Herald"—the only newspaper in the world printed on a railroad train."

The boy now learned telegraphing, and rapidly attained proficiency, and occupied difficult and responsible positions. While at Cincinnati, when he was only twenty, he invented the important process of transmitting two messages over one wire simultaneously. Two years later he invented the duplex and printing telegraph which is at the basis of the Gold and Stock Exchange reporting instrument—the familiar "ticker." When he was at Boston he played an ingenious trick, which cost him his place. It was the rule for each night operator to telegraph to headquarters every half hour the number "0," and the name of the office, to demonstrate that he was wide awake. Edison contrived a machine which would, at regular intervals of half an hour, satisfy the central office without waiting him up, if he chose to sleep. He sold them to other operators, and was discovered, and "dismissed the service in disgrace."

It was about this time that inventing became a passion with him. He would work all night, and experiment with wires and batteries all day. This caused much confusion, for which he was occasionally reprimanded.

Edison is a tremendous worker. Work is a dissipation with him—his only bad habit. For the last ten years he has averaged eighteen hours a day at his desk. His home is within fifteen rods, but when he is in the crisis of an invention he does not go home for days, either to eat or sleep. He never went to school but a month in his life, but has taken out 157 inventions and filled 67 caveats, and is now only 31. Twenty-five men are employed in his laboratory merely to materialize his ideas. He is worth $150,000, and now has an income of nearly that every year.

Sunday, Oct 28

A beardless young man, of a pale, studious face, clear blue eyes, dreamy aspect, and chestnut locks —this is Edison, the inventor of the phonograph. He is very fast, and, it is said, has never heard clearly the voice of his invention. The phonograph is the 126th patent, and from his ingenious no is said to draw a large income. He has a bashful, quiet manner, but does not seem to enjoy society, and is rather so miserable as when he is alone. It is related that when in his city a few weeks ago, he spent three hours in an opera factory, and in that time he was introduced to only one of the little musicians performing, although he talked to quite a number.

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ACADEMY OF SCIENCES.

PHONOGRAPH DAY.

A NEW VICE-PRESIDENT AND SECRETARY—A CHEAP METHOD OF FINDING THE SUN'S DISTANCE—THE PHONOGRAPH AND VARIOUS TELEPHONES EXHIBITED—HIS AGENCY MUCH ANIMES—HONORS TO MR. EDISON, AS INVENTOR.

[FROM A STAFF CORRESPONDENT OF THE TRIBUNE.]

The Academy met, April 15—The elections at the business session of the Academy attracted a notable share of attention. Professor O. C. Marsh was elected vice-president in place of Dr. Wolcott Gibbs, whose term of office had expired. It was deemed desirable to have the Secretary's address delivered during the evening, following the official heads of the Academy; hence this evening's session was all arranged in advance of mechanical adjustments. On this account Dr. Gibbs kindly urged the election of Professor Newcomb, as well as an increase in the terms of the new candidate. Professor J. W. C. Coffin (formerly superintendent of the Nautical Almanac Bureau), and of course a mathematician), takes the place of Professor J. D. Hilgard as Home Secretary—a circumstance which also furthered his view. Professor Marsh being Foreign Secretary of the Association for the advancement of Science, is now rapidly reaping the honors which have been justly his due; the Academy, in making him Vice-President, gets as much as it can for four. A verbal dispute, in the way of election within the past two or three days, the members felt the rioting from that kind of interesting combination. Consequently they did not add, as they were expected to, two more new members, to make the annual yearly addition of five. There is indeed a harrowing feeling among the friends of candidates, that the three elected yesterday are all who will be so honored this April. There are many of the other members who have not at all students to increase the number of membership, and a similar feeling is apt to be developed annually in the younger ones the day after they are elected.

MEASURING THE VELOCITY OF LIGHT.

The first scientific paper of the morning was by Professor Simon Newcomb, on "Plans for Measuring the Velocity of Light." He began by saying that he was communicating last results of determining the problem of the solar parallax—the distance of the sun. Among the most eloquent of the methods tried for this purpose was that which depended upon the speed of light. It is evident that if we know how many seconds it takes light to come from the sun to the earth, and we know how far it is from the sun in miles, we could at once calculate the distance of the sun by multiplying the two numbers together. Or, if we know the speed of light in miles, we can find the sun in miles by dividing the two numbers together. The former of two methods is pretty accurately determined by two independent methods, and the latter is the subject of the present discussion. Of the two methods the latter was perhaps the first to be suggested, and the finding by star light, travels in a second at certain approximate figure, but instead of caravan difficulty, devised a method by which the speed of light could be measured on the earth. The problem now to be attacked, is to send the light by means of a revolving mirror to a fixed mirror at a distance, and receive it back again on the revolving mirror from which it was sent. A new method of doing this has been devised, which seems to have been destined by an officer in the Navy; but on this the Professor Newcomb has as yet no particulars. The difficulty in the way of the method is the very limited character of the apparatus for such a long distance; hence, there is the chance of the light not being returned, the return ray, by which the velocity of light is measured, being too feeble. The method of Professor Cornu consists in the use of a crystal to produce the electric light alternately. The method of Professor Newcomb proposes to use

MR. EDISON ENTERTAINED.

Mr. Edison appeared somewhat overwhelmed by the attentions showered upon him at the banquet, but that this was merely shame, including a realization that Mr. Edison's work could not speak for itself. The phonograph and thermogen exhibited, and numerous associates, in the intimate atmosphere of the exhibition, succeeded in making the evening a most delightful one. Mr. Edison will remain with great discretion. Impromptu conversation was then held with Philadelphia, and all of the guests were introduced and responded briefly to the various telephones.

OXYGEN IN THE SUN.

When the Academy of Sciences met on Monday, Professor Henry Draper, of New-York, gave a report of progress in his experiments proving the presence of oxygen in the sun. Before Professor Draper made the discovery of that substance, it was supposed that the solar spectrum contained only black lines; he found a series of bright lines, which he has since identified as those of the oxygen. Photographs of the oxygen spectrum, with the solar spectrum alongside, of the same bright lines, were exhibited. To the twenty lines which he had previously identified he has since added ten, making the thirty best known lines of the gas.

Professor Draper gave a brief account of the difficulties of his experiments, and the ingenious means by which he had made them successful. One of the most curious of these contrivances is a "quartz compensator," which is used to correct the errors of the lens. The ordinary refracting substance, glass, is useless for spectral examinations, because it interferes by reason of its composition. He has sought for other substitutes in the sun; I think a thick crown of carbonic acid would be theoretically as yet almost useless. His most successful substitute is a lens of quartz, which he has used in the photographs of the oxygen spectrum that have shown the level of the photosphere. Professor Langley remarked that the photographs of the oxygen spectrum were the most beautiful he had ever seen. Dr. Peters on the solar parallax, discussing from historical and other data the evidences as to orbital calculations of the distance of the sun should be considered the most trustworthy.

Dear Doctor Agnew

LET THE EXHIBITION EXHIBIT.

Let us give a hint to the management of the Permanent Exhibition. Their programme for opening day, we very much fear, is not auspicious nor an augury of success. It was a fallacious idea to open on the first of May, along with and out of compliment to the great Exposition at Paris, but then the happy thought seems to have stopped. The programme, so far as developed, indicates nothing new; nothing attractive and nothing striking. It is, in fact, the conventional routine, worn and brass band of the village stage of municipal existence.

Now this kind of thing will not do in Philadelphia, or for any enterprise of the proportions and magnitude which the exhibition must assume to command success. An oration is simply a mechanical show-piece, and for such an occasion as this of the first of May utterly meaningless and inadmissible.

The Permanent Exhibition, if it is to be an institution, must move forward all the time. It must be on the wing. Stories of the past or on the work of the past, no matter how grand those memories are, how wonderful that work. It must gather as it goes, and sum up from year to year, and month to month, the record of all the progress of the world.

Since the closing of the Centennial Exposition there have been three great practical developments in the history of science, or, to speak more accurately perhaps, three great discoveries which have come down to the range of popular understanding. These are—

I. The Telephone.

II. The Phonograph.

III. The Electric Light.

If, on May 1, the people of Philadelphia, of Pennsylvania and of all the great cities of the United States, should know that in the old-main building of the great Exposition, all these three wonderful achievements of scientific discovery would be demonstrated and exhibited on a grand scale, not only the buildings but the grounds adjacent would be flooded and washed with a human sea. The present projection of the American mind is in the direction of scientific study and investigation. Popular science is the law of our people. Even technical scientific lectures crowd the Academy of the lecturer is a recognized authority, a Tyndal, a Huxley, or a Barker. How much greater would be the attraction of the brilliant demonstration which should embrace at one place and within the limits of one day the results of these three discoveries, which are dividing the eager thought and curiosity of the whole country. A telephone, or telephones, for popular use could easily be placed in each end of the great building three-fifths of a mile long. A phonograph, or series of phonographs, that never needed rest, from the cranks, might talk all day long in English, French, German, Spanish, Russian and Japanese, giving directions and information, to the surging throngs of strangers. The whole building could be easily flooded with the delightfully intensified moonlight of electric illumination. It is not too late to do this yet; ten days or five enough to switch in contractors altogether, and plenty of time to fit up an exhibition hall.

Dr Peter Weir, Akron
Apr 19

ANOTHER BENEFACTOR.

Dr. D'Unger, of Minneapolis, the Chemical Genius, Prospers Before the Days of the Centennial—He Cures Death Upon the Diabetic's Trembled Stomach.

[Chicago Tribune, April 11.]

In the issue of the *Tribune* of March 24 was printed the following important letter:

MINNEAPOLIS, Minn., March 21.—Editor Tribune: Can you have published numerous articles on the subject of diabetes, but none of them, so far as I have been able to discover, have resulted in relief to the sufferer. They were hopeless. With your permission, I will now give to the world, through the Tribune, a remedy that cures for diabetes—a cure that has been tested practically, and always successfully.

Let the invalid—I mention not whether he is bed-ridden, getting off, in beginning it, or on a tapper, or anywhere between—take a wine-glass of Dr. D'Unger's Diabetic Compound (Peruvian bark). This will cure any diabetes. Then, to not increase the dose to six glasses (teaspoonfuls) without any danger, and take it three times daily, one hour before a meal. It will create a healthy appetite for food. In the course of a few days the distressing symptoms of the diabetes begin to disappear, and in less not only all pain for the kidneys, but also the tendency to the way of disease.

Secondly, in this city, a well-known gentleman, who had been suffering not less than six months, and who was reduced to the verge of death by the various drenglists whom he had tried in vain for relief, and would recover, that he could almost see death; but they could hardly be called drenglists, for they were not, because, never before in the history of the world, did a remedy like this, and in the course of the first week I saw a change for the better. During the three months of his medicine for his own benefit, but the literature of medicine did not. Indeed, This case can be verified by the professors of nerves of our drug-stores. He will satisfied any one who will call on him. He will guarantee a cure in all cases, using this remedy alone.

E. D'UNGER, M. D.

In a subsequent letter communicated to the Chicago *Tribune*, Dr. D'Unger says:

As all medical men are doubtless aware, there is a large amount of admiration in the popular mind, and, consequently, banks which are blind with the greatest possessing that the curative power of medicine, but not the effective and certain properties which the genuine bark alone possesses. Quinine is a mineral, and we have, therefore, I should have mentioned that the bark out of which it is made *used to have*, for it is the most *terrible* property that exists in medicine.

It is a well-known fact that the doctor's remedy is a nostrum, and that he has ordered no prescription. The extract has also shown that it is not a nostrum, but a well-known compound, and the prescription is given in detail, so that any one can use it if he is careful to procure the right drugs. There have already appeared numerous lines in our columns attesting to the efficacy of Dr. D'Unger's cure, and we are pleased to observe one amusing at it, and another, that it is a "new" remedy for drunkenness. In the gospel temperance meetings at Farwell Hall the remedy is very much needed. It can be had in every town and city, sufficient quantity can be kept in a house. It is an excellent tonic, whether it cures intemperance or not. Chicago is full of people who ought to give it a fair test, and there is much sneering at it because it will work until it has been proved a failure.

If Dr. D'Unger has really discovered a specific that will cure diabetes of the terrible stage of insanity or dreaming death, he will be one of the greatest benefactors to the human race the world has ever known. If this remedy proves successful and possesses the wonderful curative properties that the writer of the above letter claims for it, he will be entitled to every man and woman who has an appetite for liquor, it would be a blessing to the world. If it will do this, it would do away with crime almost altogether. It would bring sunshine into that clouds of darkened homes. It would banish poverty. It would vanish crime and misery. It would make men industrious and economical happy. Any man who can bring about such results as these, has made a discovery that is the talk of which Mr. Edison's discovery is small. It may be that Dr. D'Unger's remedy is a specific for diabetes, but it is probably incorrect in this trial, and there are plenty of men in this city who ought to test it at once. There is no secret about the medicine or the formula. It is openly announced, and any one can prepare it. A very short time will test its merits. If it is found, the victim finds himself entirely free from it. He makes a brief struggle, but finally he has all the appearance of success. The meetings of the Farwell Hall sort in the city would be glad to give it a thorough test. A society free or small-pox, and it must be tested as that disease are. They, or those are open before the eyes of every abstruse philosopher on earth, whether or not the bald philosopher has learned that two straight lines cannot inclose a space. Appears, we are pleased that Mr. Thomas A. Edison, according to the only-written article in the Chicago *Tribune* by Mr. George H. Hiles, has been too busy with his inventions to elaborate a system of theology of his own,

for he simply believes that the existence of God can be proved in numberless ways, and on this simple truth his mind rests, meanwhile he gives his time to inventions that are of incalculable benefit to mankind. We must congratulate Mr. Edison on having a

Dear Mission Agnew

Apr 22. 1879
Chicago Tribune

ONE SCRUPLE ENOUGH.

"One peculiarity of theology is that it is so simple a sphere of truth that every man, however unlearned, can demonstrate the axiomatic propositions that have puzzled the ages. Every other and every deacon knows all about providential government, election, atonement, and the motives that enter into every act of a divine being. Courts will sometimes spend months and listen to learned arguments, to discover, if possible, the motive of a human being in a given act; but there is no such hardness and mistaken that motives are concerned. One of these are open before the eyes of every shallow philosopher on earth, whether or not the bald philosopher has learned that two straight lines cannot inclose a space. Appears, we are pleased that Mr. Thomas A. Edison, according to the only-written article in the Chicago *Tribune* by Mr. George H. Hiles, has been too busy with his inventions to elaborate a system of theology of his own,

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MARTIN COUNTY, MINN.

Dear Mission Agnew Apr 22

Will The Man Who Thinks
That he knows it all please step forward?
Chicago is full of Editors known, and mid-wisdom, above the clouds, and Philadelphia is not behind her sister cities in the number of self-made, self-satisfied, self-opinionated gentlemen, who, if they would only deliver in the ranks, discourse with the Almighty Himself—day in, day out. Congress lives over $20,000 to one man ("Prof." Hayden) to complete the Tribune Statistical Encyclopedia is far off still feasible. What has the Government done for the discovery of the Phonograph, Telephone and Meters. Representatives, your constituents are making themselves heard. The time may come when the long among men will be recognized. "Behold him! It is he who discovered the hidden wealth and power of nature, grasped it, and made it serve humanity."

Let Congress follow suit from its example by generous and appreciative

Inventors, such a class, are modest. Being devoid of self-assertion, they are frequently left to struggle with poverty, and the world is the loser. Congress should sacrifice for material wealth. Would it not add to the honor and interest of the centennial celebration if Congress would endeavor to protect and encourage the inventor? Would it not be a fitting tribute to the memory of the inventor of the telephone (the inventor), ought they not to be rewarded? Congress appropriated $100,000 for the Centennial. Would a similar amount be too much for a phonograph, while a meritless, grasping corporation like the Bell Telephone Co. has been allowed to fatten on the profits for years, while the inventor, for lack of means, has been unable to defend his rights, and has been defrauded of his just dues.

Apr 23. 1879
Chicago Tribune

N. Y. Allgemeine Zeitung

Mittwoch, den 16. April.

Herausgeber: Wilhelm Wagner.
Office: 21 und 23 Park Row.

Der Phonograph.

Das neueste pyrotechnische Wunder, die in Amerika so ungeheuer Sensation machende, neulich auf einigen Tagen in den Spalten des Sun, Herald, Graphic, Tribune, Times, Staats-Zeitung, Herold, Staats-Zeitung und Freiheit gedruckte Erfindung des Herrn Edison, welcher sich bereits durch andere nützlich-wissenschaftliche Erfindungen einen Namen erworben hat, ist der Phonograph. Derselbe hat die wunderbare Eigenschaft, daß Jedermann Telephon (der Erfinder), ought they not to be rewarded? Congress appropriated $100,000 for the Centennial. Would a similar amount be too much for a phonograph, while a meritless, grasping corporation like the Bell Telephone Co. has been allowed to fatten on the profits for years, while the inventor, for lack of means, has been unable to defend his rights, and has been defrauded of his just dues.

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Lastkasten und mittheilte it well, und wir hoffe he will grower find laissen for informing the world on theological matters, for such ingenuity as he could display would revolutionize the thinking of our day. Not that Mr. Edison, or any other man, can set aside the historical facts of Christianity, and the great essential truths of Christ's mission and love, but that in these fields of controvertied thought he would be entitled to a hearing to *baptize or atonism* that would set the world almost a century.

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Volkszeitung

New York, Sonntag den 7. April.

Edison's Sprechmaschine.

Thomas A. Edison in New York, der erfinderische Geselle mit seinem Telephon, seinem Mikrophon und seiner Quadruplex, ist wieder da. Edison ist in New York mehr als Zauberer, denn als Erfinder bekannt.

Edison's Erfindungen der menschlichen Sprache gehören zu Edison's Allotrien auf dem Gebiete der Wissenschaft, wie Jules Verne's tollen Spukmachereien. Neulich die neueste Erfindung Edison's, welche Edison's neugierigen nachgerade zuletzt, wie Hohn, Spott und Verachtung auf Edison's tollere Treiberthiele auf. Die Schöpfungen Edison's sind Experimente, welche meist mittelst einer Platzthiele automatisch auf ein Stück Papier oder Leinwand Striche und Figuren ziehen, welche Niemand verstehen kann, als Edison selber und seine Assistenten Experimente sind und bleiben, um ihn herum Niemand Dutzend bei Edison's Experimenten ein Dutzend mal Mundvoll der Erfinder selber, welche Edison's

Phila Inquirer Apr 20. 78

men!" Ring mit Trommelfell und Nadel werden jetzt durch Drehen etwas vom Cylinder entfernt und siehe da, die Nadel hat ganz deutlich in der Rinne die Schwingungen registrirt, die während des Sprechens das künstliche Trommelfell machte. Es werden jetzt ebensoviele Rückwärtsdrehungen der Kurbel nöthig, um zum Anfangspunkte zu gelangen, als während des Sprechens Vorwärtsdrehungen stattgefunden. Ehe die Nadel wieder in die Rinne eingedrückt wird, setzt der Experimentator ein Schallrohr (Resonator) auf den das schwingende Scheibchen tragenden Ring auf, um die Schallwellen zu verstärken. Jetzt dreht er wiederum vorwärts und ein ganz deutliches, Herrn Applebough's Stimme bis auf einen gleich zu besprechenden Mangel getreulich wiedergebendes: „Good afternoon, Gentlemen!" begrüßt uns aus dem Resonator. Der erste Eindruck ist wirklich überwältigend.

Von allen Lautbildungen und Tönen ist am deutlichsten zu hören das, in etwas erhöhtem Tone laut gesprochene Wort. Zunächst deutlich war Husten und Niesen, dann kam Gesang; ferner Hundegebell und Miauen der Katzen; ziemlich deutlich war auch der Refrain des Liedes von den drei Krähen: „Crow, Crow, Crow." Weit weniger deutlich war Pfeifen und — Küssen!

Einen merkwürdigen Effekt brachte der Experimentator dadurch hervor, daß er dreimal die Nadel über denselben Theil des Zinnbleches weggehen ließ, während er jedesmal etwas Anderes sagte. Als er nun ein viertes Mal dieselbe Stelle vor der Nadel vorüberführte, jedoch mit aufgesetztem Resonator, hörte man deutlich alle drei Sätze zu gleicher Zeit. Es erzeugte dies die äußerst komische Täuschung eines heftigen Wortwechsels im Resonator (a tempest in a teapot). Doch konnte man jedem einzelnen früher gesprochenen Satze genau folgen. Ja sogar ein Vers des Liedes, der damit zusammenfiel, übertönte ganz deutlich den Anfang dieses imaginären Wortwechsels.

Unter den zahlreichen, verschiedenartigen Fragen, die von einer amerikanischen Zuhörerschaft mit der üblichen, republikanischen Ungebundenheit bei solchen Gelegenheiten gestellt werden, war auch die, ob der Phonograph nicht rückwärts sprechen könne. Herr Applebough gab der Fragerin den Bescheid, daß er nicht zweifele, daß sich dies bewerkstelligen lasse, doch sei vorläufig die Befestigung der Theile nur im Sinne der einen Drehungsrichtung geschehen und könne er deßhalb keinen Versuch machen.

Der oben erwähnte Mangel nun besteht darin, daß die Sprache des Phonographen denjenigen Timbre hat, den wir fälschlicher Weise als „durch die Nase" erzeugt betrachten. Bekanntlich wäre es richtiger zu sagen „ohne die Nase", — wie sich jeder leicht durch einfaches Zuhalten der Nase beim Sprechen überzeugen kann. Die Erklärung ist sehr einfach: da nur diejenigen Schwingungen das künstliche Trommelfell in Bewegung setzen, welche direkt aus dem Munde kommen, während die durch den Resonanzboden der Nase austretenden darüber hinausgehen und das schwingende Scheibchen nicht treffen, so werden nur die ersteren von der Nadel auf dem Zinnblech registrirt und ihre Wiedergabe verursacht auf unserem Trommelfelle den Eindruck, als wenn „ohne die Nase" gesprochen worden wäre. Ich theilte Herrn Appelbough meine Ansicht hierüber mit und er stimmte mir sofort bei in Bezug auf das Entstehen dieser Erscheinung. Ob Herr Edison diesen Umstand schon in Erwägung gezogen und das nöthige Mund- oder vielmehr Nasenstück an seinem großen in Menlo Park aufgestellten Phonographen angebracht hat, das konnte mir der Herr nicht sagen. Er erwähnte nur beiläufig, daß das letztere Instrument bis auf 160 Fuß Entfernung deutlich gehört werden könne.

The Telephone and Phonograph.

Professor T. A Edison, with the speaking phonograph, made some practical exhibitions of it at the Patent Office, before the commissioners and examiners, and then before the Senate Patent Committee and the House Patent Committee, attracting so much attention at the latter as to almost break up a quorum in the House. This evening he visited the White House by invitation. Quite a number of the members of both houses tested the machine, and were amazed to find their speeches reproduced with lifelike exactness. After the House had adjourned the phonograph was set on the Clerk's desk and told the affecting story of Jack and Gill so it could be plainly heard in all parts of the hall and galleries. Professor Edison received quite an ovation wherever he went. His reception by the Academy of Sciences, at whose invitation he visited Washington, was pronounced by the president of the society to be an era in the history of that body. He was introduced as the greatest living inventor of any country.

Daily Graphic Apr 22

—The talking-phonograph feels its responsibility.

…COU… THE…
A GREENBACK SONG.

[TUNE AMERICA.]

…r country, let's agree,
…m errors chains to free,
While Freemen stand;
…truth our watchword be…
…Within our land.

II.

…hearts with sadness swell…
…Dear land we love…
…Faith, Hope and Love…

III.

…Greenbacks our…
…Silver…
…Break the Gold Gamblers'…

IV.

National Banks…
…Greenbacks…
Government…
Honestly…
Gold, Silver…
…Our Nation…

…Greenbacks…
All money…
On the land…
…Nation…

Evening Post Apr 17 78

THE PHONOGRAPH.
An Evening with the Machine in a Western Home.

It happened that Mrs. Barstinglow was going down to Keokuk for a few days, and Mr. Barstinglow was inconsolable. At one time he protested that she should not go; he could not endure the lonesome house during her absence. And then again, he declared that if she must go, he would neglect his office, and let his business go to the bow wows, and he would go with her. At length, however, she persuaded him to be reasonable, and on her repeated assurance that she would not remain away longer than three days, he consented to let her go. He even bought her ticket, and ordered the carriage and paid for it two days ahead, lest his resolution should give way and he should forbid her going from him. And from that time till the morning of her departure Mr. Barstinglow spoke in subdued tones, and moved about with the air of a man whose heart was buried under mountains of grief.

Before she left the house, Mrs. Barstinglow set the phonograph in the sitting room, behind the clock. Then she kissed her disconsolate husband, and begged him to preserve his precious life for her sake while she was away, and then she was gone.

Every day, during her three days' visit in the Gate City, she received a letter from her mourning husband, begging her to come back and telling her how lonesome he was without her, and how like a grave the empty house seemed, and how the hours dragged over his aching heart with leaden feet. And in three days she came home, and filled the solemn house with sunlight and laughter again.

The evening after her return to Burlington, she took down the phonograph.

"I wonder," she said, "what we said last in its hearing! It must have been something while we were discussing my visit. Or may be it has caught some of your poor, longing moanings while I was away."

And then she turned the crank.

"No," croaked the phonograph, in tones of hearty reassurance, "no danger of that; she's safe in Keokuk for three days; saw her safely off, myself, this morning. Light your cigar while I light another lamp and make the room look cheerful."

"Why," exclaimed Mrs. Barstinglow, in a countenance of amazement, "what on earth is it saying!"

"Oh, some nonsense some of your visitors have talked into it some time or other," replied her husband, nervously, "people talk all kinds of stuff into a phonograph, you know. They say anything for talk."

Mrs. Barstinglow, looking only half convinced, gave the crank another turn.

"This is good whiskey, Barsty," ejaculated the machine, very earnestly. "You don't get it in Burlington, do you?"

Mrs. Barstinglow gave a little shriek.

"My dear," said her husband, looking now quite as worried as he had looked when he was begging her not to go to Keokuk, "put it away; somebody has had it out in the stable, and it might say something perfectly shocking, you know. Put it away."

But Mrs. Barstinglow, upon whom the spirit of investigation had descended with great power, ground away, and the phonograph, in a voice marvellously like her husband's, went remorselessly on.

"Not much; they don't make this kind now. It's some old Monongahela, copper distilled, that Mrs. Barstinglow's mother gave her for medicinal purposes three years ago. Fill up, there's plenty of it, and I can replace it with any kind of beverage when it's gone. The old girl won't know the difference."

Mrs. Barstinglow felt herself turning to stone, but the next turn of the crank brought out an uproarious—

"Ha, ha, ha! Here's to the o. g!"

That fanned her cheeks into a flame.

"For mercy's sake, Malachi Barstinglow," she shrieked, "what does this mean!"

Mr. Barstinglow now looked as though he really did wish she had never gone to Keokuk.

"It's just as I tell you," he said, with an effort to look unconcerned that was like a humorous book, a colossal success, so far as its utter failure was concerned, "Somebody has been talking all sorts of nonsense into it just for talk's sake. How else could it get hold of such dreadful stuff in our dear little home, lovey!"

Mrs. Barstinglow didn't say, but she turned away and the phonograph asked carelessly,

"Throw round for the deal!"

She thought she would faint but she didn't, and the pitiless machine proceeded to remark, with a variety of voices,

"It's my age." "You'll have to straddle that blind if you come in." "Give me two cards." "Chip one." "I'll see your little one and raise you a couple." "Push the bottle this way, Ben." "Ain't you going to stay in, Harry?" "Can't stay in on a pair of sixes." "Call you" "Two small pair, kings to head." "Tens and deuces. Take the pot." "Barsty, get us something to eat. Old girl left the cupboard keys, didn't she?" "Yes; told her I was going to keep back, at home, to save expenses and keep out of bad company." "Ha, ha, ha!! Ho! ho! ho!!!"

"Oh!" yelled Mr. Barstinglow, unable to contain himself any longer, while his wife, more dead than alive, leaned over the phonograph and ground away at the crank, in a dazed kind of way, "Oh, keep it up! That's right! Keep her agoing! Grind it all out! Confound the diabolical piece of black art and the vile assassin that invented it. Keep it up! That's right! Believe a senseless diabolical piece of monstrous mechanism rather than your husband. Keep her agoing. Keep it up!"

And Mrs. Barstinglow did keep it up. She kept it up and listened to that phonograph swear and shout and howl; she heard it shriek, "Oh! my eye, my eye!" She heard it tell some one to let some one else "have it again in the same place;" she heard it warn somebody to "hold his head over the stove hearth, and not let his nose bleed on the carpet," and at last, as it assured her very thickly and with some difficulty, that it was "a ban' of jorry goot ful-fal-fellows," and that it "won'-hic won' g' ome till morning," she ground it into silence, and sank back, speechless and breathless, while Mr. Barstinglow took the phonograph out into the back yard and smashed it into so many and such small fragments that it couldn't reproduce even a steamboat whistle.

And now, when people go over to the Barstinglow's to spend a pleasant evening, and happen to say, "What have you done with the phonograph, Mr. Barstinglow?" it affords the visitors entertainment for the rest of the evening to study the different expressions which creep over the faces of Mr. and Mrs. Barstinglow, while Mr. Barstinglow, as he answers the question, thinks he would give ten thousand dollars if he could find out how the members of the Paragraphers' Association tell lies so easily and make them sound so marvellously like the truth.—[*Burlington Hawkeye.*

THE DAILY GRAPHIC
TUESDAY, APRIL 30, 1878.

☞ Art correspondence, with sketches of important occurrences and notable scenes, and also photographs of interesting subjects, are solicited from all parts of the world. If used they will be liberally paid for.
The sender's name and address required on every communication, not for publication, but as a private guarantee of good faith.

INVASIONS BY THE TELEPHONE.

If the telephone shall justify the promises that have been made for it, it seems certain to change so radically the current methods of communication as to amount almost to a revolution. Leaving out of the discussion, as merely a speculative theory, the assumption of some that the telephone will ultimately supersede the telegraph altogether, making the agile-fingered operators no longer necessary, and enabling friends to communicate, at long or short distances, by word of mouth, without the intervention of third parties, we may consider two things as practically settled, as indicated by our interview to-day with the Western Union Telegraph Company:

1. That the telegraph is to be superseded by the telephone in all municipal service.

2. That the telephone is to be adopted as the feeder and auxiliary of the telegraph at all small way stations now too unremunerative to pay the cost of an operator.

The telephonic service for cities, as outlined in our interview, seems likely to be of the greatest practical value. If telephonic wires, by converging at a common centre, where alone there is a manager, can be hitched and unhitched at call, so as to place it in immediate communication with B, without any danger of being overheard by other parties, the importance of this establishment can scarcely be overestimated. When extended and developed, as it undoubtedly would be, it would go far towards making the mail, the telegraph and the district messenger obsolete for the purposes of communication in cities.

The addition which, it is said, the telephone is to make to the provincial telegraph system, is not much less important. The placing of 3,000 or 4,000 little towns in connection with the telegraph, by dropping a telephonic mouthpiece into their midst, will greatly accommodate large regions of country and add much to the aggregate comfort. The arrangements to increase the public service which are being made by the Western Union, under its new management, are highly creditable to the enterprising spirit of that gigantic corporation.

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Washington Apr. 24 '78

The Post And Union.

THE POETRY OF THE PHONOGRAPH.

Its Marvelous Feats and Capabilities—Its Humors and Solemnities.

The following extracts from a report of Hon. S. S. Cox's late lecture on the Tenth Muse are too good to be permanently crowded out. To impart valuable information in captivating periods is truly the Coxian method.

"A teacher of the deaf and dumb is in love with a pupil. He desires to converse with her. That was natural. To do this, he studied the law of sounds. He makes an artificial ear. He teaches the deaf and dumb to talk, although they could not hear. He instructs them to divine thought by the motion of the lips. Melville Bell is the Ohio teacher. He is the discoverer of what he called "visible speech." He taught how to use the mouth for sounds, which served as letters and words—a process by which sounds caused by air waves of various density and rapidity were transmitted to any distance by telegraphic circuit. Then follows the still more wonderful sound-waves from the electric wave, and lo! the telephone! Then follows the method of Edison, which registers the tones of the voice, reproducing every word with exactness; and we have the phonograph! Next comes the ærophone, which increases the sound.

"These machines are wonders. The faster you turn the cylinder the higher the voice is pitched, and if it is turned irregularly it will sing you a falsetto. By varying the velocity of the cylinder you make the voice a bass. When you reproduce tone by electro-magnetism it is the human ear with its stretched membrane or diaphragm that is used. It is the tympanum sent on a distant flight by a metallic conductor. The idea of talking into a machine—an iron thing—seems absurd. But I have talked with people not half so interesting [laughter] and whose tympanum was not nearly so refined and sensitive as this metallic sheet. The dead metal is sensitive—more so than our nerve power, quicker than our speech-faculty. Ear and tongue are one, and each, in the telephone, an improvement of the original. If I may be excused for a personal allusion my first interest in this phase of poetic science was awakened by the account given in the New York *Tribune* of the first words spoken into the instrument in the Centennial building by Sir Wm. Thompson. He picked up a chance paper; it gave an account of the St. Louis convention. He read: "S. S. Cox has arrived." [Laughter.] Owing to the sibilants in the name, the articulation was imperfect, but that is corrected now. Edison, in a late number of *Appleton's Science Monthly*, accounts for it, by the fact that to make such sounds you want to talk into a smaller hole with sharp edges. Then, the consonants which hiss the ss-es so sharply are sounded with the serene sweetness of a summer sunset. [Laughter.] There is no doubt that the plate of the phonograph may be made durable. It is separable from the cylinder. Letters, instead of being mailed, may be sent by telephone, and they will talk out loud when you get them. One may have a pigeon-hole full of love letters from different persons on tin foil, and all the interjections, and sighs and protestations reproducable in tones. This would be touching. [Laughter.] Even the prattle of childhood or babyhood may be preserved. Think of it! How pleasant to know in after years what was the tenor and effect of your first squall on entering life. [Laughter.] How pleasant the first lisp for milk or ma, mush or pa. [Laughter.] Another use would be not less marvelous. There would be no dead languages. Dialect, brogue and pronunciation would be restored by a turn of the cylinder. All the sounds of nature, from the enlivening chirrup of the Nebraska grasshopper to the hoarse thunder of Niagara; all the music of the world, from the thrilling trills of Patti to the turbulent diapason of a Congressional chorus. [Laughter.] If one may hear out of "ear shot;" if one may hear a sound shot under the ocean, from one hemisphere to another, if soon one's words may be made into lightning and then transformed back into audible words, why may not the dead speak to the living? The phonograph completes the circle by covering the tenth muse, with something more than the fading wreaths of poetry. Why may we not soon learn to hear one another think? Or perhaps, transfuse one mind with another? Marvelous muse of Mechanism! What Wagner shall sing thy music of the future! When not only the voice of those absent or dead can speak to the present and the living, when not only the gentle tones of friends can be frozen like the voice in Munchausen to thaw under other conditions, thus crystalized for future use and comfort, but the voice of the orator and the harmony of the opera, may give immortality through charming sound to mind and soul! What wonder, then, if in some still more interesting future the same muse may immortalize other poems of feeling through other methods? Why may not "John Anderson my Joe" and his elderly spouse reproduce the days not merely by a memory, but by actual feeling when they were first acquaint? Aye, revive again the very hawthorne fragrance which gave its sweetness to their early love, and roll forward from the past and its abyss the hours which, on angels' wings, "flew o'er him and his dearie."

"Suppose some Dr. Schliemann or Cesnola, in prowling among the tombs of Greece or Cyprus, should find not merely the manuscript, but the enbalmed eloquence of Demosthenes and Æschines in their contest for the crown, and should, by a turn of the crank, let us have it in very tone and truth, it would be accounted marvellous, but it is simple compared to other phenomena now, all too familiar to be marvellous. An exhibition of Cicero, hurling his anathema against Catiline—if it were enfranchised in the Academy of Music or Lincoln Hall—would it not empty the galleries of Congress, even if a doorkeeper struggle were on debate? What an audience would rush to hear the unsealed eloquence of Samuel Adams or Patrick Henry with all its patriotic fire and indignant resonance.

"Think of some of the home utilities of this invention! A wife dies; her husband takes a second. By the poetry of mechanism, the wife anticipates the event, lays up in metallic foil a few choice ærial vibrations seasoned with healthy indignation. It is arranged to be let off with velocity, on a high key, at intervals, into the inconstant's ear! For, it being understood that to make sound, a stream of thrills is shot out from its source at the rate of 1,100 feet per second; and as the air waves are short, long or complex, so is the noise. Add, therefore, to these thrill-waves of 1,100 feet per second, the intense feeling of the husband and his second and you have a scene from the comic drama of Mechanism. How the membraneous drum of the husband's ear would tingle with old associations. How it would disturb the calm current of domestic bliss." Suppose he were in the act of kissing No. 2, and the machine should accidentally go off, and a voice scream, "Obadiah, what on earth are you doing!" [Laughter]. What consternation. No. 1, however, would have one advantage, being insulated in another world. He couldn't "jaw back." Hence he would be doubly unhappy. Life and death are full of compensations. Besides, a mode has been found out, by which the volume of sound can be largely increased. What consequences flow from this? It gives commerce advantages. It may save ships and lives. It would abolish the trumpet, fog-horn and steam-whistle. Already the machine is being tested, whereby the engineer on the locomotive may announce to the train of passengers, the coming station. What advantages would accrue to the pulpit and choir of the church. All the minister would have to do, would be on Saturday night, to speak his sermon against the diaphragm of a telephone! The choir might sing their hymns after the same method. Sunday morning the cylinder is brought in and by reversed revolution, the service goes on. No other physical power would be necessary, than the dog power that is harnessed to a churn.

"Why should it not be utilized in public affairs? Instead of the dumb show when the inaugural is read from the east portico of the Capitol, the President could simply speak into the telephone and fulminate over acres of listeners. This might even be accomplished without his personal presence. In a few months Edison tells me he will have a voice to be heard all over Washington. How would it operate in Congress? Admirably in a night session "for debate 'only,'" and tolerably on other occasions. Not only would the extraordinary noise of the House be overcome, but the weakest lunged member would have equal advantage with the loudest. All would become Stentors. The personal presence of members might be dispensed with and the constitution satisfied by a quorum of telephones. Pages or supernumerary doorkeepers might be utilized to turn the crank and evoke from the already overburdened tin-foil, heavy speeches on pig-iron, musical sentences on silver and solemn obituaries over departed statesmen. All this amidst the thundering echo of the galleries, from each independent citizen with a pocket telephone! Nothing of this kind is improbable under the auspices of this new muse of mechanism.

"If during the last few months, science has liquefied the most permanent of the refractory gases, under a pressure of 280 atmospheres, why should we marval at so simple a result, as the enlargement of sound in our ordinary atmosphere? It is no less simple a process than that of the familiar ear trumpet. Makes a bigger ear—that's all. Bulwer in his "Coming Race," did not draw wildly on fancy, when his hero heard the opera of birds in the heart of our subterranean nature. They sang duets, and trios and quartettes and chorusses,—all as if one piece of music. Nature is thus prodigal no less with her forces than her music. Bulwer but anticipated the telephone and phonograph. I hold in my hand this strip of tin foil. Last night, in my presence a friend sung into the tympanum of the phonograph, the nursery rhyme, "Dickory, dickory, dock;" then, by another turn of the cylinder, he whistled upon the membrane of foil, "Yankee Doodle." Then readjusting the point of contact, he ground out of the dents, both the song and whistle in the grooves, intertwisting them into one strand, yet each distinctly audible and separable upon the human ear. I could not help but wonder whether the instrument would survive some of the turbulent incoherencies which distinguish a field day in Congress.

"This invention would rise to its highest domestic interest, I think, at a party of ancient maidens. What a record of gossip might be made, if one of these instruments were wound up and set a going under the tea-table? And yet these phenomena are not so wonderful as the spectroscope, which tells the very elements of the farthest fixed star by little bars! The one is at home and in our midst, doing familiar service; the other ranges through the farthest stellar spaces, and by recording its observation, makes the nebulæ no longer hypothetical, but gives intelligent and staunch unity to the Universe of God."

THE EVENING TELEGRAM.
NEW YORK, THURSDAY, APRIL 25, 1878.

The American Mechanic.

The visit of Mr. Thomas Edison, the inventor of the telephone and phonograph, to Washington last week, during which he was the centre of personal interest at the capital, illustrates very strikingly the difference between the fields in which American genius has achieved its greatest triumphs in this century and in the last one. The chief benefits which America conferred upon mankind in the eighteenth century were political. The statesmen of our revolutionary period were instructors of the world in the art of government. The Declaration of Independence and the Constitution of the United States were their illustrious products, and remain political achievements to which succeeding ages have furnished no parallel. The great emergency of our civil war and the subsequent period of reconstruction and reconciliation have not evolved a single measure of statesmanship instructive to the world, with the one exception of the Geneva arbitration, and we are doing our worst to deprive ourselves of any credit from even that exploit. Our national fame in the history of the nineteenth century will rest upon practical discoveries and inventions in natural science and the arts tending to promote the conveniences of life. The Capitol symbolizes American triumphs in the last century, the Patent Office in this.

Nor do we perceive any likelihood of a change from the direction of our present tendencies. One extraordinary invention succeeds another with increasing rapidity, and the circumstances favoring their multiplication are equally on the increase. Very few inventions ever are due to accident, and in spite of the opinion of so high an authority as Henry Buckle, the historian, to the contrary, very few are due to deductive reasoning. Shrewd observation and abundant opportunity for experiment have preceded almost all the important inventions of the last thirty years. They have originated in the workshop, not in the closet; among artisans, not among scholars. Machine tools have contributed to their origin in a hundred times greater proportion than book learning. "Neither the naked hand," said Lord Bacon, with a foresight which has been approved by experience, "nor the understanding left to itself can do much; the work is accomplished by instruments and helps." "The great inventor," says Isaac Taylor, "is one who has walked forth upon the industrial world not from universities, but from hovels; not as clad in silks and decked in honors, but as clad in fustian and grimed with soot and oil." Perhaps this is only an elaboration of the ancient proverb that necessity is the mother of invention. Certain it is that in our time almost every inventor of uncommon merit has risen from humble ranks, is a master in the arts of making and using tools, and has instructed himself by experiment, usually in the course of hard labor for bread, in some branch of manual industry.

The American mechanic, being thus the hero of our country in the nineteenth century, as the American statesman was in the eighteenth, we naturally find a degree of public curiosity attaching to all the details of the manners and methods of his daily life such as in former ages was displayed only concerning potentates of the earth. There is a much more general and genuine desire, for instance, to know how Mr. Edison commonly passes his days between waking and sleeping than how President Hayes does, or Mr. Tilden, Mr. Evarts, Mr. Vanderbilt or Mr. Astor. His portrait is more sought after in the print shops than that of any of the famous politicians, generals or writers of the day. Every scrap of information about him is scanned with eager interest, and there is not an assembly in the land into which the entrance of this mechanic—whose renown is so recent that his name does not appear yet in any cyclopædia or biographical dictionary—would not create excitement and be greeted with applause.

These are facts on which the industrial classes have a right to dwell with satisfaction and encouragement. Here is a man who began a life of self-support as a newsboy then learned the trades of printer and telegraph operator, and now, scarcely thirty-one years old, fairly ranks with Franklin, Watt, Stephenson, Fulton and Morse. The advantages he had at the beginning are surpassed by those of two-thirds of the mechanics in this city. He won all his facilities by hard and persevering toil. So lately as ten years ago he was working at his trade all night to get the means to carry on his experiments in the daytime. The secrets of his success those who know him concur in testifying are honesty of ambition, skill in observation, accuracy of perception, fidelity in attention and clearness of thought. There is not one of his marvellous inventions which does not lie in some field that has been diligently worked by others. Many of them doubtless knew far more than himself, but he rises superior to them by his capacity to turn all he does know to practical account. In this day of selfish rivalries, sordid aims and corrupt ways, it is wholesome to turn aside from the fetid arena of American politics to contemplate the spectacle of a world-wide reputation which it is possible to behold without contempt and admire without envy.

—Because of his efforts to solve the apparently insoluble, Edison was nicknamed "Luny" by his companions years ago. Insanity seems to pay.

Electro-Synthemeter

Sino. the maker pronunciation

Prof. name by Bliss

Carbon Electric thermometer

17

Phila Times Apr 25

THE DOINGS OF CONGRESS.

This country has felt wounding that the inventor of the phonograph has got his machine before Congress. A talking machine in Congress is nothing new, but it is something that the country doesn't need any more of, and, as the political conventions always remark in their resolutions, the phonograph in Washington will be viewed with alarm by everybody. And yet this new and truly wonderful machine may be as useful as it is dangerous, if handled with any sort of discretion. The correspondents will find it useful to set up in the house when executive sessions are in progress, or in committee rooms when the doors are closed on the public. The machine can be put under a desk and taken out afterward and a full report of the proceedings ground out of it. To Congressmen the phonograph will prove a great labor saver and do the work with much more exactness than the average statesman. No member can afford to be without at least one machine, and some members, as Hale and Spooner and Conger, can have their phonographic utterances stored to order by the wholesale, after the same pattern, without any particular manner of brains, but fixed to reel off words and words on the perpetual-motion principle. A rattle-box with a patent crank would make an economical sort of machine for this kind of member. But a good many phonographs of special talents would be required. Mr. Glover will want a machine adapted to the work of getting up in the House over blessed morning and making a personal explanation, and unless the fearless character of Mr. Glover's consultees is extraordinary he will have employment for a great number of these little instruments in the personal explanation department alone. Mr. Sam Cox will want a light and airy phonograph, nearly only a mustache, that he can fill with comic remarks and keep pointing at Mr. Ben Butler; it will be necessary to have this machine constructed with some fortification for defense, or at the very least to have some power to kick back when seized in its own hungries. Congressman Thompson will want one he can fill with a few select but profane and wicked things in Pennsylvania, when there is plenty of room for something of that kind at this particular time, goodness knows! Mr. While needs a phonograph mounted on a rather active pair of legs to move around newspaper row and tell the correspondents all about it; Senator Don Cameron may attempt his to secretest notes that shall float out on spring breezes laden with the perfume of pop blossoms, for there—

[Inventor Wade Owen the full heart reveal
The presence of the how it would sound.

Mr. John I. Mitchell can put his phonograph under his arm, and going up to the White House jog in the evening Sunday evening and converse; Pennsylvania would be in search of a machine which never said anything intelligence in the matter of the draw, and there are quite a number of other members who will want about it to pass in the Senate, where they do many to see that a few objections will give the country fewer words, and they may as well begin. Senator Conkling will want a machine that will say "I resign my seat," and Senator Platt will want one for Senator Morton that will say "I am not dead," and Senator Dorsey will demand a kind that can make suspicious postal contracts and not get found out. Senator Bill Russell Smith must on instrument that he can set up behind the door when he wants to communicate with—Garfield, for instance; Senator Kellogg's phonograph will have to understand the noble virtues of the Returning Board cured—something not within human understanding—and grief out its praises and work to get ofice Federal offices for it while honest people sleep; General Butler will probably fill his with bricks and fractional currency and Democratic veterans of ten wars and such loose articles, and when these things begin to fly around the House all other phonographs will have occasion to get out of the way. There will be an overwhelming demand for a common kind of phonograph that can make a tair stump speech full of expressions of love for the people, to circulate in the various Congressional districts. It won't be much trouble for the inventor to get up a machine of this kind, needing only care to see that it isn't too intelligent, in which event the people would just as likely as not want to have their law making done by phonograph without the expensive trifling of human beings in the transparent disguise of statesmen. Anybody can see that the phonograph will have its uses even in Congress, but these ought to be a limit to the number.

N.Y. Herald Apr 24-79

WASHINGTON.

Republican Programme for the Fall Campaign.

THE FORCE BILL AND OTHER CLAIMS

FROM OUR REGULAR CORRESPONDENT.

Passage of the Senate Force Bill—Other Bills Passed by the Senate.

WONDERS OF EDISON'S INVENTIONS

The Practical Results Expected to Follow.

DEBATE ON THE RIVER AND HARBOR BILL.

FROM OUR SPECIAL CORRESPONDENT.

WASHINGTON, April 23, 1879.

REPUBLICAN LEADERS MAKING UP A PLATFORM FOR THE EMERGENCY OF THE FALL CAMPAIGN—CLAIMS THAT DATA HAVE BEEN MADE.

The republican leaders are gradually getting to their line and preparatory plans of campaign. A large number of party policy for the fall according to the views of the Democrats and they seem to make a point of the Southern claims business. The appointment some, for the Ways and Means Committee of the House, two for places from the republican States, a year and one out of the same box; Senator Conkling will be willing to pass in the Senate, where they do not have that a few objections will give the country fewer words, and they may as well begin. Senator Conkling will want a machine that will say "I resign my seat," and Senator Platt will want one for Senator Morton that will say "I am not dead," and Senator Dorsey will demand a kind that can make suspicious postal contracts and not get found out. Senator Bill Russell Smith must on instrument that he can set up behind the door when he wants to communicate with—Garfield, for instance; Senator Kellogg's phonograph will have to understand the noble virtues of the Returning Board cured—something not within human understanding—and grief out its praises and work to get ofice Federal offices for it while honest people sleep; General Butler will probably fill his with bricks and fractional currency and Democratic veterans of ten wars and such loose articles, and when these things begin to fly around the House all other phonographs will have occasion to get out of the way. There will be an overwhelming demand for a common kind of phonograph that can make a tair stump speech full of expressions of love for the people, to circulate in the various Congressional districts. It won't be much trouble for the inventor to get up a machine of this kind, needing only care to see that it isn't too intelligent, in which event the people would just as likely as not want to have their law making done by phonograph without the expensive trifling of human beings in the transparent disguise of statesmen. Anybody can see that the phonograph will have its uses even in Congress, but these ought to be a limit to the number.

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THE RIVER AND HARBOR BILL—A DISCUSSION WHICH REVEALS THE BAD FEATURES OF THE MEASURE.

The House spent a useful and accurating day over the present against the River and Harbor bill. The discussion, as usual in such cases, took a wide range, and the bill, when has passed the House, will probably remain in the Senate through the expensive months of a law only of the last business today. Mr. Cockrell, of Kentucky, remarked that in house one of the rivers proposed to be "improved," and that the only way to improve it was to demolish it. Mr. Wright, of Pennsylvania, knew two of the stone rivers and told the house that their sentiment never was about enough to drive one herdsman stood great distance on a dry day. Mr. Kelley, of West Virginia, was one of the members of the bill, confessed that the committee under his leadership had uttered new surveys whenever members desired them, without [illegible] Mr. Kelley, several members, representing Messrs. Reed, Hewitt and Hamilton, presented against the bill, and Mr. Wright, without distinction of politics, Mr. Randall, Wright, of Pennsylvania, who is sometimes to vote in favor of such appropriations as interest his own district, and Mr. Reed, said he would vote a great if $150,000,000 of $10,000,000 for proper objects, but he would not support the bill, which goes money for improper objects and for the benefit of such a man as Jones. Kinney was no other point than the house must decide whether a present by Congress was a privilege matter, but by time the real purpose of the present necessity, to have their present representatives in the last interest of the bill, was attained, it is probable that time is the last River and Harbor bill that will be passed by the present Congress.

A POLITICAL CONUNDRUM BY A REPUBLICAN ORGAN.

The political papers here were stamped all day and evening in an effort to unravel a mysterious conundrum which appeared tantalizingly in the political news of the morning papers upon the morning. The conundrum was printed as it is in the original form of the story. The inscription on the piece read:

WILLIAM ORTON,
Died at Geneva,
April 27 1878.

At the head rested several beautiful sentiments and a floral arrangement of blue violets, white roses, and immortelles. Next silver, the gift of the triangular Association, of which the deceased was a member, and a cross two feet in length. The cross was also filled with fragrant flowers, and standing in the centre of the floral arrangement. Next was a magnificent floral piece, composed entirely of flowers, the gift of the mercantile house of Orton Brothers. The piece was in the form of a wreath by banging over and partly hiding the casket, two exotics, the portions of which filled the entire space.

Next in magnificence was the floral arrangement on either side of the two central pieces were accepted by the Geneva Lodge of Masons, of which the deceased was a member. It consisted of a floral triangle and compass, surrounded by the letters G. L. Next was a floral piece, the gift of the Geneva Lodge of Odd Fellows, of which the deceased was also a member. It was composed of white flowers, and standing in the centre of the floral arrangement was a broken column, with the letters I. O. O. F. on the front. Next was a floral piece, the gift of the Geneva Lodge of Elks, of which the deceased was also a member. It was composed of white flowers, and standing in the centre of the floral arrangement was a broken column, with the letters I. O. O. F. on the front. Next was a floral piece, the gift of the Geneva Lodge of Elks, of which the deceased was also a member. It was composed of white flowers, and standing in the centre of the floral arrangement was a broken column, with the letters I. O. O. F. on the front.

FROM OUR REGULAR CORRESPONDENT.

WASHINGTON, April 23, 1879.

THE DAILY GRAPHIC

FRIDAY, APRIL 25, 1879.

JOHN PAUL'S ADOPTED HOME.

When Thompson was recent years old his parents removed to Port Homo, Scotch., and his father still remained there. After his father's death Paul went to sea, and in 1768 he was master of a merchantman, commanding an ever $40,000, have been left by his father. He was a passenger from Virginia to Europe, and in order to avoid a passenger the worth of his property he changed his name to Paul. He returned to Virginia, and left the short time here is slightly over. His brother William died in 1773, and left his property to his brother Jones. Jones was born in 1747, and was born in Saint Mary Stillwell, of Scarsdale, N.J., and the two children, a little boy four years old, and a little girl two years younger. Jones was the only one of the children, a little boy four years old, and a little girl two years younger. Jones was the only one of the children, a little boy four years old, and a little girl two years younger. Jones was the only one of the children, a little boy four years old, and a little girl two years younger. He is affectionate and kind to his children, and is very fond of them. His income the present year will be about $50,000.

Evening Post Apr 26

Together.

The paragraph will probably be called a "fake," because it reports everything.—Cincinnati Breakfast Table.

Brooklyn Apr 26-79

WILLIAM ORTON'S FUNERAL.

DISTINGUISHED PERSONS PRESENT—THE THE MANY CONTRIBUTIONS TO THE BEAUTIFUL.

[From our Fourth Edition of Yesterday.]

The Church of the Holy Apostles, at the corner of Twenty-eighth street and Ninth avenue, was densely crowded with the relatives and friends of the late William Orton, owing to the funeral services this day. Long prior to the arrival of the funeral carriages from the residence of the deceased, where brief services had been held at ten o'clock, distinguished persons began to arrive at the church. They were for the most part gentlemen, and were followed by two ladies dressed in black, who engaged seats to those who were known to them.

Among those present were Mr. Thurlow Weed, Judge John Davis, William H. Vanderbilt, Cornelius Vanderbilt, Jr., Hamilton Mckay Twombly, Chauncey M. Depew, General Sickles, several members of the Legislature, Thomas Conigan, Colonel Cockcroft, Mr. Bowen, Mr. Bell, Mr. Hamilton, Mr. Gilbert, and the proprietors of the Times, Tribune and Herald, Messrs. Reid, Jones, Hoe, Pulitzer, and Gallagher. Among the ladies present were Mrs. Twombly, Mrs. Depew, Mrs. Pulitzer, Mrs. Gallagher, and Mrs. Hoe. Numerous telegrams and letters of condolence were received by Mr. Orton and his family, and a committee from the Union League Club composed of Messrs. Horace Porter, Cornelius Vanderbilt, Jr., Chauncey M. Depew, Edward Cooper, Hamilton Fish, Jr., Samuel Sloan, Jr., Samuel Sinclair, Samuel Thomas, Lieutenant Governor and David Dows. The Secretary of the Western Union Telegraph Company were present during the services. The floral offerings were very beautiful and appropriate, and were in the nature of this and various other orders. Near them stood a magnificent floral piece, the gift of the Union League Club of New York City, of which the deceased was a member, and which was received by the Rev. Dr. Morgan Dix, Rector of Trinity Church, and Mr. Bowen, Mr. Bell, Mr. Hamilton, Mr. Gilbert, Mr. Sloan, Mr. B. H. Bristow, Mr. Cornelius Vanderbilt, Jr., Mr. Depew, Mr. Cockcroft, Mr. Conigan, Mr. Sickles, Mr. Weed, Mr. Davis, and Mr. Vanderbilt. As they slowly passed down the aisle the choir chanted the solemn words of the burial service appointed for the occasion. The casket, which was of rosewood covered with dark cloth, with silver handles, was borne by the pall-bearers, who were followed by the relatives and friends in front of the altar. The inscription on the plate read:

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April 27 1878.

At the head rested several beautiful sentiments and a floral arrangement of blue violets, white roses, and immortelles. Next silver, the gift of the triangular Association, of which the deceased was a member, and a cross two feet in length. The cross was also filled with fragrant flowers, and standing in the centre of the floral arrangement. Next was a magnificent floral piece, composed entirely of flowers, the gift of the mercantile house of Orton Brothers. The piece was in the form of a wreath by banging over and partly hiding the casket, two exotics, the portions of which filled the entire space.

Next in magnificence was the floral arrangement on either side of the two central pieces were accepted by the Geneva Lodge of Masons, of which the deceased was a member. It consisted of a floral triangle and compass, surrounded by the letters G. L. Next was a floral piece, the gift of the Geneva Lodge of Odd Fellows, of which the deceased was also a member. It was composed of white flowers, and standing in the centre of the floral arrangement was a broken column, with the letters I. O. O. F. on the front. Next was a floral piece, the gift of the Geneva Lodge of Elks, of which the deceased was also a member. It was composed of white flowers, and standing in the centre of the floral arrangement was a broken column, with the letters I. O. O. F. on the front. Next was a floral piece, the gift of the Geneva Lodge of Elks, of which the deceased was also a member. It was composed of white flowers, and standing in the centre of the floral arrangement was a broken column, with the letters I. O. O. F. on the front.

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THE EVENING STAR.

WASHINGTON:
THURSDAY.............April 18, 1878.

The National Academy of Sciences.

SCIENTIFIC PAPERS.

The first paper read at the scientific session of the National Academy of Sciences yesterday was by Prof. Alex. Agassiz, entitled a "Preparatory Report in the Deep Sea Dredgings of the United States Coast Survey Steamer Blake, during the past winter, in the Gulf of Mexico and the Gulf Stream." An interesting account of the methods employed in the dredging and sounding operations, was given, and the scientific results of the expedition were slightly touched upon. To increase the rapidity and certainty with which soundings were made, and also as an improvement in the dredging work, wire was substituted for rope. Specimens of dredges were exhibited by Prof. Agassiz, who, by this means, and by speaking without notes, caused his remarks to be highly appreciated by all of the audience. "Abrasions on the coast of North America" was discussed by Professor George Davidson, who described the elevated terraces at various points on the western coast of North America, and ascribed them to the action of ice in the glacial period. A paper on "The Law of Boyle and Mariotte," by Dr. Wolcott Gibbs, and a "Memoir on the Intersection of Circles and the Intersection of Spheres," by Gen. Benjamin Alvord, brought the scientific season to a close. The last paper was highly commended for originality by Dr. Hilgard. The results were reached by old style geometry and not by the analytical method.

At half-past four o'clock the scientific session was adjourned, and the Academy resumed its business session.

THE FOLLOWING NEW MEMBERS

were elected: Gen. Francis A. Walker, of Yale College, New Haven, Conn.; Prof. John Trowbridge, of Harvard College, Cambridge, Mass.; Prof. John Le Conte, president of the University of California, Oakland, Cal.

AT THE MEMORIAL MEETING,

in All Souls' church last night, interesting tributes to the memories of deceased members were read, as follows: "Biographical Memoir of Louis Agassiz: second part, relating to his life and work in America," by Arnold Guyot; "Memoir of Jeffries Wyman," by Asa Packard, jr. In Prof. Packard's absence, this memoir was read by Dr. Elliott Coues.

TO-DAY'S PROCEEDINGS.

The Academy of Sciences met at quarter of eleven this morning. Prof. J. Asaph Allen, of Cambridge, Mass.; Prof. Arnold Guyot, of Princeton, N. J.; Prof. Stephen Alexander, of Princeton, N. J., and Mr. Charles E. Peirce, U. S. C. S., New York City, are names which have been added to the roll in addition to those previously published in the STAR. Elections to fill the two offices vacated by the expiration of the terms of the incumbents at this session were held.

Dr. Gibbs and Prof. Hilgard having positively declined a re-election to the offices of vice president and home secretary, respectively, Prof. O. C. Marsh, of Yale College, New Haven, Conn., was elected vice president, and Prof. J. H. C. Coffin, U. S. N., (retired,) of Washington, was elected home secretary for the ensuing six years.

A resolution of thanks to the retiring officers, for the zeal and ability with which they had discharged their duties for the past six years, was unanimously passed.

Members of the Council for 1878-9 were then elected as follows: Prof. S. F. Baird, Dr. Wolcott Gibbs, Prof. Asaph Hall, Prof. J. E. Hilgard, General M. C. Meigs, Prof. Simon Newcomb. The officers of the Academy are now: Joseph Henry, president; O. C. Marsh, vice president; F. A. P. Barnard, foreign secretary; J. H. C. Coffin, home secretary; Rogers Fairman, treasurer, and the council as above.

AT THE SCIENTIFIC SESSION.

Prof. Newcomb delivered a lecture on a "Plan of Measuring the Velocity of Light." He illustrated his remarks by diagrams on the black-board, and was listened to with great attention. He made many valuable suggestions in respect to the best method of determining this important constant in physics and astronomy.

After Prof. Newcomb had finished his lecture an interesting discussion on the subject by other members of the academy followed. Prof. Stephen Alexander, of Princeton; Prof. E. C. Pickering, Boston, Mass.; Prof. C. H. F. Peters, Clinton, N. Y.; and Mr. S. P. Langley, of Allegheny Observatory, participated. Several objections to the plan proposed by Prof. Newcomb were made and suggestions offered. The Professor was heard in reply to the objections, and the debate was quite animated.

MARS AND ITS SATELLITES—INTERESTING PARTICULARS ASCERTAINED BY PROF. HALL.

Since his discovery of the satellites of Mars, Prof. Asaph Hall has been engaged at every available moment in computations by which to determine their orbits, distances and periodic times. Though his labors are not yet completed, enough has been done to indicate that these new-comers will enter, with all their characteristics properly described, into the pages of the next text book on astronomy. In his recent address before the Academy of Sciences, Prof. Hall gave an interesting description of the methods of computation which he employed and the results obtained. The elements of the orbits of the satellites were first ascertained with considerable accuracy by graphical methods. For the outer satellite, or Deimos, the time of revolution around the planet was thus found to be 30 hours 18 minutes; for Phobos, the inner satellite, 7 hours 39½ minutes. After these approximate elements were determined the method followed was to use first, only the observations taken at Washington, because this series was by far more extensive than any other that had been made. Moreover it would have been very difficult to unite the observations made at different points into one group. Those at Washington, were taken between August 11th and October 31st. There were 50 observations of Deimos, and 39 of Phobos. The results of these labors were then compared with the approximate elements. What are called equations of condition, or differential equations, were computed between these residuals and the elements. There were 48 equations for Deimos and 79 for Phobos, the equations containing 7 unknown quantities. This mass of equations was solved by what is called the method of least squares, in order to get the most probable corrections of the assumed elements. Long and laborious calculations were involved. Years of watching and months of complicated computation, are required to ascertain astronomical facts to which the college student grudges an hour's study. The corrections were then applied to the assumed elements and gave the final elements which corresponded very well with the results of the Washington observations. Thus the periodic times were found to be, for Deimos 30 hours 17 minutes 53.90 seconds, and for Phobos 7 hours 39 minutes and 15.07 seconds. The distances of the Satellites from the center of Mars when that planet is at distance of unity from the earth were found to be, for Deimos, 32.354 seconds, and for Phobos, 12.9331 seconds. By means of these periodic times and distances in a very few minutes the mass of Mars can be computed. Using Deimos in our calculation the value of Mars is found to be one—3095313th; from Phobos it is ascertained to be one—3078453th; the mass of the Sun in both cases being taken for unity as is the custom in astronomy. These values of the mass of Mars are probably much more accurate than any that have ever before been computed. They show that the mass of

THE PLANET IS SMALLER

than has heretofore been assumed. The former values were found by the perturbations which Mars [illegible]rted on other planets. About the beginning of this century Burchardt gave its value, obtained in this way, as one-2680000th, and some years ago Leverrier, the French astronomer, after a laborious calculation found its mass to be one-2680000th, a value only a little larger than that given by the motion of the satellites.

CURIOUS FEATURES OF THE SATELLITES.

Another curious feature is that the orbit of the outer satellite is very nearly a circle, while that of the inner one seems to be decidedly eccentric, or to be an ellipse. Attention is called to this point because such a discovery is hardly what would be expected. The attempt to explain the rapid motion of the inner satellite by assuming the existence of a resisting medium around Mars would here be met by this objection, that although a resisting medium would indeed shorten the time of revolution it would also diminish the eccentricity of the orbit, so that we might suppose that the inner satellite would have an orbit which would be sensibly a circle; but this, as we have seen, is not the case.

The distances of the satellites from the surface of Mars are, for Deimos 12,500 miles; for Phobos 3,670 miles, or about the distance from Washington to Berlin. The nearness of these satellites to Mars will cause some very curious appearances to an observer on that planet on account of the rapid motion of the inner moon as it rises in the west and sets in the east. Its horizontal parallax of about 21 degrees will delay its rising so that it will mount slowly to the meridian, and then sink rapidly in the east—the setting being hastened by the same cause which retarded its ascent.

The work which remains to be done by Prof. Hall, and which he hopes to complete in a few months, is to compare all the observations of the satellites made in this country and in Europe with the elements already computed, and to determine from each set the correction for the distance of the satellites from Mars, and then to compute from each set of observations the mass of the planet; also to prepare an ephemeris of the satellites for October and November, 1879, when they will again be visible. Observations in that opposition, made with proper precautions, will enable him to determine very accurately the times of revolution of the satellites.

Com Advertiser Apr 26

What makes the phonograph so much admired is the statement made by its inventor that the speeches of our Congressmen can be preserved in tin-foil and ground out of an organ for the delectation of future ages. It would be still more satisfactory to the present age if future ages alone would be compelled to listen to the grinding.

Paste this in your hats, boys, for reference.

N Y Mail Apr 26

Uses of the Phonograph.

Prof. Edison thus enumerates the possible uses of the phonograph: 1. For dictating it will take the place of shorthand reporters, as thus: A man who has many letters to write will talk them to the phonograph, and send the sheets directly to his correspondents, who will lay them on the phonograph and hear what they have to say. Such letters as go to people who have no phonograph will be copied from the machine by the office boy.

2. For reading. A first-class elocutionist will read one of Dickens' novels into the phonograph. It can all be printed on a sheet ten inches square, and these can be multiplied by the million copies by a cheap process of electrotyping. These sheets will be sold for, say, twenty-five cents. A man is tired, and his wife's eyes are failing, and so they sit around the table, and hear the phonograph read from this sheet the whole novel with all the expression of a first-class reader. See! A company for printing those is already organized in New York.

3. It will sing in the very voice of Patti and Kellogg, so that every family can have an opera any evening.

4. It may be used as a musical composer. When singing some favorite airs backward, it hits some lovely airs, and I believe a musician could get one valuable popular melody every day by experimenting in that way.

5. It may be used to read to inmates of blind asylums, or to the ignorant who have never learned to read.

6. It may be used to teach languages, and I have already sold the right to use it to teach children the alphabet. Suppose Stanley had had one, and thus obtained for the world all the dialects of Central Africa!

7. It will be used to make toys talk. A company has already organized to make speaking dolls. They will speak in a little girl's voice, and will never lose the gift any more than a little girl.

8. It will be used by actors to learn the right readings of passages. In fact, its utility will be endless.

N Y Tribune Apr 27

Mr. Edison, as a young telegraph operator at Memphis, was known for the quaint drawings with which, in odd leisure moments, he illustrated the Southern press reports. One habit was to convert the tails of his g's and y's into faces, with the most ludicrous expressions imaginable. Another habit was to draw a railroad curve around a hill, with a train of cars at full speed; on the first car was a T, on the second Y, and so on until Tyler, the signature to the report, was spelled out, and on the last car, barely perceptible around the curve, was "30," or finis. This continued for some time, until a Memphis editor published a paragraph praising in the highest terms the beauty of the sketches, but objecting to them on the ground that the printers took up too much time in admiring them, and in trying to find appropriate cuts to represent them. This was the last of the "illustrated press reports," as Edison was exceedingly sensitive.

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WASHINGTON LETTER.

Curiosities of the Dead-Letter Office—Night Seeing and Star Gazing—The last Card of the Monopolists and a Trump.

From an Occasional Correspondent of the Boston Journal.

In my last letter I briefly alluded to the postal system of the United States—how it had grown up in a hundred years from a few letters posted in all the country in saddle-bags, to a most wonderful, omnipresent, complicated but ever acting screw, whose operation brought manifold blessings to forty-five millions of people. But the most curious part of the work assigned to the postal machinery is that which it fails to perform. Those failures, however, must be charged to the people, and not to the mail carriers. If you wish to see how many ridiculous mistakes and blunders people can be guilty of, there is no better place to study this subject than in

THE DEAD LETTER OFFICE.

Here come every day thousands of letters, packages and postal cards from all parts of the United States, which have by some means or other missed reaching the persons for whom they were intended. There are thrown in huge piles upon tables, and a score or more of clerks deftly open the stray missives that have come back because they could find no owners. The cause of going astray is frequently made apparent by slight examination. Directions illegible has more to do in the matter of mistakes than anything else. One man forgets to put a stamp on his letter, and the only way to secure this omission is to send the letter to the P. O. D. at Washington, where it is opened and returned to the writer. Another man writes his own name instead of his friend's on the superscription, and, after wandering thousands of miles, like a lost spirit, it finally gets back to him through the Dead Letter Office. Another forgets to write any direction at all, and the poor whitefaced envelope must assume the responsibility of a traitor to the general receipt-file for all stray mails. Still another directs his letter to "John Smith, New York City." As there are several hundred of this distinguished name in the great American metropolis—one or more in every ward's block—the letter is opened and examined by score of John Smiths, and after many visitors to Washington, and chance look to the writer, it is the rule of the Dead-Letter Office to return to writers all letters of any possible value, where the name of the writer appears. This does not always appear, however; and still more frequently is so badly written as to make it impossible to do anything more than attempt to imitate an ugly scrawl on the returning envelope. The queer things embraced in the vast or colossus of these vagrant epistles must fully satiate the curiosity of the lady clerks who operate in this department. If Madame Eve had been in a good letter it is doubtful whether she would have ever attempted to seek forbidden knowledge by eating forbidden fruit.

Outside of the letters, however, there is an immense number of strange and curious things that find their way to the Dead-Letter Office, and as these cannot be returned to the senders, they are sold. Irony time to time at public auction. There has lately been an auction sale of this kind, the printed catalogue of which embraced nearly ten thousand different packages. These immense omnium gatherum embraced enough to stock several provincial clothing, jewelry and notion stores, besides a large curiosity shop. Here are a few sample bricks from the collection. One dozen smoked herring; one whetstone; one bar lunge, bologna sausage, loaves of bread, crackers, cheese, &c., six lamp mats, birds' wings, flags, small saws, pocket-books, stockings, garters, false hair, tooth brushes, knives, purses, pictures, bed spreads, underwear, slippers, toy engines, shoes, carved pipe, dice, chemise, playing cards, pills, corsets, fox skin, comforter, bass bells, cartridges, molders' tools; one knife, one stove, one bugs, buttons, yarn, books, watch-crystals, lamps, looking-glasses, leather apron, sheets, cameras, revolvers, ammunition, telegraphic instruments, music skin, bear skin, strawberries, condensed milk, horse powder, untanned lure, wax flowers, mathematical instruments, glass ornaments, lunar, saw, mill saw, hammer, dagger, centiped and tarantula in liquid, life preserver, billiard balls, five boxes of snuff, bustles, weights, scales, specimens of opium, &c.

SIGHT-SEEING AND STAR-GAZING.

Last night I went with Rev. Dr. Wilde and my friend Colonel Gustin, of Georgia, upon a pleasant invitation from Prof. Hall, of the National Observatory, to have a peep at the moon through the monstrous telescope. This is the largest, and probably, the best, instrument of the kind in the world. The best of all is it of home manufacture, having been completed by the Messrs. Clark, the famous instrument-makers. This telescope is a refractor with an object glass twenty-six inches in diameter and more than twenty-two feet focal distance. The view of the lunar mountains was most satisfactory, as well as of some double stars. Prof. Hall has immortalized both the instrument and himself by doing it up discover the two moons of Mars, and has heartily glad that a man so favored in the heavenly science of astronomy, and so dignified for his modesty and urbanity, should have made the grandest celestial discovery in the nineteenth century.

I have just now returned from a room of the Senate Committee on Patents, where I met for the first time Mr. Thos. A. Edison, the great inventor of the age. The room was crowded with a hundred or more, including Senators, scientists, ladies and others, and Mr. Edison gave a most satisfactory exhibition of that modern miracle, the phonograph, or talking machine. This instrument has already been described in almost every newspaper of the country, and I shall not attempt a repetition. It preserves and repeats articulate sounds, and variously every word and every tone of voice used by the speaker. In the present instance it produced in the hearing of the company a great variety of words and sounds. The whole repertoire of barn-yard music, from the cooing of a dove to the quacking of ducks, tackling of hens, crowing of cocks and lowing of cows. Then it repeated sentences of common music and into the mouth-piece; also Yankee Doodle, Dixie, Old John Brown and other popular airs. Then it would burst out in strains of poetry, such as "Bigger on the Table," "Mandalay," Old Mother Hubbard, Jack and Jill, &c. Then whistling, laughing, crying, shouting and singing, by turns.

"Mary had a little lamb,
Its fleece was white as snow,
And everywhere that Mary went,
The lamb was sure to go."

This, and scores of other bits of talk or poetry, were given with amazing accuracy and distinctness. Mr. Edison, like every great man, is a most modest, unassuming gentleman, but possesses a wonderful genius as an inventor. He has taken out in the last few years 150 patents and seventy-five caveats, and in the last year upon the threshold of his life's work, FIFTY-FIVE.

THE LAST CARD OF THE PACIFIC MONOPOLISTS.

Congress has not made any great progress in legislation during the past week, but the committees generally have been hard at work.

In the House Committee on Pacific Railroads an effort was made by the attorney of some French holder of bonds issued by the Memphis & El Paso Railroad, to invalidate the title of the Texas & Pacific Railroad, Messrs. Scott, Brown, Vice-President of the Southern Pacific road, proved to the satisfaction of the committee the perfect validity of his road to all it claims. This comes to nought, and the combined Southern opposition to the T. & P. to the California railroad syndicate only increases the strength of the measure which they wish to defeat. Men that were doubtful now mostly see the

Mr. Bacon Sunday, Apr 23

CLOCKS WHICH WILL TALK.

THE WONDERFUL POSSIBILITIES OF EDISON'S INVENTION.

How Letters may be Dictated, Books Read, Songs Sung, Bells Made to Strike Hours, and Cry—All Through the New Phonograph.

Mr. Edison's Office Crowded for Half the Day.

Of all the writer's inventions, none has commanded such profound and eager attention throughout the civilized world as has the phonograph. This fact manifests properly to that peculiarity of the invention which brings its possibilities within reach of the specialist's imaginations of all thinking people, as well as to the almost universal applicability of the foundation principle, namely, the retaining by and recalling of sounds hitherto fugitive and their reproduction at will.

From the very abundance of conjectural and prophetic opinions which have been discriminated of the press, the public is liable to become confused, and less accurately informed as to the tremendous boon and absolute novelty which that the invention had been one month ago. Until a specific application, or line of applications, is made, the public is liable to lose interest in the matter. The fact that the invention is not perfected at the moment of its announcement, but that it is only in the line of future improvements, is liable to create a feeling of indifference. Yesterday the writer had an interesting one, and seems to us well worth being followed out.—Ed. [Ed.

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1. Industrial economical conduct in the accomplishment of that to the greatest degree of [illegible] 1,027, but the stock of [illegible] 1,027, but the stock of [illegible] the quotes was established, 10 years [illegible] Fabulous Simds was born at Rome in 1572. 2. The [illegible] *Salamina Andantonia de Fonsalgonsalo* [illegible] appeared at Rome in 1617. Secondly, [illegible] 3. Industrial economical conduct in this country. The particulars relating to the locations has been translated into English, and is printed in *The Standard*, *The Oxford and Cambridge Mercury*, 1756. Fourthly, [illegible] 4. Industrial economical conduct in this country. The particulars relating to the locations has been translated into English, and is printed in *The Standard*, *The Oxford and Cambridge Mercury*, 1756. Fifthly, [illegible] 5. Industrial economical conduct in this country. The particulars relating to the locations has been translated into English, and is printed in *The Standard*, *The Oxford and Cambridge Mercury*, 1756. Sixthly, [illegible] 6. Industrial economical conduct in this country. The particulars relating to the locations has been translated into English, and is printed in *The Standard*, *The Oxford and Cambridge Mercury*, 1756. Seventhly, [illegible] 7. Industrial economical conduct in this country. The particulars relating to the locations has been translated into English, and is printed in *The Standard*, *The Oxford and Cambridge Mercury*, 1756. Eighthly, [illegible] 8. Industrial economical conduct in this country. The particulars relating to the locations has been translated into English, and is printed in *The Standard*, *The Oxford and Cambridge Mercury*, 1756. Ninthly, [illegible] 9. Industrial economical conduct in this country. The particulars relating to the locations has been translated into English, and is printed in *The Standard*, *The Oxford and Cambridge Mercury*, 1756. Tenthly, [illegible] 10. Industrial economical conduct in this country. The particulars relating to the locations has been translated into English, and is printed in *The Standard*, *The Oxford and Cambridge Mercury*, 1756.

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when the letter was dictated, &c.

The advantages of such an innovation upon the present slow, tedious, and costly methods are too numerous, and too readily suggest themselves, to warrant their enumeration, while there are no disadvantages which will not disappear coincident with the general introduction of the new method.

Dictation.—All kinds and manner of dictation which will permit of the application of the mouth of the speaker to the mouthpiece of the phonograph may be as readily effected by the phonograph as in the case of letters. If the matter is for the printer, he would much prefer, in setting it up in type, to use his ears in lieu of his eyes. He has other use for them. It would be even worth while to compel witnesses in court to speak directly into the phonograph, in order to thus obtain an unimpeachable record of their testimony.

The increased delicacy of the phonograph, which is in the near future, will enlarge this field rapidly. It may then include all the sayings of not only the witness, but the Judge and the counsel. It will then also comprehend the utterances of public speakers.

Books.—Books may be read by the charitably inclined professional reader, or by such readers especially employed for that purpose, and the record of such book used in the asylums of the blind, hospitals, the sick chamber, or even with great profit and amusement by the lady or gentleman whose eyes and hands may be otherwise employed; or, again, because of the greater enjoyment to be had from a book when read by an elocutionist than when read by the average reader. The ordinary record sheet, repeating this book from fifty to a hundred times as it will, would command a price that would pay the original reader well for the slightly increased difficulty in reading it aloud in the phonograph.

Educational Purposes.—As an elocutionary teacher, or as a primary teacher for children, it will certainly be invaluable. By it difficult passages may be correctly rendered for the pupil but once, after which he has only to apply to his phonograph for instructions. The child may thus learn to spell, commit to memory a lesson set for it, &c.

Music.—The phonograph will undoubtedly be liberally devoted to music. A song sung on the phonograph is reproduced with marvellous accuracy and power. Thus a friend may in a morning call sing us a song which shall delight an evening company, &c. As a musical teacher it will be used to enable one to master a new air, the child to form its first songs, or to sing him to sleep.

Family Record.—For the purpose of preserving the sayings, the voices, and the last words of the dying member of the family—as of great men—the phonograph will unquestionably outrank the photograph. In the field of multiplication of original matrices, and the indefinite repetition of one and the same thing, the successful electrotyping of the original record is an essential. As this is a problem easy of solution, it properly ranks among the probabilities. It comprehends a vast field. The principal application of the phonograph in this direction is in the production of

Phonographic Books.—A book of 40,000 words upon a single metal plate ten inches square thus becomes a strong probability. The advantages of such books over those printed are too readily seen to need mention. Such books would be listened to where now none are read. They would preserve more than the mental emanations of the brain of the author; and as a bequest for future generations they would be unequalled. For the preservation of languages they would be invaluable.

Musical Boxes, Toys, &c.—The only element not absolutely assured in the result of experiments thus far made—which stands in the way of a perfect reproduction at will of Adelina Patti's voice in all its purity—is the single one of quality, and even that is not totally lacking, and will doubtless be wholly attained. If, however, it should not, the musical box, or cabinet, of the present will be superseded by that which will give the voice and the words of the human songstress.

Toys.—A doll which may speak, sing, cry, or laugh may be safely promised our children for the Christmas holidays ensuing. Every species of animal or mechanical toy—such as locomotives, &c.—may be supplied with their natural and characteristic sounds.

Clocks.—The phonographic clock will tell you the hour of the day, call you to lunch, send your lover home at 10, &c.

Advertising, &c.—This class of phonographic work is so akin to the foregoing that it is only necessary to call attention to it.

Speech and Other Utterances.—It will henceforth be possible to preserve for future generations the voices as well as the words of our Washingtons, our Lincolns, our Gladstones, &c., and to have them give us their "greatest effort" in every town and hamlet in the country upon our holidays.

Lastly, and in quite another direction, the phonograph will perfect the telephone and revolutionize present systems of telegraphy. That useful invention is now restricted in its field of operation by reason of the fact that it is a means of communication which leaves no record of its transactions, thus restricting its use to simple conversational chit-chat, and such unimportant details of business as are not considered of sufficient importance to record. Were this different, and our telephone conversation automatically recorded, we should find the reverse of the present status of the telephone. It would be expressly resorted to as a means of perfect record. In writing our agreements we incorporate in the writing the summing up of our understanding—using entirely new and different phraseology from that which we used to express our understanding of the transaction in its discussion, and not infrequently thus begetting perfectly innocent causes of misunderstanding. Now, if the telephone, with the phonograph to record its sayings, were used in the preliminary discussion, we would not only have the full and correct text, but every word of the whole matter capable of throwing light upon the subject. Thus it would seem clear that the men would find it more advantageous to actually separate a half mile or so in order to discuss important business matters, than to discuss them verbally, and then make an awkward attempt to clothe their understanding in a new language. The logic which applies to transactions between two individuals in the same office, applies with the greater force to two at a distance, who must discuss the matter between them by the telegraph or mail. And this latter case, in turn, is reenforced by the demands of an economy of time and money at every mile of increase of distance between them.

"How can this application be made?" will probably be asked by those unfamiliar with either the telephone or phonograph.

Both these inventions cause a plate or disk to vibrate, and thus produce sound waves in harmony with those of the voice of the speaker. A very simple device may be made by which the one vibrating disk may be made to do duty for both the telephone and the phonograph, thus enabling the speaker to simultaneously transmit and record his message. What system of telegraphy can approach that? A similar combination at the distant end of the wire enables the correspondent, if he is present, to hear it while it is being recorded. Thus we have a mere passage of words for the action, but a complete and durable record of those words as the result of that action. Can economy of time or money go further than to annihilate time and space, and bottle up for posterity the mere utterance of man, without other effort on his part than to speak the words?

In order to make this adaptation, it is only requisite that the phonograph shall be made slightly more sensitive to record, and the telephone very slightly increased in the vibrating force of the receiver, and it is accomplished. Indeed, the "Carbon Telephone," invented and perfected by the writer, will already well nigh effect the record on the phonograph; and, as he is constantly improving upon it, to cause a more decided vibration of the plate of the receiver, this addition to the telephone may be looked for coincident with the other practical applications of the phonograph, and with almost equal certainty.

The telegraph company of the future—and, that no distant one—will be simply an organization having a huge system of wires, central and sub-central stations, managed by skilled attendants, whose sole duty it will be to keep wires in proper repair, and give, by switch or shunt arrangement, proper attention to subscriber No. 923 in New York when he signals his desire to have private communication with subscriber No. 1,001 in Boston for three minutes. The minor and totally inconsequent details which seem to arise as obstacles in the eyes of the groove-travelling telegraph man, wedded to existing methods, will wholly disappear before that remorseless Juggernaut, "the needs of man;" for will not the necessities of man surmount trifles in order to reap the full benefit of an invention which practically brings him face to face with whom he will, and, better still, doing the work of a conscientious and infallible scribe?

THOMAS A. EDISON.

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The Future of the Phonograph.

A highly interesting article on the phonograph, written by Mr. Edison, the inventor of this latest mechanical marvel, is published in the *North American Review*. We reprint to-day selections from this article, which derive their value from the source of the information they impart. Of the future of the phonograph its inventor confesses himself unable to speak positively, because its application cannot be defined like that of an instrument intended to fulfil specific purposes, like a clock, a sewing machine or a reaper. The range of application of the phonograph seems unlimited, because the mechanical difficulties to be overcome are reduced to a minimum by the simplicity of its mechanism, and it is not dependent on the operation of forces other than purely mechanical. Yet Mr. Edison has sketched for us a description of the uses to which the phonograph can be put immediately and without any further important development of its powers. Basing his statements on the fact that the phonograph captivates fugitive sounds and imprisons them for unlimited reproduction, independent of their source of origin, he declares that the instrument can be used for letter phonautographic writing, by which the recorded sounds can be transmitted through the mails and reproduced as often as desired at distant places. It is, as it were, a mechanical letter reader operated by clockwork. The receiver of the letter sits at his desk and the instrument reads his correspondence for him as clearly and much more accurately perhaps than a clerk could do it. In like manner phonographic books can be prepared and the instrument can read these aloud in a public hall or school room for the benefit of large audiences. Music can be repeated in the same manner, and the cries, calls, &c., used for business advertising, uttered in sonorous tones by a tireless, lungless piece of machinery. The surprising accuracy of the record of sounds is proved by their reproduction. It is in these processes that the marvellous simplicity of the phonograph strikes the observer and hearer. The childhood of the future will be amused in a manner that can be at once entertaining and instructive, for speaking toys will become as common as the squeaking dolls and dogs of to-day. In combination with the perfected telephone the phonograph promises to revolutionize the present system of telegraphy. It will no longer be necessary to write messages for a telegraph operator to read and transmit. They can be spoken and heard only by the sender and receiver, who are interested. As the steam engine and the telegraph have been the great engines of this century one of those of the next will undoubtedly be the phonograph.

N.Y. Herald apr 28

EDISON'S WONDER.

The Phonograph and Its Application Described by Its Inventor.

World Apr 28

GREAT POSSIBILITIES.

Fugitive Sounds Captured and Imprisoned in Tin Foil Sheets.

TELEGRAPHY REVOLUTIONIZED.

From an authority so worthy of attention as the inventor himself we learn of the many applications to which that new mechanical wonder, the phonograph, can be put. Under the title "The Phonograph and Its Future" Mr. Edison publishes an article in the *North American Review* for May-June, in which he details the marvellous results he has obtained from his experiments when developing his invention, and points out the manner in which the new instrument is to simplify, and in many instances render unnecessary, the labors of the telegrapher, the writer, speaker and singer. He undertakes to show that in the near future a complete revolution will be accomplished in the now costly and laborious work of bookmaking, and that imperishable records of the identical utterances of men can be secured and reproduced as often and in as many places simultaneously as is desired. It is with the view of setting unintelligent conjecture at rest that the inventor of the phonograph gives his own description of the instrument to the public. He says:—"From the very abundance of conjectural and prophetic opinions which have been disseminated by the press the public is liable to become confused and less accurately informed as to the immediate result and effects of the phonograph than if the invention had been one confined to certain specific applications, and therefore of less interest to the masses." "And with regard to the possibilities of the application of the phonograph he adds:—"In the case of an invention of the nature and scope of the phonograph it is practically impossible to indicate it to-day, for to-morrow a trifle may extend it almost indefinitely."

WHAT HAS BEEN ACCOMPLISHED ALREADY.

The success already achieved by Mr. Edison is thus summed up by him in answer to categorical questions assumed to be put regarding the phonograph:—

1. A vibrating plate or disk is "capable of receiving a complex motion which shall correctly represent the peculiar property of each and all the multifarious vocal and other sound waves."

2. Such a complex movement can "be transmitted from such a plate by means of a single embossing point attached thereto, to effect a record upon a plastic material by indentation, with such fidelity as to give such indentation the same varied and complex form," and this being the case, "this embossing point, upon being passed over the record thus made, will follow it with such fidelity as to retransmit to the disk the same variety of movement and thus effect a restoration or reproduction of the vocal or other sound waves without loss of any property essential to producing upon the ear the same sensation as if coming direct from the original source."

With regard to the foregoing Mr. Edison further states that "by application of power for uniformity of movement and by attention to many seemingly unimportant and minor details—such as the form and the material of the embossing point, the proper dampening of the plate, the character of the material embossed, the formation of the mouthpiece over the plate," &c.—he has "at various times during the past weeks reproduced these waves with such degree of accuracy in each and every detail as to enable his assistants to read without the loss of a word one or two columns of a newspaper article unfamiliar to them and which were spoken into the apparatus when they were not present. The only perceptible loss was found to be in the quality of the utterance—a non-essential in the practical application of the apparatus." He makes the curious and important announcement that "the articulation of some individuals has been very perceptibly improved by passage through the phonograph, the original utterance being mutilated by imperfection of lip and mouth formation, and these mutilations eliminated or corrected by the mechanism of the phonograph."

3. A record can "be removed from the apparatus on which it was made and replaced upon a second without mutilation or loss of effective power to vibrate the second plate."

This Mr. Edison regards as a matter of "mere mechanical detail, presenting no greater obstacle than having proper regard for the perfect interchangeableness of the various working parts of the apparatus.

4. "But about ten or fifteen seconds suffice for placing or removing the recording sheet. A special envelope will probably be required for the present, the weight and form of which, however, will but slightly increase the postage."

5. "Repeated experiments have proved that the indentations possess wonderful enduring power, even when the reproduction has been effected by the comparatively rigid plate used for their production. It is proposed, however, to use a more flexible plate for reproducing, which, with a perfectly smooth stone point—diamond or sapphire—will render the record capable of from fifty to a hundred repetitions, enough for all practical purposes."

6. "Many experiments have been made, with more or less success, in the effort to obtain electrotypes of a record. This work has been done by others, and, though the writer (Edison) has not as yet seen it, he is reliably informed that, very recently, it has been successfully accomplished. He can certainly see no great practical obstacle in the way. This, of course, permits you indefinite multiplication of a record and its preservation for all time."

7. In reply to the inquiry, "What are the requisite force of wave impinging upon the diaphragm and the proximity of the mouth to the diaphragm to effect a record?" the inventor says:—

These depend in a great measure upon the volume of sound desired in the reproduction. If the reproduction is to be made audible to an audience considerable force is requisite in the original utterance; if for the individual ear only the ordinary conversational tone (even a whisper has been reproduced). In both cases the original utterances are delivered directly in the mouthpiece of the instrument. An audible reproduction may, however, be had by speaking at the instrument from a distance of from two to three feet in a loud tone. The application of a flaring tube or funnel to collect the sound waves and the construction of an especially delicate diaphragm and embossing point, &c., are the simple means which suggest themselves to effect this. The writer has not as yet given this stage of the development much attention, but sees no practical difficulty in gathering up and retaining a sectional part of the sound waves diffused about the original source within a radius of say three feet (sufficiently removed not to be annoying to a speaker or a singer).

The actual practical results obtained from the phonograph may be set down as follows:—The captivity, permanent retention and reproduction at will with original characteristics, of all sound waves heretofore designated as "fugitive." The transmission of captive sounds in material form "for purposes of communication or as merchantable goods." The indefinite multiplication and preservation of sounds, without regard to the existence of the original source, and the captivation of sounds with or without the knowledge or consent of the source of their origin. Among the more important prospective applications of the phonograph may be mentioned letter writing and other forms of dictation, books, education, reader, music, family record and such electrotype applications as books, musical boxes, toys, clocks, advertising and signaling apparatus, speeches, &c.

THE LETTER WRITER PHONOGRAPH.

"The apparatus now being perfected in mechanical details will be the standard phonograph. The general principles of construction are a flat plate or disk, with a spiral groove on the face, operated by clockwork underneath the plate, the grooves are cut very closely together so as to give the greatest length to each inch of surface—a close calculation gives as the capacity of each sheet of foil, upon which the record is had, in the neighborhood of forty thousand words."

"The practical application of this form of phonograph for communications is very simple. A sheet of foil is placed in the phonograph, the clockwork is set in motion and the matter dictated into the mouthpiece without other effort than when dictating to a stenographer. It is then removed and placed in a suitable form of envelope and sent through the ordinary channels to the correspondent for whom designed. He placing it upon his phonograph, starts his clockwork and listens to what his correspondent has to say."

BOOKS, MUSIC, RECORDS, &C.

Books may be read by the charitably-inclined professional reader, or by such readers especially employed for that purpose, and the record of such book used in the asylums of the blind, hospitals, the sick chamber, or even with great profit and amusement by the lady or gentlemen whose eyes and hands may be otherwise employed; or, again, because of the greater enjoyment to be had from a book when read by an elocutionist than when read by the average reader. The ordinary record sheet, repeating this book from fifty to a hundred times as it will, would command a price that would pay the original reader well for the slightly increased difficulty in reading it aloud in the phonograph.

"As an elocutionary teacher, or as a primary teacher for children, it will certainly be invaluable. By it difficult passages may be correctly rendered for the pupil but once, after which he has only to apply to his phonograph for instructions. The child may thus learn to spell, commit to memory, a lesson set for it, &c.

"The phonograph will undoubtedly be liberally devoted to music. A song sung on the phonograph is reproduced with marvellous accuracy and power. Thus a friend may, in a morning call, sing a song which shall delight an evening company, &c. As a [mus]ical teacher it will be used to enable one to mas[ter] a new air, the child to form its first songs, or to [sin]g him to sleep."

"A book of 40,000 words upon a single metal plate ten inches square becomes a strong probability. The advantages of such books over those printed are too readily seen to need mention. Such books would be listened to where now none are read." We may add in this connection that phonographic books would become as useful and interesting to the unlettered as to the highly educated, as both would receive the information they contained by hearing only.

TOYS, CLOCKS, TELEGRAPHY, ETC.

It is possible now by means of the phonograph to attach to toys, dolls, &c., an interest before unknown. Speaking figures can be made to utter familiar commonplaces and indeed carry on a prearranged conversation. Clocks, with a phonograph attachment, instead of striking the hour will call it out distinctly. Will say in the morning, "Hallo John! time to get up," like a forty-horse power mother-in-law, or as Mr. Edison suggests, may politely invite "dear Charles" or "Henry" to go home when ten o'clock P. M. arrives.

A more important use, however, can be had for the phonograph. Mr. Edison says of it:—

Lastly, and in quite another direction, the phonograph will perfect the telephone and revolutionize the present systems of telegraphy. That useful invention is now restricted in its field of operation by reason of the fact that it is a means of communication which leaves no record of its transactions, thus restricting its use to simple conversational chit-chat, and such unimportant details of business as are not considered of sufficient importance to record. Were this different, and our telephone conversation automatically recorded, we should find the reverse of the present status of the telephone. It would be expressly resorted to as a means of perfect record.

"How can this application be made?" will probably be asked by those unfamiliar with either the telephone or phonograph.

Both these inventions cause a plate or disk to vibrate, and thus produce sound waves in harmony with those of the voice of the speaker. A very simple device may be made by which the one vibrating disk may be made to do duty for both the telephone and the phonograph, thus enabling the speaker to simultaneously transmit and record his message. What system of telegraphy can approach that? A similar combination at the distant end of the wire enables the correspondent, if he is present, to hear it while it is being recorded. Thus we have a mere passage of words for the action, but a complete and durable record of those words as the result of that action. Can economy of time or money go further than to annihilate time and space, and bottle up for posterity the mere utterance of man without other effort on his part than to speak the words.

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THE DAILY GRAPHIC

FRIDAY, APRIL 26, 1878.

A SHOCKING BAD CONFESSION.

UNCLE SAM (hearing a noise outside g[illegible] to the door and observes two se[illegible]ing men waiting to be spok[illegible]n to)—Co[illegible] [illegible]hat can I do for you?

Enter McLIN and DENNIS—Some fellers ne[illegible] rol[illegible]ed ye down in Florida. We come in to confiss their sins.

UNCLE SAM (to McLin)—"Well, man, what do you know about it?"

McLIN—Well, yer Honor, they seen a big pile of yer property and they tuk it unobsarved.

UNCLE SAM—How do you know?

McLIN—I seen 'em do it, yer honor, right fernist me eyes.

UNCLE SAM—Why didn't you prevent [illegible] or give an alarm?

McLIN—Sure I was wid 'em. I didn't mane to stale, but I think I was onconsciously mismerized.

UNCLE SAM—You actually helped the other thieves carry off the plunder, did you?

McLIN—Yis; I did it all by mysilf; I was mismerized.

UNCLE SAM—Well, where is the property now? What did you do with it?

McLIN—Sure, I carried it off and giv it to Rud Hayes. He's a livin' on it now this minute—the vagabone and thafe of the woods! I was mismerized.

UNCLE SAM—"Mismerized!" Well, you havn't been "mismerized" ever since—all these two years, have you?

McLIN—No, faith; I bin tryin' every day to git some of the stolen property back.

UNCLE SAM—For me?

McLIN—No, for me.

UNCLE SAM—Oho! That's it, is it?

McLIN—Yis—oho, that's the very thing.

UNCLE SAM—Did he promise to give you a part of the stolen goods?

McLIN—Faith, he did, or a frind of his did. He said if I'd do all the shtalin' he'd give me some of the loot; an' yer Honor—it's the truth I'm tellin' ye—divil a haporth have I got a sight of! The auld villain!

UNCLE SAM—I understand you to acknowledge that you appropriat[illegible] [illegible]oods.

McLIN—What's that, yer riverince?

UNCLE SAM—Stole the goods—you say you stole them yourself.

McLIN—The saints presarve me, I tuk 'em—but I was mismerized, yer H[illegible]or.

UNCLE SAM—And if this Rud Hayes you speak of had given back a part of the goods, would y[illegible] have used them?

McLIN—Wud a hog ate acorns, yer Honor?

UNCLE SAM—And, in that case, you wouldn't have told anything about the robbery?

McLIN—Av coorse not. Why should I, yer Honor?

UNCLE SAM—And it is because you didn't get any benefit from the robbery that you exposed this Hayes?

McLIN—Yis; he's a dishonest and traitorous auld divil.

UNCLE SAM—Well, Dennis, what's the matter with you?

DENNIS—Same thing, yer Honor, long life to yez! I stole some of your things that some other feller tould me this feller wanted, and not a cint has he ever giv me for it.

UNCLE SAM—How came you to do such a wicked thing?

McLIN—I was mismerized.

UNCLE SAM—And you didn't either of you know that you had done anything wrong till you found that there wasn't to be a fair divide?

BOTH—Yis, that's it, yer honor; we're awfully chated, and we two arphans, and large famlies depinding on us for an honest livin'!

At this juncture Uncle Sam stepp[illegible] porch and unchained seven bull-dogs that [illegible] purposes of moral suasion, and merel[illegible] [illegible]-s-steboy!" The dogs and the two honest informers started simultaneously for the front gate and a long reach of open country beyond. Uncle Sam smiled blandly, and went in to continue his experiments with the phonograph. And as he turned the little vocal cylinder, it said: "Ha! Ha! Ha! Ha! Ha! Ha-ha ha ha-ha!"

A Phonograph at Niles.

Niles, April 25.—The process of making the asphalt pipe which we use here, requires machines which have a cylinder equal in diameter to the pipe to match, and which revolves very slowly. An idea entered the head of a certain person to attempt a phonograph, which was carried into effect. A sheet of heavy oiled paper which is used to prevent the asphalt from sticking, was carefully placed around one of the cylinders, and a cone made of tin with a diaphragm made of very thin sheet brass with a point soldered to its center was so attached as to travel slowly from one end of the cylinder to the other, so that both being in motion a spiral line was projected on the cylinder. The parties trying it were all quite ske[illegible]al, but after running a few turns an[illegible] [illegible]usting the cone to what seemed to [illegible] its best position, the point made plain and distinct puncture, and by turning the cylinder back the sounds spoken were, to the surprise of all, plainly repeated in a strange muffled sound like a person speaking under bed-clothes or shut up in a closet. The experiment seeming likely to prove a success, means were taken to get a number of visitors to come and see the operation of making the pipes, they not being informed that a phonograph was recording all that was said. In the evening an initiated few went to the shop, locked the doors, and reversed the motion. Back to our ears came a babel of sound that was indescribably ridiculous such as: "More soup," (the technical term for hot asphalt) this very loud, "Oh, what a nasty smell," "Hold up your dress," "Get out of the way," "—— the stuff," "[illegible] [illegible]re in —— is the driver?" "More sand," "There's the doctor; isn't he sweet?" "Oh, there's the man that sings in the choir," "More soup," "There's a pretty girl," "Don't bring that snake [illegible] to ——," etc.

MORE FACTS ABOUT EDISON.

[*From the Boston Herald.*]

While running to Detroit he became acquainted with the telegraph operators and began telegraphing the newspaper heading to stations in advance of the train. He became impressed with the value of the telegraph and determined to learn the business. He purchased a work on the electric telegraph and, in [illegible]junction with James Ward, one of his assistants, constructed a line between their residences in Port Huron, using stove-pipe wire, insulated with bottles placed on nails driven into trees and crossed under an exposed road by means of a piece of abandoned cable captured from the Detroit River. The first magnets were of wire, wound with rags for insulation, and a piece of spring brass was used for a key. The first attempt to generate a current was by means of cats rubbed vigorously together at each end. This failing, they soon after purchased some old instruments and other materials, and a success was accomplished. About two months afterward, as the railroad train was switching some cars on to the side track at Mt. Clements station, the agent's little boy, two years old, crept upon the track in front of the approaching cars. Edison, seeing the danger, sprang to the ground, seized the child and barely saved his life. J. A. McKenzie was the agent and operator, and in gratitude for the act volunteered to assist Edison to learn telegraphy. Thereafter, on reaching the end of his route, Edison would go back by freight train to Mt. Clements, and worked nights to perfect himself in operating.

N.Y. Times Apr 24/78

PRACTICAL USES OF THE PHONOGRAPH.

Since the general characteristics of the phonograph have become known to the public a great deal of fanciful ingenuity has been exercised in efforts to forecast for it a marvelous future. Indeed, the imaginative and the inventive have entered so much even into descriptions of the instrument and accounts of its experimental working, that some matter-of-fact people have been disposed to question its actual existence, and to regard it as a myth concocted by enterprising reporters. But there can no longer be any doubt that such a machine as the phonograph has been invented, and it is so far developed and perfected that its application to practical purposes can be discussed with some degree of accuracy. The inventor himself, in a paper contributed to the *North American Review*, has given in a very plain and straightforward way an account of the results already attained, and has indicated the practical uses of the instrument which he regards as fully assured. The accomplished facts are these: A vibrating plate or disk is capable of receiving a complex motion "which shall correctly represent the peculiar property of each and all the multifarious vocal and other sound waves." This is already practically applied in the telephone. Such complex motion may be transmitted from the vibrating plate by means of a single embossing point attached thereto, so as to produce by indentation on a plastic surface a record having a corresponding variety and complexity of form; and the same embossing point on being passed over the record again will follow it with such fidelity as to retransmit to the disk the same variety of movement and reproduce the vocal or other sound waves without loss of any property essential to producing on the ear the same sensation as if they came directly from the original source. The record once produced can be removed from the apparatus on which it was made and placed upon another without mutilation or loss of effective power to vibrate a second plate. In making the change from one instrument to another the record may be transported any distance. It may be made sufficiently durable to undergo from 50 to 100 repetitions. It may be duplicated and rendered permanent by an electrotype process. This much is set down by Mr. EDISON as demonstrated.

Now as to the practical application of these facts, toward which the ingenuity of the inventor is at present directed. The essential parts of the standard phonograph are to be a flat disk with s[illegible]ral groove on its face, operated by clock-work attached to the under surface, the mouth piece, into which the sounds are to be spoken or otherwise conveyed, and the vibrating plate with its embossing point. The record is to be received on a sheet of foil about ten inches square and capable of receiving 40,000 words. Into this a letter or communication of any length may be dictated, the sheet may be transmitted any distance and placed on another machine, and the communication may then be reproduced perfectly, even to the tones and inflections of the sender. It may then be filed away for future reference. Confidential or business letters may thus be dictated without the intervention of an amanuensis or the trouble of writing. Two copies may be made at once and one retained by the sender, and duplicates may be produced at will. Matter may also be dictated to be put in print and the type-setter may hear the words distinctly uttered instead of having to struggle with "bad copy." Books may be read into the phonograph by a trained elocutionist, copies may be multiplied and the effect of the reading may be enjoyed in the sick chamber or the drawing-room, while the hands and eyes of the hearers are employed at something else. The machine may also be used as an auxiliary in the school-room, in training children to read properly without the personal attention of the teacher; in teaching them to spell correctly, and in conveying any lesson to be acquired by study and memory. In short, a school may almost be conducted by machinery. The instrument may also be used to preserve the sayings and speeches, the voices, and even the "last words" of friends or of distinguished persons. Not only may books be read by means of the phonograph, but a volume of 40,000 words may be preserved on a sheet ten inches square, and libraries collected and enjoyed without the effort usually required in reading. Songs and music may be kept "on tap" as it were, dolls and other toys may be made to talk and to laugh and to cry, clocks may not only tell the hour, but call us up in the morning, summon us to dinner, and send us to bed. As a final triumph for his invention, Mr. EDISON expects to be able to combine it with the telephone, so that the sound waves may be transmitted over long distances and recorded by the phonograph, with all the useful results which that fact would imply.

Amazing as these things seem, they proceed from no flights of the fancy, but are prosaic results of the application of processes already successfully working. They are set down as certainties, only waiting for realization until the necessary apparatus and appliances can be perfected. The far-reaching effects upon commercial and social economy may for the present be left to the imagination, but unless they are realized, and that quite speedily, the ingenious Mr. EDISON will evidently be very much disappointed.

PUCK. Apr 24

THAT AWFUL PHONOGRAPH.

HOW THE DEACON SURPRISED HIS AUDIENCE.

THE Phonograph is certainly the most wonderful invention of this or any other age, and the purposes to which it may be applied are manifold and surprising.

Mrs. Carmeen need no longer sit up until midnight for a late husband—that is, late coming home. She can now speak her lecture in the diaphragm of the phonograph, attach one end of a cord to the crank and the other end to the knob of her chamber-door, and retire to her downy couch, with the sweet and comforting assurance of having "spoken her mind" where it will do the most good. Carmeen will come sneaking in at 1 A.M., as usual, and creep stealthily up-stairs, but no sooner does he open his bedroom-door than that awful phonograph will up and tell him in his wife's well-known voice, what she thinks of "such conduct as this," winding up with the stern command: "Now, come to bed, you old fool, and don't sit there blinking like a sick owl!" And all the time this performance is in progress, Mrs. Carmeen may be reveling in sweet dreams, in which spring bonnets and the latest lovely thing in polonaises predominate.

The phonograph is also capable of playing some pretty shabby tricks, and if Deacon Peppers could have laid his hands on the inventor, a few nights ago, he would probably have torn him into two thousand fragments—more or less.

The Deacon is—or rather was—a good man, and a class-leader in the Brownsville church. He visited New York recently and wandered into an establishment where several phonographs were on exhibition and for sale. He became much interested in the instrument; and when he spoke into the mouth-piece of one of the machines, and heard his own words ground out with startling distinctness, he manifested his astonishment in one prolonged "W-h-e-w!"

Then a happy thought struck him. He usually made a brief address at class meetings on Friday evenings, and he suddenly conceived the idea of speaking his piece in the phonograph, purchasing the invention, and surpr[illegible]ng the brethren and sisters at the next mee[illegible] The idea was carried into execution to sc[illegible] extent. The Deacon charged the phonograph with an appropriate address, and whilst he was bargaining with the owner for the instrument, in another part of the room, a rough, bushy-whiskered individual, attired in corduroy pantaloons and a speckled shirt, slipped in unobserved and howled a lot of stuff into the same machine. The Deacon paid for and carried off the phonograph, entirely ignorant of the frightful sentences injected into it by the rough person, who, as subsequent events proved, was the intellectual driver of a mule team, and not very choice in his language.

The next day was Friday, and in the evening the Deacon marched into the church with his phonograph under his arm, and his face illumined with a radiant smile.

"My friends," he commenced, "I have a little surprise for you. I do not intend to address you this evening. I have brought a substitute to speak for me. This little instrument I have here (holding up the phonograph) will now address you briefly on your duty to the Church and to suffering [illegible]."

Then the Deacon, with a smile extending from ear to ear, gave the crank a couple of turns, and all the color faded from his face as the phonograph thundered forth:

"Git up there! you dashed old cripple! Whoa, Sal! you blind—"

It was awful.

The hair of the brothers in the front pews stood straight up, a sister in the back part of the house fainted dead away, and the Sexton yelled "fire!"

"There—is—some—terrible—mistake here," gasped the Deacon, after a few minutes of painful silence. "I must have turned the crank the wrong way—or maybe the linch-pin is loose, or the safety-valve has lost a screw, or something." And, perspiring at every pore, the Deacon essayed another turn, and the machine yelled:

"Gee, Bill! Where in the dashnation are you going, you son of a mule! Peddi-whoa! Blast your eyes, can't you—"

The awfulness became more awful.

Three more sisters fainted, several brothers clapped their hats on their heads and their fingers into their ears, and started for the door shouting "police!" and the Sexton hallooed "murder," while the Deacon wildly clutched the phonograph by the neck and choked it until it was black in the face, and its eyes bulged out an inch.

But 'twas no use. The internal arrangements of the machine were evidently demoralized, and the cylinder continued to revolve, grinding out the most frightful language ever heard outside of a political ward convention; and when the audience were saluted with "I'll knock your dashed brains out, you long-eared—" they didn't wait for the remainder of the "address," but got up as one man—and one woman—[illegible] a dash for the door in a decidedly pa[illegible] [illegible] manner. The Deacon, with his face [illegible] color of a small-pox flag, sprang [illegible] threw the phonograph over th[illegible] after it, and kicked it down the aisle into the street, where the Sexton smashed it with an axe, just as the Deacon's address began to issue from its mouthpiece, and then placed it under the hydrant and let a stream of water run on it all night.

A committee was appointed on the spot to investigate what appeared to be the Deacon's highly improper and painful conduct, and that well-meaning person has concluded to move West and grow up with the country.

J. H. WILLIAMS.

27

The Phonograph

In reference to Prof. Mayer's account and Prof. Fleming Jenkin's letters, I may say that I had an opportunity of Mr. Isenor's observation of a phonograph constructed by Mr. Stroh, 432a, Hampstead Road, on April 3, at the invitation of Prof. Graham Bell. The difference between words produced from the phonograph and those spoken into it, gave me the impression of a difference between a worn print and an embryonic of no engraving. When the words were uttered loudly and slowly by real voice rather faster, it was easy to catch the sense and meaning, but I doubt whether unknown English words would be recognised, and certainly unknown foreign words would present insuperable difficulties. I should myself feel the phonograph of engraving pronunciation, especially delicate shades of distinct utterance. Some words, as *ee, oo*, almost disappear, *sh, ch, s* are difficult words, so that Prof. Bell at first thought that the first sounded like the second, while in reality both are altered to half-shut sounds that I do not remember to have heard in speech. The resemblance is great, however, that *Ada, Anna* could not be distinguished, though two cards neatly with *a* and the other neatly with *oo*, and their only other difference in its *oo, ds* in *Sea, Send*, are really the only good ones. Hence I feel quality by altering the rapidity of rotation and therefore pitch. As far as I could observe the quality did change, as it does in good sounds, but as might be expected—even when the effects were recognisable, they were not always true. Thus, *Anna, mother, pencil master*, fat *mates* failed. The instrument is, however, not delicate enough for being out these differences. The mechanical obstacle of the tin-foil, which has to be interval, and offers too much resistance, seems to be the cause of it. Such a word as "no, when sung rapidly, at the beginning of *Scots wha hae*, degenerated almost into the simple vowel, the

initial and final *s* were quite lost, and the action of the mute *c, t*, was almost nil.

The invention is highly interesting, the effects at present produced are sometimes startling (as it cries, coughs, laughter passion of a very complex compound character, and using it as a model to reproduce that vibration) is exceedingly attractive, differing in many respects from the one described by Prof. Mayer—has not been beyond a lecture illustration or a philosophical toy.

ALEXANDER J. ELLIS

April 13

Country Journal: Michigan

—We have written on to Edison for five phonographs. When we get them we will talk our editorials to them, thus saving the time and trouble of writing. Then when they are finished we will set them up over the printer's cases with a treadle attached to each so that the printers, with their feet, can regulate their to show off the words and whatever them in their own just as fast as wanted. Then the compositor's ears will take in his copy and their eyes will only have to watch the type. We expect Edison to give us two machines for suggesting this new use for them.

EDISON:

An Interview with the Great Inventor of Electrical Machines.

From the New York Graphic.

We went over to Menlo, N.J., two days ago, to see Edison and his wonderful inventions and make some discoveries and sketches for the *Graphic*. Menlo Park is not a park. It is not a city. It is not a town. It is not in any way related to Mungo Park, the great Scotch African. Although it is on the Pennsylvania Rail-road (just beyond Rahway), it is not even a stopping place, except when the agent flags the train to take on waiting passengers. It is composed wholly of Edison's laboratory and half a dozen houses where his employes live. It is, in short, Edisonia, and nothing else.

Just north of the track is a long, plain, white wooden building, full of windows and two stories high; this is the laboratory of the Newer Columbus whose name has suddenly become famous. Many telegraph wires are fastooned from it. The first floor is occupied by scribes and book-keepers in one end, and at the other some ten or twelve skillful workers in iron, who, at forge, and lathe and drill, are solely engaged in making patterns for the genius of the establishment. His iron ideas, in tangled shapes, are scattered and piled everywhere; turninglathes are thickly set on the floor, and the room is filled with the screech of the tortured metal.

Up stairs we climb to a room the size of the building, with twenty windows on sides and ends. It is walled with shelves of bottles, like an apothecary shop—thousands of bottles of all sizes and colors. In the corner is a cabinet organ. On benches and tables are batteries of all descriptions, microscopes, magnifying glasses, crucibles, retorts, an ash covered forge, and all the apparatus of a chemist. At a table sit two earnest men each holding alternately to mouth and ear the mouth-piece of a telephone.

"Well, what are you up to to-day?" asks an acquaintance who has summoned in.

"We have got the Chicago telephone repeater in the circuit at last, and we are now talking through 800 miles of wire, via St. Louis, Cincinnati, Louisville, Washington and Philadelphia—the parabola of the West. It doesn't work well yet. This is the largest circuit ever attempted and it would not be possible without Edison's repeating machine."

In the middle of the room is a man about five feet ten inches high, with a thin face, high cheek bones, and a long lean neck. He would not be picked out in a crowd as a man of more than ordinary intelligence, and he is the person whom a bang-stretcher

étendu, la plume peut être promenée sur le papier avec une certaine vitesse. On n'écrit pas aussi vite qu'avec les plumes ordinaires, mais on écrit à peu près comme un calligraphe qui s'appliquerait beaucoup et voudrait faire de belles grandes lettres moulées.

Le mouvement alternatif est donné à la plume par

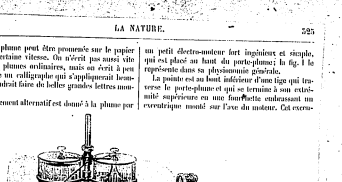

Fig. 1. — Plume électrique d'Edison, avec sa pile.

trique est à trois cames, et il suffit de 60 révolutions de l'axe par seconde pour produire les 100 battements dont nous avons parlé tout à l'heure. Cet axe porte une plaquette de fer doux, fonctionnant comme armature mobile d'un électro-aimant fixe devant lequel elle tourne avec rapidité par l'action d'un

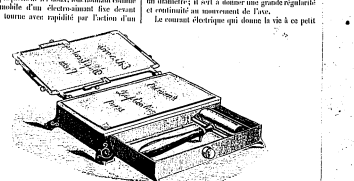

Fig. 2. — Presse de copie au verso des épreuves.

quercil est fourni par une pile de deux éléments au bichromate de potasse qui a été étudié avec soin par M. Edison, et dont la disposition est heureuse. Les couvercles des deux éléments sont formés de plateaux d'ébonite (caoutchouc durci) reliés à une pièce métallique centrale qui glisse sur une tige verticale. Les couvercles portent les deux électrodes, charbon et

commutateur très-simple, qui interrompt le courant deux fois par révolution. Un volant fonctionne, relativement lourd, embrasse cette armature qui en reçoit un demi-tour; il suit à donner une grande régularité et continuité au mouvement de l'axe.

Le courant électrique qui donne la vie à ce petit

zinc. Quand on emploie la plume, on plonge les électrodes dans les liquides; la figure 1 représente la pile dans cette condition. Quand on cesse d'écrire, on relève la pièce centrale, on l'accroche à la partie supérieure de la tige qui lui sert de guide et on préserve ainsi les électrodes du contact des liquides et par suite le zinc de l'usure inutile.

THOMAS A. EDISON, MENLO PARK, N. J., INVENTOR OF THE PHONOGRAPH, CARBON TELEPHONE, DUPLEX TELEGRAPH, ETC.

Thomas A. Edison, the Miracle-Maker of Menlo Park—A Cabinet Minister of Science.

[With Portrait.]

The inventions of Thomas Alva Edison are the wonder of the world. He has done more than any other man to perfect and advance the various systems of telegraphy, and is still hard at work for the accomplishment of other improvements.

Edison was born in Milan, Erie county, Ohio, on February 11, 1847, and is, therefore, only thirty-one years of age. Yet he has taken out 157 patents for inventions of his own, and has filed 77 caveats for other patents. His grandfather came from Holland, and settled near Newark, N. J., marrying an Ogden, one of the New York branch of that name. The Ogdens were of English descent. When Thomas was eight years old his parents removed to Port Huron, Mich., and he entered on a life of self support very soon as a newsboy. This he followed for some years. About the age of thirteen, just before the beginning of the war, he obtained a contract for the exclusive sale of newspapers on the Grand Trunk Railway in Canada. His energy soon placed him at the head of his business. He continued in it for several years longer, employing other boys, and building up a large trade. Concurrently with his newspaper sales, he bought a small outfit of type, which he carried on the train, and with which he printed the Grand Trunk Herald, a little weekly paper. He was, says Professor Edward H. Johnson, to whom we are indebted for these facts, editor, manager, typo, devil and printer—all within himself. He did his printing on a hand-press and ran up the paper to 400 subscribers. This was during the war. Young Edison finally abandoned the printing business, and got together a travelling chemical laboratory, consisting of numerous bottles and packages of chemicals. These he carried with him on the train, and experimented with them during leisure hours, until the spontaneous combustion of phosphorous set fire to the train one day, when he was obliged to give up his "tricks." But not content, Edison learned the telegraph business, became a proficient operator, and rapidly rose to the highest position in the craft. While in Cincinnati in 1867, when he was twenty, he conceived the idea of sending two messages over one wire at once. He perfected the idea in Boston, where he was discharged from service because he devised an automatic arrangement which would regularly repeat a night signal to the central office to indicate that the operator was not asleep.

The duplex instruments, the Pope & Edison printer used by the Gold and Stock Company in giving quotations, and indeed most of the improvements in telegraphy, have been invented by Edison. Some $100,000 made by his inventions has been spent in trying to discover new ones. Of Edison's latest and most wonderful invention—the phonograph—the reader has doubtless an idea. It looks like a small-barrel butter-churn, as big as a vegetable can on a toy windlass. The can or cylinder part is of brass or iron, voluted or screw-threaded. On this you roll a piece of tin-foil smoothly, and winding the barrel by the handle, speak upon it through a mouth-piece about as big as a watch-case. In this watch is a plate of ferrotype or tin-type metal which may be supposed to vibrate under the voice as a piece of sheet-iron makes thunder for a theatre. This little plate guides a needle of steel around the thread of the screw, so that it punctures the tin-foil, while the cylinder is revolving. The voice speaking there is registered, much as your face is printed by the light on the sensitive silver of the daguerreotypist. This man Edison has found a way of casting the voice in type, so that it speaks into a type-foundry, and is cast there. Then, with this tin-foil sound type he drums back on the ferrotype plate, the needle following the holes exactly, playing shuttlecock to them. The voice is so exactly reverberated or reproduced that it is distinguishable as the individual's. A spring is in the mouth-piece to give the needle play. Any appreciable sound, whether it is a noise merely or a musical note, the wheezy cough of an old man, or the sweet warbling of a Patti, the loud barking of a dog or the scream of a parrot, if once written by the phonograph on its sheets of tin-foil, can be reproduced therefrom at pleasure as distinctly as it was first emitted. In mechanism the phonograph is simplicity itself.

The utterance of a formal platform speech is given with every change of intonation. The emphases are marked and the pauses, inflexions, &c., as perfectly regulated and reproduced as if repeated by the original speaker. In a word, every sound of a pitch that causes vibrations of the tin-type diaphragm and thereby the most minute impressions of the pointer attached to it on the tin foil wrapper of the cylinder is reproduced, no matter how that sound may be in combination with others. The echo returns words only while you are present to speak them; the phonograph is an echo which will retain the very tones of your voice for hundreds of years and enable your great grandchildren, and even their great grandchildren, to know how you spoke as a photograph will tell them how you looked. We think we render the phonograph intelligible to those who have not witnessed it by describing it as an imprisoned echo; which can be released at pleasure. Of its uses, it is impossible yet to prophecy. It can record anything vocal—the song of a vocalist, the dying confession of a criminal, the chirp of a bird, the oration of a statesman, and reproduce it at will after any interval of time. It is possible we may yet see the phonograph put on the stand as a witness in court, or that it may be made yet to give forth in evidence against an accused man either the sounds of his own voice as he uttered them during his crime; or, in a murder case, the voice of the murdered victim may speak through Edison's instrument the last utterances of the murderer's victim, and fix the guilty deed beyond question.

Illustrated Police News
May 4-1878

The World.

NEW YORK, THURSDAY, MAY 2, 1878.

Mr. Edison will speedily become a Parisian celebrity, if our esteemed contemporaries of that city have their way about it. *Figaro* has copied one of THE WORLD's interviews with the "restless inventor" of Menlo Park—nay, has translated and reproduced THE WORLD's headings for the admiration and consternation of French journalists, beginning, "Cet Etonnant Edison!" The same enterprising journal now informs its readers that "the last invention of the American Eddison" has arrived at Paris, the aerophone, "a steam machine which carries the voice to a distance of eight kilometres. You speak in the jet of vapor; a friend previously warned understands readily your words at a distance of two leagues. Let us add that the friend can answer you by the same method." After this simple and intelligible description of the aerophone, *Figaro* proceeds to give some interesting details of "M. Eddison's" home life, as follows:

"It should be understood that M. Eddison does not belong to himself. He is the property of a telegraph company which lodges him at New York in a superb hotel, keeps him upon a luxurious footing, and pays him a formidable salary so as to be the only one to know of and profit by his discoveries. This company has in the dwelling of Eddison men in its employ who do not quit him for a moment, at table, on the street, in his laboratory, so that this wretched man, watched as never was a malefactor, cannot give a second's thought to his personal affairs without one of his guards saying to him, *Mister Eddison, à quoi pensez-vous?*"

"Mister Eddison," what do you think of that?

Operator May 1-78.
Oh ma

OUR PHONOGRAPH ABROAD.—The phonograph is carried Paris by storm. At first the story was ...tually spread abroad that the machine was simply mystification, and that the person who exhibited ...e phonograph was merely a clever ventriloquist ...d imitator of other peoples' voices. No mind but ...hat of a Paris cockney could have conceived of ...uch an idea as that. As soon as the Academy of Sciences had testified to the genuineness of the ...nvention the town went wild about it, and Edison ...as had such advertising as in his wildest dreams he ...ould not have expected.

Operator May 1-78

Dot Earophone.

Noddings but drooubles gomes py a Chermans. ...vas py yesterday in der delegraff office, und vile I ...vash looking roundt at der kromos on der vall, a ...nen sdeps op py me, und oxglamet, "Halo Tuchy! ...vhose your peezness here? Someding you don't ...ant, eh?" I oxblainet dot I used der vas a oberad...r mineselof vonce, unt of he dont got some dis...hection, I vill lofe to look py some ouf der improfe...ments vot got happened ladely. "Oh yaw, dot's ...oot," he replict. "all ride, come mit me, und I ...ill show you der delefone," und he vas ferry much ...ind mit me, und showed me all der vonders py ...ot crate infention vot Misder Edison whittled owet ...it a chackknife—so dot oberador dolt me. Vaell, ...ter I seen all opowet der delefone, und ve vas ...ing drough der pattery rooms, dot vailler sdopped ...n, und onquired of I had me efer seen der earo...one; "Vot's dot?" I onquired. "Oh," says him, ...ot's der ladest owet;" den he bicks him op a ...ak prass horn from the floor mitowet some keys ...it, und says he, "now, Tuchy, dot vas a aero...aph, und of you vill like to vitness der vorkings ...dis vonderful insdromendts, it vill peen nezessary ...t ve shall verst make zome arrangemendts. Dis ...drumonts vas used for sbeaking mit crate dis...ces, making sbeeches in Poston to a audience ...t ish mit Noo Yorkg, und dot forth. You vill ...fe to bractice a leedle virst, let me hear you sbeak ...it vonce." So I raised der pugle to mine lips, ...d spoke; "Louder!" says dot oberader, so I yells ...lder dot time, "Dot's goot. Now, Tuchy, you go over mit der gourt howess, und get bermission for dot shanitor to ko op on dot roof, und bractice mit dot earophone, und in dot meantime, I vill go me on top mit der roof py dis office mit a bisdle, und ven you ket mit der kourt howess (dots dwo miles avay) you vill hollers vire! und so soon ash I shall hear you, I vill fire me off dot bisdle." All riot, I dolt him, unt I vash ferry much excitet abowet it. Vell, I kot me no droobles mit der gourt howess, und der shanitor dolt me sthay so long ash I vant. So soon ash I kot me mit der roof I puts der boogle to mine mouth, und hollers mit all my might, vire! But I hears me no bisdle, so I yells fire! again, so louder as pefore, sdill I dont hears no bisdle, den I got me mat, und I yells dwice so loudt ash pefore vire! vire! vire! Shust den I hears me vone awful beak noices. Der visles gommenced der plow, der bells pegan to ring, horses und vagons vas running away. Dot racket und konfusion I dont shall nefer forget. Bretty soon I vash me surrounded py more ash two dousant beeples, und I pulldt up my mindt dot folks vas ketting oxsitet apowet dot earcraff, und I vas fraid it vouldn't been a sugcess, so I yells me louder ash louder, vire! vire! vire! vire! Shust den I hearet a beak noices py der sdairs, und I looked me dowen, und dare was eight or ten mans coming op der sdairs. Zer virst one had some prass puttons mit his koadt, undt so soon ash he kets mit der roof he snatches me py der kollars, und oxglaimet: "skoundrel! lunadix! tempfool! who you mean py dose alarm vot ish valse. I vill deach you some petter ash dot. Kome mit me!" I tried to oxblain but der more ash I say, der more he kalls me earo phone fool. Den he said he: "bact two of one," dot I sdole dot fire drumpet. Vaell, ven he kot me dowen dot sdairs he took me mit der shail, und puts me in vone shacket vot is sdraight, und keebet me dere dill dey dink I dont vas grazy some more, und dots der reason, misder edider, vy you dont hear py me quicker pefore.

YOSEF.

APRIL 18, 1878.

Operator May 1.78

The Edison Quadruplex Suits.

It will be remembered that a suit was brought about a year ago by the A. & P. Telegraph Company, before Judge Sanford, to restrain the Western Union from using the Edison quadruplex. The case was before the courts for several months, and was fully reported at the time in THE OPERATOR. Another suit by the Western Union against George Harrington, Thomas A. Edison, the Atlantic and Pacific Telegraph Company, and others, which was begun before that brought by the A. & P., was before Judge Sedgwick in the Supreme Court last Monday—the day Mr. Orton died—on a demurrer to the complaint. The suit is to establish the title of the Western Union Company to Mr. Edison's inventions in quadruplex telegraphy, and to enjoin Harrington and Edison from carrying on certain prior suits in equity in the Federal courts. These suits are for the infringement of a patent obtained by Harrington and Edison for one of those inventions, and also to establish their title to all of them, as against the claims of the Western Union Company, under certain agreements alleged to have been made by the Western Union Company with Edison, and with him and Prescott, the company's electrician.

The present suit involves almost the same issues. The complaint claims that Edison in 1873 agreed to sell to the Western Union Company the inventions he might make for a just price, to be agreed upon or determined by arbitration; that Edison after making the inventions assigned them with the consent of the Western Union Company to himself and Prescott in August, 1874, and that afterward, in December, 1874, they made an offer in writing, unsigned, to sell the inventions to the Western Union Company for a certain sum to be then paid, and a royalty of $166 a year for each circuit created; that the offer was accepted, and part payment made in advance. Upon the demurrer, last Monday, Mr. W. A. Butler argued, first, that the agreement made in 1873 was insufficient in law to create any title to the inventions; at most the Western Union Company could only maintain an action against Edison for damages for refusing to name arbitrators if they had requested him to do so, and no such request was alleged; second, that the agreement of December, 1874, is invalid under the Statute of Frauds, it being an agreement not to be performed within a year, and the payment in advance on account not being a part payment of the purchase price of the property sold by the contract sought to be enforced; third, that the action cannot be maintained because the complaint shows that the suits in the Federal courts were brought before this action was begun, and that all the matters sought to be litigated in this action are embraced in those suits. After hearing Mr. Soren in opposition, Judge Sedgwick reserved his decision.

Newark Register
May 3. 1878

RIDAY, MAY 3, 1878.

EDISON'S MACHINE.

HOW A PIECE OF MECHANICAL INGENUITY REPRODUCES THE HUMAN VOICE.

A GALA DAY AT THE HOME OF THE PHONOGRAPH —IT LAUGHS, IT SINGS, IT RECITES AND DOES EVERYTHING THAT HUMANITY CAN DO —PRACTICAL EXPERIMENTS MADE BY NEWSPAPERS YESTERDAY.

There was a train left this city yesterday afternoon at 3:30 o'clock. It was not exactly a special train, but it had two special cars attached, which were compatibly mendicoupled until their arrival at the Market street depot.

There a delegation of Newark gentlemen awaited it; conspicuous among whom were the following: Hon. George A. Halsey, Senator Kirk, Dr. Green, Postmaster Dobbins of the Board of Education, School Superintendent Barringer, ex-Judge Samuel P. Bigelow, ex-Sheriff Hopper, Hon. George S. Duryee, President of Council Young, Alderman Thirkcuth, Rev. Dr. Wood, Rev. Dr. Howard Smith, Doctors Otis, Osborn, Thomas, Hollon and Wallace, William Clark, Prideaux Jones, Col. Swords, Dr. Thomas Dunn Eng. lish, Daniel Stockton, County Clerk Smith, ex-Register Sharp, ex-Ald. Pennington, John H. Wecker, J. D. Daniels, Andrew Albright, A. H. Lemsley, James R. Pearson, Thomas Smith, T. T. Cairo, Mr. Mellowell, Secretary N. J. Association, Silas Haley, Secretary Boland, H. B. Mandeback, Chas. H. Ingalls.

The Press was represented by Messrs. Woodruff and Hoyt of the Advertiser, Wilson A. Ure or the Morning Call and Dr. Vedder of the Register.

These people had been invited by Mr. Edison to visit Menlo Park, and made a practical test of that most wonderful of all wonderful inventions the phonograph.

Upon the arrival of the train at Menlo Park the gentlemen proceeded to Mr. Edison's manufactory. It was found to be a modest and unpretentious-looking building, only two stories in height, and occupying a position upon a slight elevation westerly from the depot.

Mr. Edison was found in the second story of the building, along side of the electric machine which his genius had seen to investigate. Mr. W. W. Dykington, of the Mutual Insurance Life Insurance Company, acted as a sort of master of ceremonies, although I hailed on signal and took the delighted visit. Mr. Edison's visitors and himself there was the Market street depot, from whence not the slightest formality. As soon as they spoke of the wonders they had seen, the groups were in a genial, off-hand manner made perfectly at home, Mr. Edison with a few remarks introduced his marvelous machine.

He first talked to it himself. He recited: "Mary had a little lamb,

Its fleece was white as snow;
And every place that Mary went,
The lamb was sure to go."

Back from the phonograph came every tone of his voice, every phrase that he made in his reading; it was really a perfect reproduction of Mr. Edison's voice, his sound, and his vocal peculiarities. Next he recited "Jack and Gill," and while he sat with mute lips and folded arms, that remarkable little boy recited "Jack and Gill" as he had done. Then he sang in the instrument; sang "John Brown's body, &c.," and took some every note of that song as clear and as strong as distinct and as accurate as he had uttered it. As soon as Mr. Edison had concluded his little bit of programme, an assistant of his, Mr. Batchelor, who occupied a table quite near to him, sang in another phonograph, the ballad known as "Old Uncle Ned." There was a momentary pause, and then the quaint old song came from the instrument with as perfect harmony as the instrument had received it. Mr. Batchelor performed many other things upon his phonograph, reciting the "Boy's Address upon the Ice" and the Burn Flower," and many others. Upon the invitation Mr. Edison made his machine repeat "Shugen on the Alps," and Mr. Joseph Poole of the Grace Church choir sang a fine Sir old negro melody, Stephen Foster.

The phonograph is in fine style song of the gr. a of Newark's musicales, as represented by Senator Kirk, who, beyond all doubt, has sent to the Paris Exposition the finest piece of workmanship that Newark has hitherto turned out. Then it said a good word for Mr. P. T. Quinn of the New Jersey Horticultural Society, and then it complimented the Reverses. The phonograph has a great many other cute things to the infinite amusement of the audience.

About half-past five o'clock Mr. Dykington called the gathering to order and introduced Colonel Swords, who had been selected as the leader on behalf of the Club to Mr. Edison, which he did with his usual politeness and fluency.

Menlo Park is one among the many garden spots of New Jersey, is one hundred and fifty acres into water, and said to be one of the lordly spots of the country.

We met not old friend M. F. Carman, formerly of this city, who is now located at this place, and has a fine residence near by, and who was kind enough to guide friend Mack and myself to Menlo Park.

Senator John C. McPherson's palatial residence stands in full view, about one mile to the southward.

On a clear day it is said the Brooklyn spires can be plainly seen.

About six o'clock the through mail train on Mr. Edison's visitors and himself there was the Market street depot, from whence not the slightest formality. As soon as they spoke of the wonders they had seen, the groups were in a genial, off-hand manner made perfectly at home, Mr. Edison with a few remarks introduced his marvelous machine.

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Back from the phonograph came every tone of his voice, every phrase that he made in his reading; it was really a perfect reproduction of Mr. Edison's voice, his sound, and his vocal peculiarities. Next he recited "Jack and Gill," and while he sat with mute lips and folded arms, that remarkable little boy recited "Jack and Gill" as he had done. Then he sang in the instrument; sang "John Brown's body, &c.," and took some every note of that song as clear and as strong as distinct and as accurate as he had uttered it. As soon as Mr. Edison had concluded his little bit of programme, an assistant of his, Mr. Batchelor, who occupied a table quite near to him, sang in another phonograph, the ballad known as "Old Uncle Ned." There was a momentary pause, and then the quaint old song came from the instrument with as perfect harmony as the instrument had received it. Mr. Batchelor performed many other things upon his phonograph, reciting the "Boy's Address upon the Ice" and the Burn Flower," and many others. Upon the invitation Mr. Edison made his machine repeat "Shugen on the Alps," and Mr. Joseph Poole of the Grace Church choir sang a fine Sir old negro melody, Stephen Foster.

The phonograph is in fine style song of the gr. a of Newark's musicales, as represented by Senator Kirk, who, beyond all doubt, has sent to the Paris Exposition the finest piece of workmanship that Newark has hitherto turned out. Then it said a good word for Mr. P. T. Quinn of the New Jersey Horticultural Society, and then it complimented the Reverses. The phonograph has a great many other cute things to the infinite amusement of the audience.

About half-past five o'clock Mr. Dykington called the gathering to order and introduced Colonel Swords, who had been selected as the leader on behalf of the Club to Mr. Edison, which he did with his usual politeness and fluency.

Menlo Park is one among the many garden spots of New Jersey, is one hundred and fifty acres into water, and said to be one of the lordly spots of the country.

We met not old friend M. F. Carman, formerly of this city, who is now located at this place, and has a fine residence near by, and who was kind enough to guide friend Mack and myself to Menlo Park.

Senator John C. McPherson's palatial residence stands in full view, about one mile to the southward.

On a clear day it is said the Brooklyn spires can be plainly seen.

About six o'clock the through mail train on

(Y 2, 1878.

The Phonograph and Mr. Edison's Other Inventions.

Everybody is talking about the phonograph —the wonderful little machine that makes it's own music and talks. Even the machine itself has been made to talk, and it is a very interesting thing to hear. The writer went out the other day to Mr. Edison's laboratory at Menlo Park, N. J., and had an opportunity there to see the latest improved forms of the phonograph, together with all the other apparatus with which his inventive genius is constantly experimenting.

Mr. Edison is a pleasant, unassuming gentleman, without the slightest pretension, and dressed like any ordinary mechanic. He is too busy to care about appearances. In fact, they say that when a barber brushes his hair nicely he runs—nicely "runs" it again, as otherwise he can't think. When he is chasing an idea and endeavoring to reduce it to practical form, he stays in his laboratory day and night, has his meals brought to him, and continues in a sort of frenzy of mental concentration until he has conquered his subject. His workshop, or laboratory, is a long, two-story frame building, in the middle of a field, looking solitary, but connected by telegraph with the rest of the world. His operations are so extensive that he has a large staff of assistants to help him experiment and machinists to turn his thoughts into iron. The dozen dwellings which make up the village are all occupied by his employees. Glancing into his laboratory, one would at first sight think it was the machine-shop of a foundry.

The phonograph is a very simple instrument. There is no electricity about it. Its movements are entirely mechanical. Roughly speaking, its necessary parts are four in number: 1. A thin iron plate, such as photographers use for "tintypes," to receive the vibrations of the human voice. 2. A sharp-steel point, or bevel of a needle, attached to the under side of the ferrotype plate, to communicate the vibrations and make marks upon a surface of tin-foil. 3. A sheet of tin-foil so arranged that it will move along under the steel point and receive the impressions, so that the result will be a series of indentations in a row. 4. A mechanical device for the tin-foil to rest on, with grooves for the steel point to press the tin-foil into as it passes along. A machine can be constructed of any shape or size, so long as it has these necessary parts, and less than adjusted together, carefully enough to work with success. The phonograph as Mr. Edison first made it, and as it has been so far introduced to the public, is thus constructed: There is a cylinder about twelve inches long and four inches in diameter, which forms the metal surface for the tin-foil to rest on. This cylinder has a spiral groove running around it, like the groove of a screw, so that the steel point has a long way to travel in following the grooves from one end of the cylinder to the other. The steel point is connected with a diaphragm, a small metal disk, so that it may turn around a center, the point in the center of the groove. Above the diaphragm is located—with the—diaphragm, of course, for the purpose of communicating over it, about it greater force. Now, with wheel and gearing, the cylinder is made to turn in its place, the diaphragm receives the sound vibrations and causes the steel point to move up and down and make such indentations on the tin-foil which in passing around on the surface of the cylinder. The talking may be continued until all the tin-foil has been marked and the entire length of the cylinder has been covered. Then the machine is rewound for talking, all the indentations being used, the steel point back to where it started and the machine over the indentations which it has just made. In this way the indentations make the needle jump up and down, the needle makes the diaphragm vibrate, and thus the exact sounds which were first put into the machine will be reproduced—the rising and falling of the voice, and all combined complaints of a good reciter, laughing, singing, whistling, coughing, the mewing of a cat, barking of a dog, crowing of a crow, etc., etc. The marks on the tin-foil, as they appear to the naked eye, and may be seen anywhere, look like a fine coarse saw. What would not literateurs give for a few words of Shakespeare by Shakespeare himself? What would not scholars give to know the pronunciation of Greek and Latin as it was pronounced by the Greeks and Romans themselves? We have the means now, and in our latest posterity the pronunciation of English as it is correct to-day, and to seal up the tin-foil in one of our greatest museums so that they may be heard thousands of years hence.

Many practical applications of the phonograph have been proposed for present use. A dictionary of words for use from the instrument and used the tin-foil or metal, and his correspondent will place it in a machine at his office and hear the communication. A phonograph with a fat-fish instead of a cylinder is being prepared for such purposes. Celebrated preachers and singers can have their voices preserved, so that persons in towns and cities thousands of miles away can hear them they may happen to be in person. Even the dying words of the faithful can be so hardened that it will repeat the same speech or sing a great many times, and thus Mr. Spurgeon or Miss Kellogg may be reproduced on demand anywhere in this world. Of course, after the tin-foil or the engraving the tin-foil will make ferrotype plates for printing are duplicated, persons will be enabled to buy the speeches or songs of celebrated persons at a steam rate, and will be able to hear them from their own phonographs as they now get photographs into a stereoscope. Letters can be dictated, and dictations may be sold in the same way, the tin-foil going along with the printed text-book. Children can be taught to repeat mental allusions at certain hours of the day. In fact, the applications that suggest themselves are very numerous, and human ingenuity will no doubt devise many that are not yet dreamed of.

The telephone is another invention which Mr. Edison intends to perfect as soon as the phonograph excitement has subsided. The vibrations of a phonograph diaphragm will be magnified and intensified in force by means of magnets and other means, and communicated to a steam whistle, so that the sounds spoken will be converted into a voice loud enough to be heard for miles. Thus a lighthouse can talk with about. "Keep off the coast!" a telegraph operator will shout, "Clear the track!" a locomotive engineer will observe with real voice instead of fog signals, and many other wonderful things will be done.

Mr. Edison has a telephone of his own invention which he claims is many times more delicate than the Bell telephone. He has discovered the property of carbon never before known to science which enables him to produce a telephone much more powerful than any heretofore made. He has recently applied it very successfully with Philadelphia a short time of our visit. He has also a repeating telephone, so that a message can be sent through a dozen circuits, if necessary, it begins to grow faint, reinforce it and send it along with all its force. With a series of repeating machines like this, the telephone may yet be used with success in New Providence as well as from New York to San Francisco.

The duplex and quadruplex telegraph, now used by the Western Union, the Roman-character printing telegraph, the fac-simile pen, and other minor very useful inventions are among the fruits of Mr. Edison's genius; but we leave the phonograph as "king," and all his associates are now directed to its improvement.

THE TELEPHONE TELEGRAPH.

THE PROPOSED EXTENSION OF PRIVATE LINES —DETAILS OF THE SCHEME.

On the door of room No. 44 of the Western Union building on Broadway, are fastened in gilt the words: "Gold and Stock Telegraph Company Superintendent's Office, Telephone-Private Lines." On the glass door of the adjoining room, No. 45 are lettered the words: "American Speaking Telephone." In the adjoining building is the office of the phonograph. In a small room in the rear of President Walker's office, reached by a dozen private through other rooms, are the telephones all in active use. They differ very essentially from each other in appearance, the principle being the same. The instrument in connection with the company's manufactory is a small affair, while that in Mr. Orton's and a fourth private operator was placed in communication with the superintendent, Mr. Charles Cushing, by a wire stretched through an intervening building and in many instances Church, and a fourth private operator was placed in communication with the superintendent, Mr. Charles Cushing, by a wire stretched through an intervening building and in many instances on roofs. Its cover has a melodeon look to it, and is somewhat ornamental. The one private wire connecting the two offices is run through the roofs of the intervening buildings, and is supported by insulators placed on the tops of chimneys. The instruments are in a small box, and are connected by a wire with the battery in the basement. The battery consists of fifty or more cells. It costs one cent.

In what way does Mr. Edison's carbon telephone differ from Bell's?

It will be simpler and cheaper, soon, further and be better adapted to the ordinary uses of the public. What, for instance, can make a telephone with a receiving tube and a mouth-piece as a mere toy, and a thousand miles are the instruments which you propose to introduce commercial use?

Yes, as soon as they are perfected. Our Superintendent, Mr. Cushing, can talk with Mr. Orton in the adjoining office, by which the two can, as Mr. Orton will tell you. They take his invention in his counter form and improve it in many respects. They can now be used for nearly any distance, and have been made almost perfect. They have been at work for a month to repeat messages. As soon as we have the perfect instruments there will be no difficulty in making every office in the city a telephone office, and in every house. We shall lease the original instruments as models and for experiment."

Have you your rights from the Western Union Company?

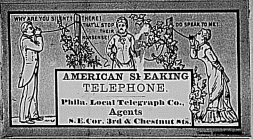
"Only partly. There is a great mistake as to the relations of the two companies. It is not a wheel within a wheel. We are an old company, formed in 1852, and have been doing a large and profitable business of the greater proportion of which is that now the Western Union furnished just—the wires and we the instruments. We have an exclusive business. We conducted the business of our company with that of their own, and contributed largely to the new kind of work—to Gold and Stock reports, to furnish market reports, etc. We have a contract with them for appropriations, but only relations with them are those that are those of a contract by which they furnish us with wires, and we furnish them and allow us the use of those wires at certain long distances at a fixed rate per mile per month. We have no other connection with them. Our capital stock amounting to two thirds of their entire interest. They agree to interfere in no way with our private business and we agree not to interfere with them for public business.

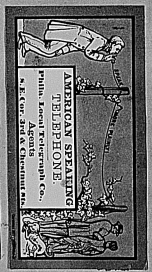
Have you any other business connect with them for the use of Mr. Edison's telephone?

"They have not been served upon at all. They have been offered it, but have declined to accept it in any case as a general rule never connect with the to-be-all their instruments and appliances for our business. The public must be able to obtain a telephone themselves.

"Then you will built our the telephone?"

"Yes. We purchased time's and Hoskins's right-long ago, and are now entitled to the benefit of it. It is our intention to put up telephones in all the cities and to their use by the public. Business only for private purposes and for private lines. For instance, a merchant may have a telephone in his office, and the right to use a telephone in the office of his customer in other cities may also. He wanted to—to—to—





AN IMPROVED TELEPHONE IN YORK.

43

Extracted from the "York Daily Herald" of April 13th, 1878.

Some important improvements upon Professor Bell's Telephone have recently been made and patented by Mr. E. Cox Walker, electrician (of the firm of Messrs. T. Cooke and Sons), of this city. As is now pretty generally known, Professor Bell's telephone consists

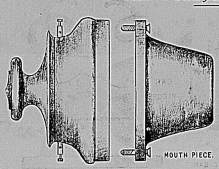
potential incurred our pieces, the advantage of which is in the ear piece being tapered to a small point, the sound can be more easily concentrated on the tympanum of the ear, without at the same time occasioning any discomfort by the pressure of the instrument, in addition to which two ear pieces can with facility be used at the same time.

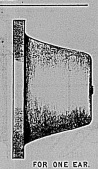
E. COX WALKER'S PATENT MOUTH AND EAR PIECES,

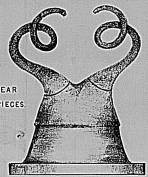
AS ADAPTED TO THE BELL

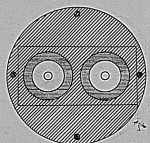
TELEPHONES (IMPROVED).

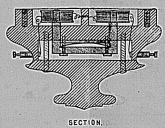
By means of which the sounds are doubled and quadrupled, and may be increased to a still greater extent.

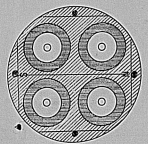












E. Cox Walker
Buckingham Works, York.

AN IMPROVED TELEPHONE IN YORK.

43

Extracted from the "York Daily Herald" of April 12th, 1878.

Some important improvements upon Professor Bell's Telephone have recently been made and patented by Mr. E. Cox Walker, electrician, (of the firm of Messrs. T. Cooke and Sons) of this city. As it is now pretty generally known Professor Bell's telephone consists of a soft bar magnet, around one end of which is wound a coil of fine silk covered copper wire, and a diaphragm of thin sheet iron or tersnipan. Upon the diaphragm a mouth piece is placed for the purpose of concentrating the voice of the speaker upon the centre of the diaphragm. The coil is connected up to an ordinary telegraph wire, at the other end of which another telephone, various articulate sounds can be conveyed to long distance. Though what at very sound could be transmitted with sound artificial distinctness, it was found both in practice and experiment that the utility of this novel instrument would be much enhanced if the sounds could be by any means intensified so as to relieve the auditor of undue attention, and avoid the necessity for the speaker to speak with more than ordinary loudness. With this view experiments were made with enlarged diaphragms, but these, although giving more volume, became a thickness and comparative intensiveness of the sound. Theoretically, it might be supposed that if the transmitting diaphragm were made to vibrate with a certain force and at a certain rate, that the intensity of the sound developed would be in the same ratio to the multiplication of the receiving and in working out this fact, Mr. Walker has effected a valuable improvement. The improvements consist in it striking or a vibrating the diaphragm and the same time, and directing the impulses so that to each diaphragm there is a corresponding sub-impulse. Instead of using two or four magnets, Mr. Walker adopts one or two magnets somewhat of a horse shoe shape, the coils being connected as for ordinary horse shoe electro magnets, and the connections made with the transmitting wire in the ordinary way. Taking the simplest arrangement as an example, it might be assumed that the magnet is placed in the centre, and in place of being direct to the diaphragm it is divided into four smaller magnets, each of which extends and draws the sound on to the diaphragm covering the magnets. Mr. Walker does not have a separate diaphragm for each pole or coil, but has so constructed the under side of the membrane that it clips to the diaphragm tightly across the middle and around the top thus encircling the coils, and virtually forms them. We had the privilege on Wednesday evening of witnessing some experiments with the improved telephone on Messrs. Cooke's premises in Coney-street, under the superintendence of Mr. Cox Walker. Conversations were carried on and songs were sung with the single telephone, the double telephone, and the duplex and quadruplex system of telephone of Mr. Walker. Comparisons could then be made, and it was found that as nearly as could be ascertained by the sufficient the intensity of the sound transmitted through the duplex telephone was double of that transmitted through the single instrument and the same proportion was found to be maintained in the quadruplex telephone. These results were obtained not only in the transmission of the human voice, but precisely the same effect was observable when the strains of a violin and a small musical box were sent through. The effect, in as of the violin were heard with great distinctness, and the whole of the experiments were of the most satisfactory character. Mr. Walker has succeeded in greatly increasing the intensity of the sound by adding to the number of coils, diaphragms, and corresponding divisions in the mouth piece, and he is hopeful that an octoplex telephone will give right tone the intensity of a single one. The improvements already effected will render the transmission, and especially the receipt of telephonic messages, a matter of much greater comfort and facility. Besides the mouth piece Mr. Walker has patented improved ear pieces, the advantage of which is that the ear pieces being tapered to a small point the sound can be more easily concentrated on the tympanum of the ear without at the same time occasioning any discomfort by the pressure of the instrument, in addition to which two ear pieces can with facility be used at the same time.

THE DAILY GRAPHIC
MONDAY, MAY 6, 1878.

Edison deserves the thanks of the sailor, for counselling Congress to force to some of their own exercises.—Boston Journal.

The Graphic says: "The pneumatic feels its supreme ability. They say does it support—Philadelphia Bulletin.

And then they clinched quite cordial like, Remaining tie for tie;
And when they parted they remarked
In the usual manly way,
—Written paper on the Fat Boston discussion.

[ANOTHER OF '42.
[Cincinnati Saturday Night.]

Edison, inventor of the phonograph, cannot be suffered to have it all his own way very long. Already a steal has appeared in the person of one John Q. Stewart, of Chicago, who, unfortunately for China, who announces a machine called the "Mikrokosm" by which the Atlantic can be crossed in twenty-four hours. The boat is furnished with revolving cylinders in front which throw the water to either side, thus gaining a rapid motion. The machine which is to control by the screw-wheel in the stern as through the air. He claims that his boat, which is to be made of steel, will be light and solid enough that 6 months' life boy would be any one to make. Danforth is confer-ring to organize a company with the necessary capital to control the invention, with Sandy and his money.

EDISON AND HIS FACIES.

Edison, the inventor, has lost an queer ideas about food as about machines. Being tested out to lunch in tish city one day last week, he ordered only pastry, and ate a piece of strawberry shortcake, a piece of mince pie, some cream, and a piece of dumpling, one after the other. He said he had a theory of food: letting that the proper and useful mixture of nutrien was only to be got by the diversity of their diet. "I wish I could subsist on one thing twice a month," he said. "There is then a lightenment and great mental activity as a variety of food. Look at Chiles, fed on okra, and on France, where they cook a thousand times a hundred different ways." Mr. Edison declares that his telegraph, recently purchased by the Western Union Telegraph Company, is "nowise likely to prevent" so many of his employees become they do not use cards. Invented by the way, the "Edison pen" is a most wonderful contrivance and curious properties not hitherto understood, that are about to be of great value to science, especially to chemistry and astronomy."

EDISON'S FRANKENSTEIN.

THE GREAT INVENTOR ESPIES A SPIRIT WHICH HE FEELS IT IMPOSSIBLE TO LAY.

While a Graphic representative was talking with Mr. Thomas A. Edison recently a rather well looking young gentleman entered and was introduced as Mr. Stewart, of Chicago, a friend of the inventor. He was a youth with balding forehead and a pleasant face, and he brushed back with his fingers.

"Well, Mr. Edison, I have been looking for you everywhere," he began, "and I want to tell you not to stay any longer. You are working altogether too much. You are killing yourself. Your health is nearly ruined by your continuous labors. You must not be complete in what you have applied directly to the amelioration of the condition of man kind itself. In human physiology and psychology you are put to with your mental interests. Do not, I know," said he, smiling his head, "this wonderful machine is at your relaxation to play upon as dog [illegible]."

"Well," said Mr. Edison, with a screwed smile, "I do not see what you are doing at. What can I do for you?"

"You are aware, Mr. Edison," recommenced the visitor, "that my interest of our wonderful is that not for sixes. What I want is that you shall [illegible] Science has destroyed the old conception of immortality so dear to our fathers. It shows in the absence of [illegible] and [illegible] Bible, by Glycerine of Darwin, Tyndall and Huxley and their conferers, it is that the material organism composing the human body dissolves at death, and that there is no conscious life after decease. There is an immortality of the material of which the body is composed and the forces by which it moves, but no one forever. We live in our children, in our work and in our influence. But this is sentimental and unsatisfactory to the selfish man."

"Well, well," said Mr. Edison, "what are you driving at, my dear fellow? I do not get the clue."

"Just this," remarked the enthusiastic theorist, putting his fingers in the arm-holes of his vest and pacing against the floor; "I want you to invent an ingredient—an elemental compound—with will give me conscious life in my stead—in other words, give me duration which I can recall next day. Three dreams must be invariably pleasant."

"Are you mad?" said Mr. Edison, leaning forward and putting his hand to his ear, as he is in the habit of doing when persons with whom he is talking do not understand that he is partially deaf.

"Well, Mr. Edison, I have been here and the narrative which go to prove your time and space have nothing to do with sleep—the experiences of Coleridge, De Quincy and Fitz Hugh Ludlow, which show that you may dream a thousand years in half a second."

"Yes," said Mr. Edison, "that is true. I remember once failing from the fifth white asleep, and in the interval between these and the floor the time was so prolonged and my consciousness so vivid, that when I awakened to write it out afterwards I filled fifteen pages of foolscap with the narrative and then did not get half through. Yes, I know that it is a matter of fact that time is not controlled by time or space, but test of that."

"Are you catch my idea?" exclaimed the enthusiast eagerly. "You remember the story of the man who dipped his head in the magic basin of water in Egypt? Between the moment of immersion and the next moment of withdrawal of his head, a century had passed; he dreamed he was married in the interim as a Sultan; was married and had a large family; and was finally the victim of an intrigue; was tried, delivered and beheaded."

"Well, well," said Mr. Edison, somewhat impatiently, "come to the point. What are you going to make of all this?"

"Well, Mr. Edison, we know, do we not, that opium and other narcotics of amazing vividness which are commercially valuable? Hashish or Indian hemp has the same effect. Tobacco users relate a kindred experience. Alcoholic stimulants excite the brain in a different way, but produce the same effect. It is a most important change that no clerk or other employee will need to be trusted with any information as to pending negotiations or orders given. One principal will speak at New York; the other will listen at San Francisco; and each can then look up in his safe a record of what was said.

The best contrast of the future will be drawn by no lawyers, to the inconvenience of the parties, wrangled over by counsel, and from as the blessed hope of a life hereafter, may be the portraits of souls, thousands our sleeping sense, so that when we lie down it will be to an eternity, a pleasant dream. Thus science, which has taken from as the blessed hope of a life hereafter, may restore it. Science answers, "which, if it could be restored—well, there's no one speculating about the results. Death it and that's best. Experience, they what you can do. Young man," and the inventor laid his finger caressingly on the shoulder of the fantastic of ideas, "if your enthusiasm keeps up for ten years or twelve delights during the time in which our minds are governed, it would, perhaps, be well to have some medical friend, with a stomach pump, looking at you every minute. You might overstep yourself, you know."

The young dreamer person out on his hat thoughtfully, and went out without saying a word.

The Public.
NEW YORK, THURSDAY, MAY 2, 1878.

THE PHONOGRAPH.

Forty years ago, when Professor Morse was exhibiting a curious invention in a hall in this city, very few persons realized that a new world, as to all financial and commercial transactions, would be the result. So completely has the telegraph entered into and transformed the processes of business, that men now in the prime of life catch themselves wondering how it was possible to do business at all in the years when they began. A single invention has thus revolutionized the commercial and financial world.

If the anticipations of Mr. Edison, so clearly and modestly stated in his very interesting article in the North American Review, are realized in any considerable degree, another revolution in commerce is at hand. The results of the phonograph, if it accomplishes only what is now expected by shrewd and cool-headed observers, will be incalculable. It must be presumed, also, that this invention like every other which has involved the use of new forces and principles, will prove capable of almost unlimited improvement and application to new purposes. But enough can even now be foreseen to cause the progress of this invention to be watched with the utmost interest. A few of the immediate effects upon business methods may be here suggested.

The time and labor of thousands of clerks can be saved, who are now employed in writing letters from dictation or otherwise. As fast as the principal can utter his directions, the phonograph will yield two copies, one to be filed away by him, another to be sent to his distant correspondent, there to reproduce precisely his own words in his own tones of voice, and also to be filed as the highest possible proof of the transaction. Handwriting and signatures may be counterfeited, and therefore may also be repudiated falsely; it will be more difficult to forge or deny tricks and tones of speech, and peculiarities of grammar or pronunciation. Experts may dispute long about writings; but any jury can judge whether an order was given by a man if, having first heard him repeat the same words on a witness stand, they next hear reproduced, with photographic accuracy, the very tones in which the order was originally given. It will be a most important change that no clerk or other employee will need to be trusted with any information as to pending negotiations or orders given. One principal will speak at New York; the other will listen at San Francisco; and each can then look up in his safe a record of what was said.

The best contrast of the future will be drawn by no lawyers, to the inconvenience of the parties, wrangled over by counsel, and from as the blessed hope of a life hereafter, may be the portraits of souls, thousands our sleeping sense, so that when we lie down it will be to an eternity, a pleasant dream. Thus science, which has taken from as the blessed hope of a life hereafter, may restore it. Science answers, "which, if it could be restored—well, there's no one speculating about the results. Death it and that's best. Experience, they what you can do. Young man," and the inventor laid his finger caressingly on the shoulder of the fantastic of ideas, "if your enthusiasm keeps up for ten years or twelve delights during the time in which our minds are governed, it would, perhaps, be well to have some medical friend, with a stomach pump, looking at you every minute. You might overstep yourself, you know."

The young dreamer person out on his hat thoughtfully, and went out without saying a word.

The check or draft of the future will be a thin metallic strip attached to such paper as is now employed. On the paper will be known stamps and signatures, as now; on the strip of metal will be the voices of drawers and endorsers. To raise a check will be impossible, for no one can interpolate new words in the continuous flow of speech. To forge a check, draft or note, the knave must be able not only to imitate, as now, stamps, forms and signatures, but to mimic known voices with accuracy. Between correspondents, private signs can easily be arranged, which shall amount to all other bearers more carelessness of speech, or peculiarities in the movement of the instrument. It is hard to guess how far this invention may be employed in the prevention of forgery, the authentication of bonds, or the verification of other important papers.

The library of the future will be one which any man can carry under his arm. Bound between proper covers will be a thousand thin metallic leaves *in inches square*, each leaf a volume of 40,000 words. And each book will read itself to a man while he works at his bench, sits at his counter, or eats and smokes; in most trades he will educate himself while he is earning a living. The cost of reproducing a book, if Mr. Edison is right in his belief that phonographic plates can be copied by electrotyping, will be much less than the cost of printing a small handbill. The paper maker and binder and printer will have less to do, but few men will be too poor to own a library. The author can talk to his phonograph instead of laboriously writing; the orator can rehearse his speech, and see how it will sound; the advertiser will send his best recommendation of his wares to as many people as he likes, that they may listen when they have a moment's leisure and the phonograph is not busy.

The business office of the future will be any pleasant room within a telephone district. For Mr. Edison believes that the same instrument can be made both to utter and to record, at either end of a telegraph wire, words spoken at the other end. Jones, then, after he has taken breakfast at home, steps to the machine in his library and hails the main office, "Put me in line with Smith, 49 Broadway." Smith is hailed, and their wires are connected, and they at once do business. Jones offers to buy goods or lands; Smith hears the proposal, and at both ends instruments record it. Smith names price; Jones reponses and wants lower; finally they agree. Ten minutes chat, every word recorded, closes the bargain, and Jones is ready for a trade with somebody else, meanwhile smoking at home. In less time than even rapid transit can take him down town, he can hail and bargain with twenty people, and be able to prove fifty years afterward every word spoken by him or to him. When he needs a clerk or any property he may go abroad unless samples can be sent, but if the inventor does not deceive himself, in the dealings of the future, between business men of the same city or of different cities, transactions by wire will be preferred to personal interviews, because delay in moving about will be avoided, but still more because every word will then be on record.

These things sound like dreams. But the telegraph was a much wilder dream til 1848, and now London orders tea from Hong Kong in "less time no time." Dreams "are such stuff as" we "are made of," and our grandest advances of commerce and industry are but the crystallization of wild dreams into every day facts. It is impossible to guess what transformation in methods of commerce and cost of doing business may be affected within the next decade by the little revolving wheel which a singular man in New Jersey has made to talk.

EDISON'S PHONOGRAPH.

A Pleasant Visit to Menlo Park.

The Talking Machine Tested and Other Remarkable Inventions Examined.

In response to an invitation extended to the Essex Club[sic] their friends by Mr. W. H. Applegate, a party of gentlemen numbering one hundred and thirty-four visited the interesting factory of Prof. Thomas E. Edison, at Menlo Park, on Tuesday afternoon last. The workshop of this celebrated inventor is located a short distance west of the Pennsylvania railroad depot on a plot of land covering about an acre, from which a fine view of the surrounding country may be had. The two-story building, about 25x100 feet, is divided into a machine shop, office and work-room on the first floor, the glass cases in the latter room containing many curious working models of telegraph instruments. Hundreds of electrical batteries of various sizes and forms are ranged on shelves around the room, while the walls and ceilings are covered with a network of wires, a dozen or more, of them leading from the building to different parts of the country. Mr. Edison's electric motor, consisting of a large magnet, three feet long and resembling a tuning fork, which he expects to utilize for running light machinery like sewing machines, was inspected by the visitors as it laid on a table on the upper floor. The electric pen was examined, and a large organ was performed upon by one of the musical experts present. The telephone also afforded considerable amusement to those assembled, who conversed with each other with the greatest facility through ten miles of wire extending in coils from the roof. Dinner was served at the upper floor. The tune, furnished by a tiny music-box at one end of the table, was also heard at the other and distinctly. Many other novelties in telegraphy greeted the eyes and ears of the visitors as they strolled through the rooms; but the chief attraction of Prof. Edison, the Phonograph, was the principal object of interest, and around two of these instruments most of the visitors clustered. Mr. Edison operated one of the instruments, while an assistant, Mr. Batchelor, had charge of the other one. The apparently simple operation of reproducing the sounds of the human voice was witnessed with the greatest delight by all present, and the sheets of tinfoil bearing the dotted lines of sound waves as they appeared from the cylinder were carefully transferred to the pockets as different gentlemen to be preserved as souvenirs of the visit. The instrument consists of a metal cylinder about ten inches long and four inches in diameter, which is made to revolve on an iron bar about three feet long, around the face of the cylinder, parallel to the extension of an inch apart, run delicate grooves. Over these grooves is placed a sheet of tinfoil five inches wide, which is held firmly around the cylinder. The machine is now in readiness to receive sounds, which are transmitted to the tinfoil while the cylinder revolves through a short tube similar to a telephone mouthpiece, and held close to the tinfoil. The impression of sound is given by a metal point attached to the centre of the diaphragm at the bottom of the mouthpiece. The voice of the operator causes the diaphragm to vibrate, and the point thus set in motion makes indentations in the tinfoil over the grooves, each dot representing a sound and conforming their impression to its tone of voice, a loud voice causing a deep impression, and, consequently, more elasticity heard when reproduced. After the operator has recited "Mary had a little lamb," or other nursery rhymes, with his mouth to the phonograph, a small paper tunnel is placed over the mouthpiece, the cylinder is again turned, when out through the funnel come the identical sounds that were uttered by the operator, whistling, singing or ordinary conversation, notes being reproduced with remarkable accuracy. When one sheet of tinfoil had been used as long as the company desired, another sheet was placed on the cylinder for the purpose of recording another series of sounds. It is claimed by Mr. Edison that the sheets taken from the cylinder can afterwards be replaced on the same or a similar cylinder and reproduce the same sounds an indefinite number of times. This experiment, however, was not shown to the visitors, the peculiar cylinder required for this purpose being still in course of construction. Should the effort prove impracticable to confine the original sounds so that they can be reproduced on different phonograph machines, the invention will be valued simply for the novel amusement it affords. Mr. Edison, however, is confident that his discovery will open up a wide field of usefulness for the phonograph. He is an indefatigable worker, and plainly shows the effects of intense mental application, although his youthful, clean-shaven face bows it serious expression when engaged in conversation. Mr. Edison, with his wife and children, lived in Newark for several years before locating at Menlo Park, and evidently finds a large and handsome frame house situated between his shop and the railroad. This corner of Mr. Edison has been an eventful one. Starting poor in life, he became an operator in a telegraph office, and walking from a Western town to Boston, entered an office there in a dilapidated condition and assisted the manager and other operators by his ability to receive a message from the most expert and rapid operator in New York without superior or break, a test that no Boston operator had previously been able to accomplish. Coming to New York, Mr. Edison gave most of his time to the invention of improved telegraph instruments, and has received many thousands of dollars from the Western Union Telegraph Company and other parties for the patents he has secured.

The State Rebel Va.
Apr 30. 1878

THE STATE.

TUESDAY.....APRIL 30, 1878

WONDERS OF THE PHONOGRAPH.

Just the Discoverer, Mr. Edison, Says Himself—Even a Constitution.

Telegraphy Revolutionized—The Practical Results.

From an authority so worthy of attention as the inventor himself, we have received explanations to which that new mechanical wonder, the phonograph, can be put. Under the title "The Phonograph and its Future" the North American Review for May-June, which is now before us, contains a paper by Edison, from his experiences when developing his invention, and points out the manner in which the new instrument is to be utilized, and in many instances renders unnecessary, the labors of the telegrapher, the writer, speaker and singer. He undertakes to show that in this new force a complete revolution will be accomplished in the now costly and laborious methods of recording the most important literary records of historical utterances of man can be secured and reproduced at will, and in as many places simultaneously desired. It is with the view of setting intelligent conjectures at rest that the inventor of the phonograph gives his own description of the instrument to the public. He says: "From the very abundance of conjectural and fanciful matter which has been published of late upon the press, the public is liable to become confused and apparently uninformed as to the immediate practical effects of the phonograph than if the inventor himself were confined to certain specific applications and therefore of less interest to the masses." And with regard to the commercial development of the phonograph he adds: "So, the case of an invention of the nature and scope of the phonograph it is practically impossible to foretell it by the, for, to converse a trifle any extent it almost intelligibly."

PRACTICAL RESULTS.

The natural practical results obtained from the phonograph may be set down as follows: The simplicity, permanent retention and reproduction of the most original characteristics of all sounds heretofore designated as "fugitive." The transcription of spoken sounds in numerical form for purposes of communication or as mechanical records.

The indefinite multiplication of any repetition of words, without regard to the existence of the original, and the exactness of the fact that it is a means of communication within itself, and by means of its own mechanism.

Among the more important prospective applications of the phonograph may be mentioned letter-writing and all forms of dictation, books, education, the deaf, the blind, family record and such elementary applications as books, musical boxes, toys, clocks, advertising and signaling apparatus, speaking, &c.

THE LETTER-WRITER PHONOGRAPH.

"The spoken word may be reproduced in mechanical details will be the same as described in connection with the ordinary telephone, and can be recorded either upon a flat plate or disk, with a spiral groove on the face, impressed by the action of the sound; the plate, the grooves are cut varying in depth to suit the pitch and volume of the sound, or upon a cylinder with a helical groove of fall, upon which the record is laid, in the form of a helix, each turn touching the next neighborhood of forty thousand to the inch.

"The practical application of this form of phonograph for communication is very simple. A sheet of foil is placed in the phonograph, the clockwork is set in motion and the mouthpiece held into the mouthpiece without other effect than when speaking to a stenographer, the words rendered and placed in a suitable form of envelope and sent through the ordinary mails to the correspondent for whom intended to the correspondent upon his phonograph, starts his clockwork, and listens to what his correspondent has to say."

HORSE, FOG, SECRETS, &c.

Books may be [illegible] by the electrically-disciplined proficient, and by many [illegible] are especially employed for that purpose, and of course [illegible] each book in the system of electricity, hospitals, the sick chamber, or the [illegible] of the world and announced by the lady or gentleman with eyes and hands busy or otherwise employed; and, in fact, because book when read by an elocutionist is [illegible] read by the average reader. The following record sheet, repeating this book from fifty to five hundred times at will, would cost but a few cents more than would pay the original readers who are [illegible] to read in the phonograph.

"An electrical phonograph may be a private nurse together for children. It is certainly to be invariably excited for the pupil last used, after which he has only to apply to his phonograph for instruction. The child may thus learn to spell, commit to memory, a lesson, &c., &c.

"The phonograph will undoubtedly be literally developed into a toy. Talking and singing phonographic reproduced may marvelous accuracy and power. Thus a friend in a morning call, sing a song which will delight an evening company, &c. As a musical instrument it will be used to enable a master a new air, the child to form its first [illegible] or to help him to sleep.

"A book of 50,000 words upon a single metal [illegible] will require a somewhat strong probability. The advantages of such books over those printed on paper are obvious to most readers. Such books would be confined to where new notes are read." We may add in this connection that phonographic books would become as useful and interesting to the blind as to those who have eyes and to the poor people, the public is liable to become confused and apparently uninformed as to the immediate practical effects of the phonograph than if the inventor himself were confined to certain specific applications and therefore of less interest to the masses." And with regard to the commercial development of the phonograph he adds: "So, the case of an invention of the nature and scope of the phonograph it is practically impossible to foretell it by the, for, to converse a trifle any extent it almost intelligibly."

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Commercial Gazette May 5 1878

NEW YORK LETTER.

Edison in a Restaurant—His Theory of Eating—Investment of the Phonograph—The City Telephone System—Newspaper Miscellanies—The Theatres.

Correspondence Cincinnati Commercial.

NEW YORK, May 2.

Edison, the inventor, whose name is now on everybody's mouth, and whose talking phonograph I told your readers something of a few weeks ago, came in from Menlo Park, yesterday, and in accepted my invitation to lunch with me. His eating as we proceeded was so interesting that, absent the subject, as an example.

I had heard his scouting assertion, Professor Edward H. Johnson, tell how difficult it always is to entice Edison to eat when the frenzy of a new invention is on him, and how they have to study his moods and depend the food around on the benches where he will discover it, and I was not unprepared to see nothing bites an epicure.

"I take this eating business" said Edison, as we went up-stairs, "I always avoid it when I can."

"It is a waste of time," I replied; "it seems as if the whole day ought to get swallowed in some mere commercial way." He cut off a suggestion about an eating machine by saying—

"It isn't so much the waste of time, but I don't like food. I have generally been in fine health, but I don't remember when I really liked the taste of food. I never eat for any reason except because Nature obtains a tantrum."

"What'll you have?"

"Anything," said he, "I don't care a rent what it is. Anything but meat, I generally take pastry of some sort at this time of day."

He took the bill-of-fare and told the waiter to bring him some strawberry shortcake, strawberries and cream, and an apple dumpling.

"You won't but beer on such food?" I said, as the waiter moved away, with an astonished expression, to fill our orders.

"No, that's good for me," he replied. "Constitutionally—but he I don't give that identical order! often. You see, Jerome, I have a theory of eating. Now, Yankee—that is the secret of it—eating. The Yankee that eat the most kinds of food are the greatest Nations. They always have been, too, and always will be."

The waiter brought the strawberry shortcake, the strawberries and cream, and the apple dumpling, and arranged them in a semi-circle around his plate, and covered it up so as to hide the tempting question if there was anything more.

"Now, as to what you should eat," Edison proceeded: "The race-cattle Nations never progress; they are the result of self-gratification for the time, they forever. Look at the potato and black-bread eaters of Ireland—the Irish are a race of slaves. The Irish be ireland are enervated by the uniformity of their food. Look at the extravagance who inhabit the Black Forests. On the other hand, what is, that we are in all the highest civilizations, and the most healthy, graceful, enlivened and accomplished. Why, France, of course, where the cuisine is the most varied. When the forests of Europe were all full of wild animals, the people lived principally upon food as nearest to nature as possible.

"How can this application be made?" will perhaps be asked. It is by the application of the ear either the telephone or phonograph.

Both these inventions cause a plate or disk to give out sound, and both depend upon the [illegible] harmony with those of the voice of the speaker. A very simple device may be made by which the ear, vibrating disk may be made to [illegible] the [illegible] of the phonograph, thus enabling the speaker to communicate with his correspondent by the [illegible] of the ear.

The [illegible] of telegraphy can approach that [illegible] combination of the distant end of the wire enables the correspondent, if he is present, to hear it while it is being recorded. Thus we have a mere passage of words for the notice, but a complete and available record of those words as the receiver of the message can economy of time and money so further that [illegible] speaking for whom intended to the correspondent upon his phonograph, starts his clockwork, and listens to what his correspondent has to say."

As machine is now right, and that accuracy in [illegible] is needed to perfect it."

"The phonographs that I have seen, Mr. Edison, have a faraway voice, as if speaking in a distant field or speaking on the other side of the partition; and some of the vowels, as 'a' and 'o,' and several of the consonants, as 'p,' 'b' and 'm' were almost unintelligible. Is this to be remedied?"

"I can do. By merely substituting steel hereafter, I have my self-acting machine as flexible voice is finished. A month ago *it would have no only three months, by carefully I should when first sang from the mouth-piece, by actual measurement, and it simply my words were registered and reproduced from.* I believe the new plate machine will do as well."

DOESN'T WANT TO BE PARSIMED.

The Lotus Club and other Clubs have tried to give Jos a reception, Mr. Edison. The Secretary of the Lotus Literary Association today obtained Cyrus W. Field's promise to preside on a dinner in your honor—"Old Newark?"

Mr. Edison said: "I have heard from several clubs, but I am not anything about this Boys' Club. I don't want to be talked about and bored by people. How are you going to conduct this kind of reception? Are you going on to Menlo Park?"

"Well," said he, with a puzzled expression, "the feeling of his not attractively. "I shall run over a week or two at my old home where people don't cause much, and if they intrude that. I shall take a vacation."

Let me say, here, that Mr. Edison is as unlikely as he looks—girl for the last century. He has made his then his proportion of the brains of the period, and he is a fact, however, for his disinclination to be "interviewed." Besides this, he probably considers that all of his time is now his employer and backers, and as others do who have seen a good deal of it.

THE TELEPHONE AND PHONOGRAPH.

It is not true that he is cloudy and unwell in appearance to-day. He had on a new suit of clothes that was not stained out of consistence by anything unusual. He had on a clean collar and his shaved and changed his shirt every morning ever since he commenced his experiments. He took out new and shiny-toe inventions before he was thirty—one years old. Edison is far above all affectations, either in dirt or dress, and is as simple-minded as a child.

ELOQUENT STONES.

The city telephone system is to undergo a change which is a revolution. Edison's telephone is to be substituted for the Gower-Bell telephone which is a practical contemptuous the City Hall, and diverging to the suburbs. A manager at the center will command and disconnect those wires according to call. For instance, if Mr. Edison wants to have a telephone, calls for No. 171, who has a telephone, the manager takes those two wires together, and the parties enjoy a secret confab without any assistance, and with no danger of being overheard by any third parties. The invention is complete, and on every one who has a telephone will be in the directory of all others who have telephones. The personal conversations will be very great. Those who have acquired no right to a telephone will either have to use a public telephone or trust to the slow messenger, delivery of dispatches at present pre-

of a friend, and, for their entertainment, he sets his phonograph in operation; they listen to the genius of the best operas sung by the most celebrated artists, a grand repertoire such as few concert-rooms could boast of; the most spirit-stirring airs played by full military bands; one of Mark Twain's or Artemus Ward's lectures in the drollest of accents; selections from the Pickwick Papers, Charles O'Malley, Theodore Hook, Washington Irving, Shakespeare and a world of authors. An automaton figure can be introduced, in character and costume, at the will of its owner, and, in obedience to internal machinery, may repeat a speech of Webster or Clay, a philippic by themosthenes or an oration by Cicero.

It would be a difficult task to enumerate the thousandth part of its capabilities. As an aid in the home education of children, an assistant to the parent, it will be invaluable; for lessons, instead of being conned over and learned by rote, will reach the seat of memory by the ear instead of the eye. Again and again, by merely resetting the cylinder, the same lesson will be repeated, whether in geography, grammar, history, arithmetic, it matters not. This marvel of science will rear the utterance of the languages, and French, German, Italian, Spanish, Latin, Greek, Hebrew, Syriac, Arabic will be delivered from the metallic plate on which they have been engraved, with the perfect utterance of skilled professors in these several tongues. It will concentrate in itself the polyglot powers of a Mezzofanti or a Barrett, and will sing or talk with equal facility in every language. Even the accidentals of the standard authors of all countries can be impressed by the steel stylus attached to the diaphragm, and listen to the future declamation. Milton, and Dante, Corneilles and Racine, Goldsmith and Sheridan, Bryant and Longfellow, will give to their rarest intellectual treats; and their works, printed on the metallic page by the voice of a first-class elocutionist, will be delivered in the same resonant tones to the household groups in city mansions or rural homes. The sick-room of the invalid will be cheered by the dulcet tones of music sweetly sounding, and hymns and extracts from the Scriptures will impart consolation in the promise they give of a better life beyond the grave. To them, indeed, the phonograph will be a blessing, if not unspeakable, certainly above all mere pecuniary estimate. Truly Edison, when he discovered the wonder and gave it expression in a form that is in itself a marvel of mechanical simplicity, "builded better than he knew."

But the social revolutions which it will accomplish and the part which it will play in the work of civilization, important as they are, are not more so than the service which the phonograph will render to the varied interests of trade, commerce and the arts, to the merchant, to the dealer, to the manufacturer. Should the head of a firm be obliged to be absent for several days, and compelled in his haste to leave certain matters unfinished, certain orders unfilled, it is only necessary for him to impart the desired instructions to his ~~private secretary~~—the phonograph, and they will be repeated with unerring accuracy, while carrying minute details as to the phonographic sheet, and the judge, in the privacy of his library, will attach it to his cylinder, set the machine by which it is received in motion, and in the library is transformed into the court-room, he is again seated on the bench, and he hears the voice of counsel in behalf of his client. The actor, studying his part, takes from the shelf in which he is to perform, wraps the page around the brass cylinder, winds up the clock-work by which it is operated, and, sitting in his cosy chair, commits to memory the words as they come from the most reliable of prompters—a phonographic sheet.

Through this wonder of wonders the types of children will produce the various sounds of the different objects which they represent, and Noah's Ark and the Tower of Babel in imagnow all the confusion of discordant sounds. Each animal in the toy-shop will be given a tongue, will be heard in his own vernacular, but hear only will the phonograph fail. It cannot reduce to intelligible sounds and translate the sacred voice of the barnyard, the stable, the sheep-pen, the menagerie or the aviary. We can imagine the delight of the mother's or the father's darling as she listens to her waxen-faced doll, with curling tresses and trousseau of the latest fashion, tell the wonderous story of Beauty and the Beast, rehearse the treasures of Aladdin's garden of gems, relate the chivalric deeds of the heroic knight errant, Jack the Giant Killer, or the extraordinary adventures of that enterprising youth, Dick Whittington and his fine conglomerate. What a world of delights it opens up to the young folk, and with what earnest interest they will listen to the soothing, lifeless counterpoint of their little selves, as they hear them talk without tongues, and give forth the lessons they have learned without hearing, and yet retained with a grasp which nore human memory could never equal.

But there is one use to which the phonograph is applicable, and which specially interests and concerns the readers of THE CONTINENT, or at least that large portion of them who take an active part in field sports. The notes of all game-birds can be recorded and produced with perfect accuracy, and thus the most reliable of decoys are obtained; and as with other kinds of game whenever it is desirable to imitate the sounds peculiar to each species. Indeed, through this echo of the roar of the cataract, the melodies of the woods, the music of the mountain streams, the confused sounds of busy insect life, the drowsy hum of summer-heated noon, all will wonderful applications this miracle of science is capable who can predict? It opens up a vast field of which no mind can see the limits; it startles the most credulous with its powers of application. Even its inventor cannot fix the scope or measure of its capabilities. It is indeed the marvel of the age, surpassing even the telegraph, which it will, in all probability, supersede; for the telephone and the phonograph, working in concert, conveying and recording sound, will take the place of the electric current in the transmission of messages, and despatches will be read aloud by the self-same instrument on which they have been written. We are, it would seem, only on the threshold of that boundless domain which holds in reserve still greater wonders than human genius has yet brought to light, or human imagination has ever conceived.

Edison, the inventor of so many wonderful instruments, is a great lion in Washington. He is constantly engaged in giving exhibitions to Congressmen, who find themselves inadequate to express their enthusiasm over the wonders of the phonograph. Among his other late inventions is a new electric car-trumpet. Edison is very deaf, but with this trumpet he can hear a fly buzz a block part of a theater with perfect distinctness

Rollin Page

THE EDISON SPEAKING PHONOGRAPH.—This remarkable invention—one of the most wonderful of modern times—is now occupying the electric telegraph—is to be exhibited in Horticultural Hall on Thursday next, and thereafter. We doubt not that such is the great interest in the subject, that it will attract thousands daily to be given here has never failed to welcome what is worthy, and especially when it is based upon such a solid foundation as is this.

1878.

Ed. Sun

Baltimore, March 19

CRYSTAL PALACE.

A sacred concert, at which Mr. Sims Reeves, Madame Patey, Madame Lemmens-Sherrington, Signor Foli, and Mr. H. Lloyd were to sing, was sufficient attraction to ensure a great number of visitors at the Crystal Palace yesterday. A visit to the Palace was in itself, a reflection of the special arrangements of the management, bound to be enjoyable. The day proved fine, the fields were bright, and green after recent rains, and the trees confidently unfolded their budding leaves to receive the full light of the sun's first real warmth, or greeted gratefully exhibited a wealth of smiling blossoms. Even within the Crystal Palace there is always much of nature to admire. The evergreen ornamental foliage so tastefully disposed among the magnificent products of art could be noticed more freely yesterday than on most other days. In addition the hustle of the busy commerce of the place may temporarily cease. Some of the numerous sights provided for the Easter holidays were to be seen yesterday, although the main feature of the day's programme was of course the sacred concert. For instance, the phonograph was exhibited by the London Stereoscopic Company, who use the English patentees of this remarkable invention. The opportunity of seeing this talking machine was eagerly taken advantage of by a number of the visitors. It was announced in the programme of the day that it would be on view at the Crystal Palace, but that more being found on hand for the proper display of the capacities of a phonograph, of the kind to be shown, the engagement was taken to the Board-room, where, we understand, it will be during the whole of the holidays. The experiments made by the phonograph were very satisfactory. Mr. J. F. Edwards first explained the simple construction of the instrument. Then he said Mr. A. Small, who has improved upon the machine as originally patented by Mr. Edison, of New Jersey, by the addition to it of a clockwork movement which fulfils a very important function, gave exercises of the capacity of the instrument, making it repeat what it had uttered, after even speeches and even their own laughter. The words were spoken into a mouthpiece similar to that of a telephone. The vibrations of the voice affect a thin sensitive iron disc in the centre centre of which is fastened a small hard metal point. The point is adjusted to fit into the narrow groove of a revolving brass cylinder, round which a sheet of tinfoil has been wrapped. It will easily be imagined that as the cylinder revolves the little metal point causes the tinfoil into the grooves and makes the same in a series of marks which vary in their number, in the nullity of their succession, and their depth, according to the vibrations in the sounds emitted by the speaker. The speech being finished, the cylinder is released from the pressure of the little pencil, but the marked tinfoil remains, and the speech can be reproduced by this or any other similar phonograph at pleasure. To reproduce the speech or song as once was necessary to adjust the machinery of listeners yesterday, and accordingly the cylinder was set back till the pencil was opposite the original point of departure. The clockwork which moves the cylinder was set going and the pencil followed the indentations it had previously made. In so doing it re-vibrated the fine discs. These vibrations were communicated to the mouthpiece through a brass mouthpiece in the nature of a speaking trumpet, and the words, and even the voice inflections originally communicated to the instrument, were given back to the audience by this curious mechanism. Coughing and laughing were successfully reproduced. A lady and gentleman by means of a double mouthpiece sang to the instrument a duet. Each was produced by the talking machine, which, however, hardly did full justice to the lady's music. The band of the Scots Guards, under Mr. J. P. Clarke, being in the Palace for the day, Sergeant Hardy played before the phonograph "Ye Land Rose of Summer." To the delight of the audience the phonograph reproduced every note of the air, though not the excellent quality of the music. The phonograph once taken can be used any number of times, and doubtless Sergeant Hardy's solo which is engraven on tinfoil will be reproduced to please future inspectors of the phonograph. One most unfortunate fact, however, is that of musical infelicities, because as the engraving is it can be reproduced backwards or in almost any fantastic order. It is obvious that when experiments are this made with the written music in the tinfoil new combinations of musical notes may be suggested to composers. The music of the phonograph was as yet, however, barely attractive enough to affect the audience in the great orchestra, which had gathered to hear the splendid selection of sacred harmonies there presided by Mr. Manns, the conductor. The Palace band and that of the Scots Guards, uniting with the choral organ, and assistance, as in the Old Hundredth, "And Then the Prince of Wales," and the National Anthem, with the voices of the whole assembled company, produced effects of sound, while also not of the popular vocalists massed at the beginning of this article were exploding as to secure more strictly concerted musical demands for encores. To these demands, however, a good-natured compliance response was made. Mr. Reeves sang an air from the Messiah, and the ladies giving way even to the extent of repeating "Crosbie's Angels" (Shattuck), which was given by Madame Patey, and "Let the Bright Seraphim," which was sung by Madame Lemmens-Sherrington to a trumpet obbligato by Mr. W. Winterbottom. In the evening the band of the 2nd Life Guards played in the great orchestra. A ballad and military concert is promised for Easter Monday.

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CRYSTAL PALACE.

Without altogether wanting the attraction which the great glass house at Sydenham was first intended to present on Good Friday, the management has certainly succeeded much to the unconfusion multitudes to which this Jew Jew is regarded simply as a sober sort of holiday. The sacred concert at Sydenham is as good as it has ever been; but it is not relied upon as the sole attraction for this anniversary. Yesterday's programme included, for example, the "Phonograph, or Speaking Machine," at which the scientific world has lately been so much agog. Despite its really marvellous effects, it is one of the simplest pieces of mechanism ever devised. Mr. Edison, the inventor of an electrician—Thomas Alva Edison, of New Jersey—he has nothing to do with electricity in its working and solely mechanical in its construction, down to the smallest detail, may be fairly considered comprehended in a minute's observation. By arrangement with the London Stereoscopic Company, who are the English licensees of the invention, the Crystal Palace directors were yesterday enabled to give a most entertaining series of experiments in their Board-room, the phonograph delightfully and intelligibly explained at each stage. The phonograph in its simplest form is a tinfoil cylinder of a foot round. It and through the middle of this cylinder runs a shaft upon which is cut a screw-thread, corresponding in pitch to the groove. As the shaft works in a screw-box, the cylinder, as it revolves, receives a horizontal or backward screw. Fixed to an adjustable arm placed in front of the cylinder is a disc of thin iron, from the centre of which on the side next the cylinder projects a hard metal point. The disc is clamped at its circumference, but being otherwise left free to vibrate, acts as a system. Each sound-wave therefore the point forward against the cylinder, or rather against a fold of tinfoil, and in its exact circumference, and only forward by a little recess at each end. Into a mouthpiece on the other side of the disc sounds are thrown. They soon to the sounds of the human voice, or, more exactly, to the sounds of the human. An impression is made by the styles on the tinfoil, each vibration causing a short recess. A long sound thus is of indentations in the tinfoil; and when the tinfoil is removed and placed first, the point is set to the end to end with another long line. So little does vary in accordance with the pitch, so little does the length of the notes. The sound is therefore recorded—so to "bottled up" as by vulgar hyperbole, it has been said—in a manner though a short transcript-like, almost over the mouthpiece. This latter sponge can also be reproduced, by means of a launch, to the performance of duets; and in the course of a private hearing, which yesterday intervened, both duets and solos were successfully tried by Madame Lemmens-Sherrington, Mr. Lemmens, Signor Foli, Mr. Manns, and others skilled

musicians, whose acute sense discovered a phonelogism, as yet not described, namely, that the musical sounds are reproduced in a high key, half a tone being the difference. While M. Lemmens and his accomplished wife were singing a duet into the branched mouthpiece something caused them both to laugh, and this instant was faithfully reproduced by the machine. The way for in this the indented tinfoil, being replaced over the cylinder, no matter at what interval of time, enables the rpoduction of the duet. The band of the Scots Fusiliers, consisted by Mr. Clarke, took part with the company's confidence and the great organ, played by Mr. Conrad, and after the concert a selection of named and other pieces was given by the Scots Fusiliers' Band, the conductor being Mr. W. Winterbottom. The great attraction of the concert were Mr. Corder Howes and Madame Lemmens-Sherrington, both of whom received a warm utterte of welcome on the fall of their former triumphs. Mr. Howes sang, first, Cowen's recitative, "Come unto Me," and air, "I heard the voice of Jesus say;" and subsequently, being in fine voice, he rendered Handel's air, "But Thou didst not leave Thy soul in hell," with such magnificent effect that, when called forward to repeat it, the applause with which he was met seemed almost overwhelming. Madame Lemmens-Sherrington sang with the chorus, the "Inflammatus," from Rossini's "Stabat Mater," in which she was encored; "Let the bright seraphim," which she was also induced, though with difficulty, to repeat; and lastly, with Madame Patey, in the duet, "Quis est Homo?" This last association of vocalists gave, with declamatory distinctness, Beethoven's hymn, "Bendelig vanlig," and was loudly called on to repeat it; and she also sang Mendelssohn's "Rest in the Lord." Mr. Edward Lloyd's songs were "Sulpice Arimon" and the air, "Then shall the righteous," from "Elijah;" and Mr. Santley sang "The trumpet shall sound" and Gounod's song with chorus, "Nazareth." In accordance with established and well-approved custom, the visitors joined in "The Old Hundredth Hymn," "Rule Britannia" and "God save the Queen." Three cheers for the Prince of Wales" and "God save the Queen." Then the number of entrances, registered at the turnstiles of the Palace and grounds, was 19,650, many of whom remained to the end.

London Figaro Apr 20 1878

CRYSTAL PALACE.

Good Friday was celebrated at the Crystal Palace with more than ordinary success. Charming weather, an inviting programme, and the well-known standing attractions of the palace combined to ensure a large assemblage of visitors, as wellas to ensure them an unusually pleasant day of enjoyment. Their patronage was pretty equally divided between the fashionable, attractions of the palace itself and the more exciting pleasure ground, which already begin to put on their summer beauties and offer many fair promises to members. Besides the musical and theatrical performances, which constituted the principal feature of the day's proceedings, the programme comprised a variety of other entertainments, some of which are already known more or less to the public—such as "The Cadora Mystery; or, The Sculptor's Model Realised with Life;" the "Living Marionettes and Lilliputian Wonders;" the "Vestibuliad Entertainment and Vocal Illusions of Professor Golding and his Troupe of fairy Folks;" and those which are to be found in the equestrian, the trotting-horse, and the monkey-hosts—there were others with which visitors are not so familiar. There was the Telephone, but even that impressive branch of wonder in scientific discovery was, for the moment at any rate, quite thrown in the shade by the other marvellous favourites called, "The Phonograph; or Talking Machine," which was exhibited at the palace yesterday for the first time by an arrangement with the London Stereoscopic Company, the sole licensees of Edison, the patentee in Mr. Thomas Alva Edison, of New Jersey, U.S.A., chief known hitherto for his improvements in telegraphy and his inventing the carbon pen and quadruple systems of signalling. This latest outcome of his genius—the phonograph—is, in its mere inquiries, an instrument for recording sound, and so recording it that it can be reproduced at any subsequent period. It was exhibited in full operation in the Queen Victoria Jubilee Hall, whence assisted by Mr. J. E. Hough and other gentlemen who have become acquainted with the ways. To be at all appreciated it must be seen and heard again for itself, its mechanical arrangements as have already described in detail. Suffice it to say that the operator has only to shout into something like the mouth of a speaking trumpet, shut up the second with a touch of the hand to a little cabinet labited, keep it hermetically sealed there as long as he likes, and then set the "machine" going to make the sound ascend when it went in. The secret of the thing lies in the sensitiveness with which the sound waves are made to impress themselves—to leave themselves as it were—upon the receiving and preserving medium, which consists of tin foil. Indentations are made on the tinfoil which, when clearly examined, are found to vary in number, shape, and depth to exact accordance with the ventriloquism the pitch, and quality of the sound or voice. These impressions, so to speak, are bottled up, and may be reproduced at any time in the original form, whether it be shouting, talking, singing, or whistling. Illustrations of the versatility of its instrument in that respect were given on the spot. A sergeant of one of the military bands charged the instrument with "Tis true 'tis true, my lord," and it was repeated with wonderful accuracy, though in falsier form. Similar successes were achieved—for instance, in the singing of "Sally in Our Alley," by recitation of the nursery rhyme of "Old Mother Hubbard," and a fit of coughing. No matter what the kind of sound, whether shouting, talking, singing, barking like a dog, coughing, sneezing, or whistling, it is always reproduced, although in a form more faint than the original, and sometimes with an amusing tendency to burlesque, arising probably from defects in the motion or mechanism, which are capable of being remedied in course of time. The pleasure imparted by the exhibition of the instrument and its performances was enhanced by a descriptive lecture, in the course of which Mr. Hough told that as the impressions produced on the sheets of tinfoil were not easily obliterated it became possible to send those sheets of impressed tinfoil to any friends in any part of the world, and afford them the pleasure of hearing our own tones conveyed to them with absolute exactitude. Stereotyped or electrotyped impressions of the tinfoil could be taken, and these so should be able to multiply as well as preserve indefinitely the original speech. There was no end to the uses to which, if thoroughly worked out, the principle might be applied. The instrument might come to take the place of the phonetic system of shorthand, and to be used as a reading aid which it might be charged, to give facilities of famous singers and orators, to play the part of a musical composer, to read in lessons of blind scholars or ignorant persons who had not learnt to read for themselves, and to teach languages. Some of these anticipations may seem rather sanguine, but the fact remains that the phonograph exhibited is a talking machine in a very clever and interesting operation with which to spend a spare hour, and visitors to the palace will do well to make its acquaintance while the opportunity is afforded them. The visitors numbered nearly 24,000.

convenient attachments. Fig. 4 is a front elevation of the electrostatic mastiphier. A is the vulcanite disk on an axis carried by insulating standards. The axis has upon it a pulley which receives a driving cord from a wheel rotated by hand. T, T, are the foil strips fixed upon the face of the disk, and S, S, are studs in metallic connection with the strips T, T. G, and G', are the metallic collecting combs that are attached, and D, D show the position of the conductors at the back. E, E, are the combs for charging the conductors; they also are insulated, and they are connected by the insulated wires, F, F, with the inductors, S, S, are the springs or wire brushes for making contact with the studs. The contact is made when a finger key (not shown) is depressed. The key acts through silken cords which draw the brushes a little way forward: when the key is released they move back out of contact. The magneto-electric machines and the electrostatic mastiphier are employed in combination for the production of the electric light. Mr. Varley causes an electric arc to be formed between carbon points in the magneto-electric machine as is well understood, and in order to render the arc more constant he applies the electrostatic mastiphier, by placing its conductors near the carbon holders, so that a stream of electricity flows to them constantly as long as the light is being maintained. The high tension electricity which in this manner is caused to pass between the carbon points effectually maintains the magneto-electric discharge.—*English Mechanic.*

THE PHONOGRAPH.

Lecture by Professor J. W. S. Arnold.

In response to an invitation from several prominent citizens, Professor J. W. S. Arnold, of the University of the City of New York, lately delivered a lecture at Chickering Hall upon Mr. Edison's recent invention, the talking machine, known as the phonograph. The lecture, says the *N. Y. Tribune*, from which we take our report, was a great part an exposition of the theory of acoustics; the performance of the phonograph was shown to be in strict accordance with that theory. All the experiments shown were quite successful, the Lissajous curves, shown by the electric light, being especially varied and brilliant in their changes of combination. Professor Arnold introduced a singing telephone, which although much commented upon, reproduced, in musical sounds, only a guitar, the notes of songs sung in another room by kid voices. The lecture was an exceedingly interesting one, and showed clearly the relation the vibrations which are caused by the voice in enunciating different syllables; the figures thus obtained flashed each for an instant into view, but they were evidently geometrical forms. The phonograph machine repeated the words spoken to it loudly and clearly, so that it was heard in every part of the hall and gallery. The tone is slightly nasalized and has a strained effect, very much like the voice of a ventriloquist; it is nearly in need of further improvement in quality and distinctness.

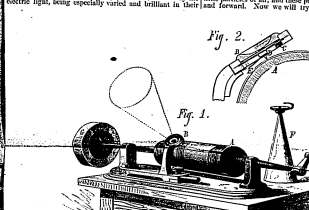
THE LECTURE.

I suppose that most of those who have come on this occasion have gathered together here for the simple purpose of hearing the celebrated machine of Mr. Edison talk. After a while we shall see, I think, that the speaking phonograph, or talking machine, is probably the most interesting piece in acoustics or the greatest mechanical phenomenon of this century. In order, however, to appreciate the mechanism by means of which the human voice is reproduced in such an extraordinary manner, we must first take a rapid glance at the principles and physiology of hearing.

The physics and physiology of hearing—like that of sight —must be studied in two ways: first of all, the actual conditions which are necessary to produce sound, and then the manner in which sound is appreciated by the individual. In other words, we must become fully acquainted with the objective and the subjective phenomena, and then bring these two together. In the first place, both light and sound are phases of motion. Light consists, as we know, of undulations or waves, and sound consists of undulations or waves also; but the undulations or waves of light differ in the manner in which they travel, in which they make their journeyings. The light waves are projected from a luminous body, and take their direction in straight lines from the luminous body, but the direction or motion of the undulations of luminous ether are at right angles to the direction of the [illegible] sound waves are transmitted in a direct line, and we have very much the same phenomena as much as we have in waves of water. That is to say, when a stone is thrown into the water you will notice that from the point of contact in the stone impinging upon the water a series of waves start, spherical in form, and are sent in all directions outward. In order to appreciate the manner in which these waves pass in the atmosphere (because it is necessary we should have some medium by which to propagate or transmit the waves) we will make use in a moment of a little mechanical contrivance, or diagram, which will give us an idea of the propagation of sound. The waves of sound, as they appear in the atmosphere, consist of rarefactions and condensations. Sound can be produced by motion or vibrations in solid bodies as well as in the atmosphere, and we shall see as we study the subject that the ear can appreciate the sensation of sound as readily when it is transmitted through the solid bodies as it can when it is transmitted through the atmosphere. But for the general condition of sound we must have air; we must have some medium by which to transmit the waves from one point to the other, and in general, every body, then, that produces a sound must, more easily, subject the air to vibrations or undulations, and stirs up these waves, and they are carried through the air.

THE MOTION OF SOUND WAVES.

Here we have a diagram to represent what would represent the waves of sound—these light points—and, as I told you, the motion of the particles, which we will study more definitely in a moment, is backward and forward. Now, when a sound is produced, the air is thrown into just the vibrations that we see here. Each one of those waves that we see here is carried on and down in all directions. Now these have actually been seen. A physicist of the name of Seebeck, I believe, has caused a sound from the electrical discharge, to see the waves of sound, and he found that these waves were spherical in form, reflected, and that they followed all of the laws which were found in light. In addition to this he found that these waves were spherical, and that the velocity depended upon the distances each of the waves as spheres overlapping each other, each made up of particles of air, and these particles vibrating backward and forward. Now it will try an experiment. Here we



THE PHONOGRAPH.

have a slit-like formation on the screen, and in this we will be enabled to see the vibrations that are produced, as the particles only for a short distance. The intensity of sound depends upon the distances each of these particles moves. By the generation of the sound it moves from its position, but it is then sent to a certain position and back again in an opposite direction, as you see represented on the screen. So far, then, for the generation of the sound waves. There are a great many other points which we have not time to hurry over to-night in order to get a ground and, consequently, somewhat superficial idea of the whole subject.

Now, the next question is the manner in which these waves can be thrown into action. The sound is produced, as we know, by an electrical discharge in the atmosphere. The electricity being driven through the atmosphere with tremendous velocity, causes the air to be thrown into waves, which cause the sound we recognize as thunder. The electricity we will not discuss. The sound is the chamber. If we agitate any body which is solid, we then produce a corresponding motion in the atmosphere, and these correspond to the vibrations of the body. If we cause a tuning-fork to vibrate, for instance, we produce a musical tone, which is simply due to vibrations of the air in the form of waves. Now, a musical sound, as we understand it, is simply a mechanical disturbance of the air, and, when in vibration, it produces what we call a musical tone.

Now, what the musical tone depends upon certain peculiar conditions, as we shall see, and we shall see also that noises differ from musical tones simply as they can be referred to other peculiarities of vibration. Its sounding a fork we have a pleasant tone to the ear. This is a mechanical vibration of the air by the vibration of the tuning-fork, the effect of which the fork is composed. In a moment we will try another experiment when we throw into vibration a column of air confined in a tube. We can also produce vibrations by a succession of puffs. Here is a little instrument called a "siren." It has a disk which is perforated, as air-chamber. There is now compressed air in the cylinder, and, as it is turned on, the puffs of air escape, causing it to come opposite the opening in this air-chamber very rapidly and evenly, and there is a succession of puffs which can be heard near by, and pretty soon a tone will break forth. [Here the lecturer illustrated his meaning by the apparatus referred to, and was applauded for the success of his experiment.]

SOUND PRODUCED IN TUBES.

The mechanism of the production of sound by this other little instrument is the decomposition of hydrogen by decomposing water with the aid of acid. There is a very fine point, from which the hydrogen burns, introduced into a glass tube. The air passing up through the tube becomes heated and is thrown into vibration by the same air being thrown up and down. If we have a very large tube we shall have a very deep tone, and another is proportional to the size of the tube diminishes. The vibrations are not so rapid in the large as in the smaller tubes, as in the other case the waves being smaller and consequently lighter in tone. The ordinary effect produced in the organ pipes of course we understand. Here we have simply the pulse of air which goes through tubes of various kinds and we get the various tones, as we shall see. [Illustrating the point by sounding certain stops on the organ.] Here we have the air thrown into vibration simply because the bellows, which is on the inside of the organ, drives the air through the speaking into the pipes, and into certain pipes which are known as the diapason pipes, and shocks the air and causes the column to vibrate in the interior of the tube. You see in this tube that I have here, and hold over the flame, the air is thrown into vibrations on account of the heat of the burning hydrogen. [Illustrating it. Applause.] There is another method of producing almost the same general effects which almost every one has heard, and that is the vibration of glass or similar metal which are met with in the little toy called the musical glasses.

Now, then, about the manner of measuring the wavelength of sound. How do we know how long a wave of light is? In measuring it we must have some standard of measurement. First, we must know exactly how rapidly sound travels; second, we must know exactly how rapidly vibrates a tuning-fork which vibrates such as 512 times in one second, and at about the temperature of the atmosphere of this room the sound will travel about 1,142 feet. Now, with this fork we will have wave-length which moves exactly two feet two inches, and the manner in which we have arrived that conclusion is by dividing the rate at which sound travels by the number of vibrations in one second. There are instruments, of course, by which we can measure very accurately the number of vibrations any body produces. Among other instruments we have the *siren*, which I have shown you; and if we produce a tone by this fork, which corresponds exactly in pitch to the tone produced in the siren, we can read off in the index to the siren the number of vibrations produced in a second.

MUSIC COMPARED WITH NOISE.

Now, we come to the question of the difference between noises and musical tones. A noise is the result, of course, of vibrations, but the vibrations are irregular. They do not succeed each other at regular intervals, whereas in every musical tone we have the vibrations following each other at perfectly regular intervals. We say that the ear is pleased with a succession of regular intervals of vibration and displeased with those which are irregular. Noise and a noise then, differ simply in this respect, and, as I have already told you, the pitch or the height of the note depends upon the number of vibrations produced in a given time. If I start the siren once more and allow it to run for a certain length of time, you will notice that as the speed increases the tone becomes higher and higher, until finally we can get quite a shrill tone when what was at first quite a low tone. [The Professor at this point performed the experiment satisfactorily, much applause.] Now, what is the difference between the timbre, or quality, of the note produced by the siren, by the violin, by a cornet, and finally by the human voice? What is the mechanism of production? It can be answered in a few words. Every time a musical sound is produced, such as we have already have in the plucking of a string or by the sounding of a fork, we hear not only one sound, but a great many sounds, and the other sounds are known as over-tones or harmonics. The fundamental tone, which is the principal one, and which we can distinguish by sounding the tuning-fork carefully. Now, yes, if I can produce another tone to the tuning-fork. [Doing so.] There is a different one, and [illustrating with another tone] is still a different tone. But by sounding them together when the fundamental tone is produced, but there is a certain quality we find as we hear them especially. Over-tones, then, give the peculiar quality to the various kinds of instruments and to the human voice, and we find now over-tones are produced in the same mathematical ratio. For example, if we have a note "C" as the starting point, we have the next octave to its octave, which has twice as many vibrations as the original note. Then the next over-tone or harmonic is the fifth above this octave. Then we have "C," and then "E flat," and so on. We have a succession of tones which are related with the fundamental tone, and these tones have the ratio of vibration of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. That is to say the first over-tone or octave of the fundamental tone has two times as many vibrations a second, the second three times as many, the third four times as many, and so on. Now, it depends upon the number of over-tones and their ratio as they mix with the fundamental tone whether there is produced either the sound of the violin, the cornet, the trumpet, or of the flute. If we take, for example, on the organ a bourdon or a clarinet stop, we have a hollow tone. Now we will take the trumpet stop, and have a piccolo. See how different they are. The human voice has its peculiarities in the same way, and if we take the human sound must be analyzed very carefully, so that the number of over-tones and the peculiar pitch of these will be ascertained, and in this manner we can appreciate the various qualities of sound in the timbre.

THE MECHANISM OF HEARING.

Now let us consider some of the points in connection with the perception of sound by the ear. The ear is a very curious piece of apparatus—the most complicated probably of any piece in the body. The ear is capable of appreciating about eleven octaves of sound. The eye is capable of appreciating but one octave in color, so that the ear has a far greater power of appreciation than the eye. There are certain peculiarities in connection with the ear by which we are enabled to appreciate these sounds, and we must not forget that our appreciation of sound—the subjective phenomena of sound—is, as we already say, very different from the actual condition of things or of matter which produces the sound. Sound consists of vibrations, and the ear takes these vibra-

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tions by a peculiar sympathetic process, which we will understand later on, and the brain then has generated in it a peculiar condition which we understand as sound. If we excite the nerves which go to the ear we feel no pain, but have a rumbling sound. If the irritation be even, so that the vibrations or taps of the nerve follow each other at regular durations and equal intervals, music is the result; if irregular, noise is the result; but the acoustic nerve can transmit no other sensation to the brain but that of sound. In like manner the optic nerve can transmit no other sensation but that of sight. If it be wounded, a flash of light follows; if the acoustic nerve be touched, a sound follows. And you know there are some nerve diseases, the result of disturbances occurring in the ear, where there is a continuous sound or humming kept up, and this gives us an idea of the peculiarities of these nerves. We can appreciate, then, the subjective conditions, and we will study now the manner in which the sound is carried to the ear. There are two distinct sets of apparatus in the ear, one for the reception of the sound and transmission of it externally, and then the internal arrangement by means of which the sound is received and transmitted to the brain.

CONSTRUCTION OF THE EAR.

We have on the external portion of the head what is called, ordinarily, the ear. Now, this is supposed, in a human being, to be of little account so far as collecting sound is concerned, because from records we have of practices in savage countries, where the ear has been cut off, we have found that the hearing is scarcely impaired; but in the lower animals, undoubtedly, by putting the ear in various positions, they can collect the sound, and cause it to enter the interior portion of the ear. In the interior of the ear, as we pass in from this exterior portion, there is a little piece of membrane stretched across, which can be described as membranous tympani, and its means of sound impinging against this cause it to vibrate, and the vibrations are transmitted, and set in vibration, by means of a peculiar chain of little bones, another membrane, and this enters a cavity filled with fluid, and within this cavity are the filaments of the acoustic nerves. These filaments are so fine as to little strings, act by sympathetic vibrations when placed in the tones—not only the fundamental tones, but all the overtones which are necessary to exist in every musical sound—and there vibrate according to the intensity of the original tone produced.

This particular part of the mechanism of the ear is inclosed in a bony box, and the complicated arrangement which is here met with is enough for a life-long study. The general conditions which I have mentioned are the most important of these carefully protected, that we have waves produced in a fluid, and that the undulations or waves in this fluid are the direct means by which the terminations of the acoustic nerves are set in motion, and these produce a sensation of sound. Now, a question would naturally arise as to whether or not these little membranes do not possess a fundamentalness. If this membrane were simply free, if it was simply stretched around an opening with nothing else in connection with it, we would hear constantly, when a fundamental tone was sounded, this ringing in our ears; but nature has provided a peculiar arrangement which we find holds good in physics, and which you will see to be beautifully represented in the talking-machine here, namely, that it has damped, that it has a certain fundamentalness. About the center there is a little bone which is attached to this membrane, and this is in connection with several other bones, which I will not now indulge. Now, if we apply this to the central portion of the membrane, it will not then respond to the fundamental tone, but by forced vibrations other tones will be transmitted, and we will not have a confusion of the fundamental tone continually thundered in our ears. And this membrane, instead of being flat, is stretched backward, and this kills, more than anything else, the fundamental tone. The result is that we have a perfect arrangement for transmitting sound.

VIBRATION OF WAVES CAUSES ON ITS SOURCE.

Here is a little piece of India-rubber with a little mirror in the center, and when certain tones are spoken in this tube which is the carrying portion of the ear, we shall see that this is thrown into vibration. I will generate here an intermittent of light from the electric lamp. Now you see the light upon the screen, and if we sing a note in the tube, you will see the membrane is thrown into vibration. If those vibrations could be photographed we could analyze the musical tone character of the harmonics. Now we will say the word "ah," and you see the bulging the notion to the word" and now when I sound the vowel "a" we see also the peculiar effect produced in the membrane. [Applause.] Now there is one method of analysis of tone.

Now then let us follow out completely the mechanism of the production of the sensation of sound. The wave is generated, and it throws into agitation the membrane, tympani, and this membrane carries it into the interior of the ear by means of a chain of bones. One of these bones comes in contact with another membrane situated deeper in, which closes over a cavity containing fluid. This fluid receives the wave impression, and as this is received the undulations are transmitted deeper into the recesses of the ear, and the arrangement here which receives the waves or vibrations and throws into agitation the fluid is called the cochlea. This contains about 3,000 in the ear, and these little cells which are in union or sympathy to the peculiar tone that has been produced by the sound. As they vibrate they agitate the internal filaments of the acoustic nerve, and this the sound is transmitted to the brain. This entire part of the ear is very complicated in structure, but we shall be enabled in a measure to see the principal part where the sound is supposed to be received. [Illustrating on the screen.] There is the bony structure of the ear, seen from its exterior entrance. Here is the membrane attached to a bony structure which is receiving the vibrations, and here is one attached to the hammer.

We can hear a tone which corresponds to about sixteen vibrations in a second; we can hear a tone which consists of about 40,000 vibrations, but when we get below about forty vibrations there is produced what would be called an unpleasant sensation, which is more than a musical tone. On the other hand, when we get above 4,000 vibrations there is a shrill scream. Music then consists of from 40 to 4,000, but the complete compass of the ear is from about 16 to 40,000. These little strings arranged in the ear are capable then of giving us this long variation, and not only this, but our appreciation of the part of an interval between two[illegible]

[illegible]ake for example what is called a full tone or a whole. [illegible]touching a key on the organ. Now the next interval, a whole tone is this [striking it], and a half tone is very close to it. The ear, however, can detect the difference between the 9/8 part of one of these tones and 17/16 part. In the ear there are

Fig. 3.

THE LISSAJOUS CURVES.

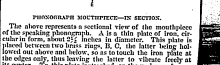
I will show you the experiments of Lissajous, where we have tuning-forks that produce different musical intervals, and they are each caused to vibrate so as to produce reflected rays of light from a mirror attached to each which these fall into which can be worked out by mathematics, so that we can understand the relation of the mathematical ratios of the vibrations caused by Lissajous' forks are simply conditions of the pendulum vibrations. It will simply show you the manner in which the vibrations appear when one fork is vibrating horizontally and the other [illegible]. I will throw a beam of light from the sun, so that it strikes a mirror. The beam of light is reflected to the screen, and you see that the fork is vibrating horizontally. Now, when both of these forks are kept in perfectly even vibrations by means of electro-magnets. The fork is slightly out of tune so that we can see the manner in which these waves are following each other, and when the proper intervals are not exactly tuned, and you will see a perfect figure which represents the interval, and there will be a perfect figure of the octave in this figure known as the waves. When their crests agree with each other in a similar way, but there is somewhat complication, that is, one fourth above the fundamental note. The nearer we approach the octave the more simple is the figure. These are the intervals which can be shown, but that is not necessary.

SCIENCE.

Voice is produced by vibrations of what are known as the vocal cords. The vocal cords are little membranes situated in the throat, and by the action of certain muscles, can be made tense and lax, and in the air which is driven out by a respiratory effort the cords are caused to vibrate, and they are thus transmitted to the column of air. Now we have the cavity of the mouth, which contains the teeth roof of the mouth, and when we enunciate certain words we approximate the tongue, teeth, and lips, and these are what are called the labials. We can thus bring back the soft palate, and the tongue, and the tongue for producing what are called the gutturals. Touching a key on the organ[illegible] consists of a funnel-shaped cavity which is capable of being changed by throwing into agitation the vocal cords, which are set in vibration by the expiratory air we send upon it by embouchure, the vocal cords being simply a tongue of metal over which is sent in order [illegible] pressure. Now, in order to appreciate these sounds, we can have in the mechanism of the voice the vocal cords, and the resonance and the guttural tones, and all of these which are common pure musical tones which are generated in ordinary conversation. By combining the two we have spoken language. If we cause the voice to throw a membrane into agitation which has any electrical connection with agitation, we will then produce vibrations which will represent the vibrations. Now I have a contact-arrangement and a singing telephone upon the table, and I shall ask my assistant, Dr. Bruce, to tell me when he is ready, and when he sings in the mouthpiece of the telephone it will be heard, but not be with the quality, which is represented in the latter body. In the place where the singers are fastened on the end of a piece of wood glued firmly to the top of the diaphragm. Secure upon that has soft iron plate, and the ends of this magnet are brought opposite this iron plate. Now, at the other end where Dr. Miller is, there is a membrane made of paper, and in the center is a little piece of metal, which is in the center of the circuit, and the pin which makes or breaks the circuit as the vibrations of his voice are brought against the membrane. [The tuneswung by Dr. Miller were distinctly heard, but with the quality of guitar music.]

By a combination of pipes in this organ [the large organ in the hall] there is what is called the *vox humana*, which gives a very curious effect [illustrating it on the organ]. It is simply the reed pipe, as it is called, which is shortened, according to the description given to me by one of the gentlemen who manufactured the organ. It is found up or confined and carried off to a great distance from the organ, and opens, in this case, in the vestibule.

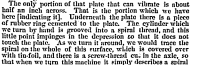
Now, if you are perfectly quiet, we will see if it is possible to have this speaking machine of Mr. Edison's recite to you something about Mary and a little lamb. [Laughter.] Now this is nothing but a mechanical contrivance. Professor A. M. Mayer has recently written an elaborate description of it, and he speaks of a celebrated speaking machine constructed by Professor Faber, of Vienna. The consisted of a machine that represented all the parts of the head and pantuts. There was a reed to take the part of the vocal cords, an oral cavity which have its shape changed by depressing keys on a key-board, a rubber tongue and lips to make the consonants, and, a little whistle to imitate the threat to make the Hz. This was simply the result of experimentation in order to produce each of the different articulations in order to produce each of the different sounds. Without question it would have to be produced, but it is found to be easier to imitate [illegible] by machinery, however, which has been accomplished. Here is simply a piece of brass plate, about 6 inches long and 1½ inch in diameter, and it is clamped at each end between two rings. These pieces of India-rubber are pressed in between these two rings so that the ferrotype cannot sound its fundamental tone. Put will only respond to what are called forced vibrations. Now, upon the under surface of this plate there is a little steel point, which is attached to the plate by means of a rubber ring intervening between the plate and the steel point. [Here the Professor drew a section of it on the blackboard.]



PHONOGRAPH MOUTHPIECE—IN SECTION.

The above represents a sectional view of the mouthpiece of the speaking phonograph. A is a thin plate of iron, circular in form, about 2½ inches in diameter. This plate is placed between two brass rings, B, C, the latter being bolted out above and below, so as to inclose the iron plate at the edges only, thus leaving the latter to vibrate freely at its center. To this plate fastened, on the under surface, a small piece of steel, D, and a fine steel point, E, is affixed to the rubber. It will be seen that the point, E, is so adjusted that when the plate A is thrown into vibration by the voice, C, the vibrations of sound produced in speaking will be communicated to the iron plate, A, thus causing the steel point to be depressed and raised, these motions succeeding each other with a rapidity depending upon the rate of vibrations in a given tone of the voice.

The only portion of that plate that can vibrate is about half an inch across. That is the portion which we have here [indicating it]. Underneath this is placed a piece of rubber ring cemented to the plate. The cylinder which we turn by hand is grooved into a spiral thread, and this little point impinges in the depression so that it does not touch the bottom. The point is so adjusted that it makes a mere impression on the surface of this cylinder, which is covered over with tin-foil, and there is a screw-thread on, in the axis, so that when we turn this machine it simply describes a spiral on the surface of the cylinder. All that it is necessary to do to make the machine talk is to put on a piece of tin-foil.



SPEECH TRANSCRIBED ON TIN-FOIL.

The needle simply is to make a very light groove, and then you talk against this diaphragm, and by a paper cone of this construction [exhibiting it]. Now you will hear me reverse the motion and turn the cylinder backward the way it was at first, and we have repeated what was said. [confusion is not very great yet, as the cylinder is not perfected. When the plate is thrown into vibration the point, pushes down and makes indentations in this tin-foil. These indentations correspond to the peculiar form of wave-motion which have been uttered by the mouth. The consonants in this machine are not very distinct, but the vowels as you see,

...ps a little bone which is stretched as full a membrane, and this is in connection with several others and acts as a damper or ...ke. Now, if we apply this to the central portions of the membranes, it will not respond to the fundamental tone; but by forced vibrations from the other membranes, as before, we will not have a confusion of the fundamental tone distinctly drummed in our ears. And this membrane, instead of being flat, is stretched backward, and this kills, more than anything else, the fundamental tone. The result is that we have a perfect arrangement for transmitting sound.

VIBRATIONS OF SPECIES SHOWN ON THE SCREEN.

Here is a thin piece of vulcanite which is fastened in the center, and when certain tones are spoken in this tube, which is the carrying medium, the whole of the vulcanite is thrown into vibration. I will generate here an intense sound of vowel vibration, and you will see on the screen the light spots widen and widen, and I could go on doing this till by the membrane is thrown into vibration. If the vowel tone could be photographed we should analyze the sound and character of the harmonics. Now we will say the words "one," "two," "three," following the action to the words; and now when we sound the vowel "o" we see also the peculiar effect produced on the screen. [Applause.] Now I will sound a series of tones.

Now then let us follow concretely the mechanism of the production of the sensation of sound. The word is generated, and it throws into agitation the membranes tympani, and that membrane carries it into the interior of the ear by means of a chain of bones. One of these bones comes in contact with another membrane situated deeper in, which closes over a cavity containing fluid. This fluid receives the wave impression, and as these are received the undulations are transmitted deeper into the structure of the ear, and the structures here take up the waves or vibrations and throw into agitation certain little fibers, of which there are about 3,000 in the ear, and these little spots vibrate in unison or sympathy with the peculiar tone that has been produced by the sound. As they vibrate they agitate the internal filaments of the acoustic nerve, and this wave of sound is transmitted to the brain. This curious part of the ear is very ex- quisitely constructed in structure, but we shall be enabled in a moment to see the principal part where the sound is supposed to be received. [Illustrating on the screen.] There is the drum cavity of the ear, seen from its exterior surface. It is a little membrane attached to a bony structure, and projecting out toward the center, where it is attached to the hammer bone. We can hear a tone which consists of sixteen vibrations in a second. Now when we put below about forty vibrations there is practically what would be called an unpleasant sensation, which is not to be considered a musical tone. On the other hand, when we get above 24,000 vibrations there is a shrill scream. Music then consists of from 40 to 4,000, but the complete compass of the ear is from about 16 to 40,000. These little strings arranged in the ear are capable then of giving us this large variation, and not only this, but an appreciation of the [illegible] of an interval between [illegible] Take for example what is called the full tone or a whole [illegible] [touching a key on the organ]. Now the next interval—a whole tone is this [striking] [illegible] and a half tone is very different, you see. The ear, however, can detect the difference between the [illegible] part of one of these whole tones or [illegible] part of a half tone. In the ear these fibers are

THE LISSAJOUS CURVES.

I will show you the experiments of Lissajous, where we have tuning-forks tuned to each other at different intervals, and they are each caused to vibrate so as to produce reflected images on screens. There are certain laws which these follow which must be worked out by mathematics, so that we can understand the relation of vibrations to each other. The Lissajous curves, or Lissajous' forks are simply conditions of vibrations in harmony. It will simply show you the manner in which they are produced. Here are two forks, the tines of one being placed to the other. I will throw a beam of light from the lantern so that it strikes a mirror. The tines could analyze the sound of the first fork, which is vertical, to the second, which is horizontal. The forks are here in perfectly even vibrations by means of electro-magnetics. The forks are slightly out of tune so that they will come to unison when the intervals are not exactly tuned, and you will see the figure which represents the interval, and there will be backward and forward phases in this figure known as the waves. When the forks are tuned with each other we have a perfect figure. When there is any difference the figure changes backward and forward in its recursive and positive phase, as it is termed. How [referring to the screen] we have a circle which is the perfect figure. Now you see that circle turned so as to form an ellipse. So the lines cross and go back again to a circle. It will take a moment or two to put in another fork, and the next one will be an octave with just double the number of vibrations. The forks are also slightly out of tune so as to show all the phases of their figure. Now the figure produced by an octave will be resolved into a circle. Here we have an octave which is resolved into a circle. Now we will try another combination, where the figure will be changed. We will take one that is somewhat complicated—that is, one fourth above the fundamental note. The sounds of the notes are the more complicated in the figure. There are other intervals which can be shown, but that is not necessary.

RELATION OF VOICE TO SPEECH.

Voice is produced by vibrations of what are known as the vocal cords. The vocal cords are little membranes situated in the throat, which, by the action of certain muscles, can become tense and lax, and the air which is driven out by a respiratory effort throws these little cords into vibrations, and they transmit the vibrations to the column of air. Now we have the cavity of the mouth, which contains the teeth [illegible] of tongue, the hard palate and the soft palate, and the [illegible] and when we enunciate certain words we produce these [illegible] and the consonants. We make use of the lips in pronouncing [illegible] the consonants. We make use certain powers back in the throat, called the labials. We use the tongue for producing what is called the gutturals, and the tongue for producing what is called the glossal sounds. All of these [illegible] are the result of changing forms of the mouth cavity. The vibrations are set up by throwing into agitation the vocal cords, which are struck on the same principle as the reed pipe in the melodeon, the reed pipe being simply a tongue of metal over

PHONOGRAPH MOUTHPIECE—IN SECTION.

The above represents a sectional view of the mouthpiece of the speaking phonograph. A is a thin plate of iron, circular in form, about 2½ inches in diameter. This plate is placed between two brass rings, B, C, the latter being hollowed out above and below, so as to touch the iron plate at the edges only, thus leaving the latter to vibrate freely at its center. To this plate is attached, on the under surface, a small piece, D, of hard rubber, with a point, E, is affixed to the rubber. It will be readily understood from the above that when the lips are placed at the opening, B, of the ring, C, the vibrations of sound produced in speaking will be communicated to the iron plate, A, thus causing the steel point to be depressed and raised, these motions corresponding each other with a rapidity depending upon the rate of vibrations in a given tone of the voice.

The only portion of that plate that can vibrate is about the size of the inner circle. That is the portion which we have been indicating it). Underneath the plate there is a piece of rubber tubing, which is not shown. The cylinder which we turn by hand is grooved [illegible] spiral thread, and this little point impinges in the depressions, but it does not touch the plate. As we turn it around, we would trace the spiral on the whole of this surface, which is covered over with tin-foil, and there is a screw-thread on, in the axle, so that when we turn this machine it simply describes a spiral on the surface of the cylinder. All that it is necessary to do to make the machine talk is to put on a piece of tin-foil.

SPEECH TRANSCRIBED ON TIN-FOIL.

The needle simply is to make a very light groove, and then you talk across this plate or through a paper cone of this construction [exhibiting it]. Now we have simply to return the needle and turn the crank again in the same way as it was at first, and we have repeated what was said. The loudness is not very great yet, as the invention is not yet perfected. When the plate is thrown into vibration the points go down and makes indentations in this tin-foil. Now [illegible] corresponds to the peculiar form of vibration [illegible] uttered by the mouth. The consequence is that [illegible] as you see.

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A VISIT TO EDISON.

GATH TALKS WITH A PHONOGRAPH.

The Inventor in His Workshop in New Jersey—Some of His Remarkable Discoveries—The Telephone, the Phonograph and the Ærophone, and their Possibilities in the Future.

Special Correspondence of THE TIMES.

MENLO PARK, N. J., April 14.

This morning, with General Corse, the hero of Allatoona ("Hold the fort, for I am coming!"); General Barnum, the first Federal commander of Savannah, and Mr. A. W. Dimmock, of the New York Stock Exchange, I visited Edison, the inventor.

We left Elizabeth in Mr. Dimmock's carriage at half-past ten, whence it is about twelve miles to Menlo Park by the Philadelphia stage road. A morning filled with Sunday wine and stirring almost sacramental sympathies escorted us with twittering sparrows, green leaf twigs and babbling waters, across the Rahway river and up its south branch to the plateau above the Raritan Valley. There the Blue Mountain line rose distinctly in the near West, and the scattered houses of Menlo Park lay over the rolling green hills. This was meant to be a great settlement in the speculative days, and now consists of thirty or forty frame villas, in large lots. It is three or four miles from Perth Amboy, which is at the mouth of the Raritan, and in Middlesex county, New Jersey, on the line of the Pennsylvania Railroad, twenty-four miles from New York and seven from New Brunswick.

EDISON DISCOVERED.

Beside the railroad track is a light-colored frame house with dark-red trimmings, wide and shallow and with cross-gables in the roof. It has no shade around it, and a naked stable is in the back corner of the up-tilted lot. There is no sign of professional life and only a child is seen surveying us from the back porch. The house and lot may be worth nine thousand dollars. Crossing the railroad, we turn the horses up a steep, ungraded hill, along Mr. Edison's lot, and, passing one or two other houses, observe on the top of the hill a frame tenement, nearly one hundred feet long, two stories high and without sign or ornament; it looks like a white frame country school-house pulled out three times its own length. Two brick chimneys rise from one of its sides. A pond of rain-water, or of water pumped up by a ram, is just beside this building, and also one big tree, the whole enclosed by a paling fence, making a lot of an acre or more. This is Mr. Edison's invention factory and experimental *atelier*. The dwelling down by the railroad is his family's. He was married in Newark, N. J., in 1873, and moved to Menlo Park, where he had bought property, in 1876. "I couldn't get peace and quiet in Newark," he said, "and was run down by visitors. I like it first-rate out here in the green country and can study, work and think." I may add that it is becoming the universal experience of men of professional or mental strain that they cannot stand the publicity of cities, the gassy hospitality and intrusive vealiness of adolescent club people, idiotic paragraphers and female men. The country gives at least refuge. Six telegraph wires clamber on short poles up the hill to Edison's factory, connecting him with the railroad wires.

As we approach the factory we see a workmanlike man reading a book on the steps in the end front. He is decided not to be Edison when our carriage comes to the gate, but as we walk up the path and get to him the man arises, puts out his hand and says: "Good morning, Mr. Dimmock." He is introduced all around. He then walks, as a matter of course, into the factory, and we follow him. As he puts the book down I notice it to be "Poems of Edgar A. Poe."

THE LITTLE GIANT.

The *atelier* or discovery-factory is one long room with a vestibule in front—divided into a designing room and a library—and at the farther end, separated only by a sash, is a smith's shop and machine place. Between is a carpenter place. Nowhere is there carpet or ornament. The ceilings are only about eight or nine feet high. Naked steps lead to the second floor, where appears to be a chemist's shop, lined with labeled bottles along the sides. Two small chimneys of rough brick intrude into the rooms of both floors. All around are work-tables, drawers, glass, instruments, iron, wire, belting, shafts.

"I keep fifteen workmen," said Mr. Edison. "When I lived in Newark and tried to carry on manufacturing, I had a big shop and three hundred workmen; but an inventor is a failure as a manufacturer."

Mr. Edison puts down a remnant of an old slouch hat, does not look twice at us, and in a docile, deaf way, walks right up stairs and along the plank floor toward the end of the loft. He sits down on a stool before a small apparatus on a table, which consists of a brass barrel or cylinder, as big as a big bottle, with a thread running spirally around it, about twenty volutes or threads to the inch. This barrel is supported and made fast to an axle, which at one end has a handle, and at the other end a solid wheel to receive a steam belt. The whole thing is about three feet long and looks like a miniature iron butter churn.

"As it's Sunday," says Mr. Edison, "I haven't got the steam power on and must turn the crank with my hand. Although I sometimes keep up steam on Sundays," he adds with an undenominational smile.

He then lifts out of a drawer a sheet of common tin foil, such as we buy around tobacco or cheese or wine corks. It is as big as a page of a book and completely enwraps the barrel. He then takes a sort of mouthpiece as big as a watch or small turnip and says:

"This contains a circular piece of ferrotype metal, such as you take the likenesses called tin-types upon. That plate receives the vibrations and by a steel needle marks them on the tin foil, following around the groove or thread."

He affixes this mouthpiece against the side of the barrel covered with foil, so that the needle is in the groove, to the left, and will be carried to the right, the mouthpiece, also moving, traveling along the barrel horizontally. Then he says in the mouthpiece, speaking with ordinary clearness:

> Our little systems have their day,
> They have their day and cease to be—
> They are but broken sounds of Thee,
> And Thou, O Lord! art more than they!
>
> Let knowledge grow from more to more,
> But more of reverence in us dwell—
> That mind and soul, according well,
> May make one music as before!

HOW IT TALKS.

When this was finished Mr. Edison drew back his mouth, slipped the mouthpiece from its contact with the groove and reaffixed it where the tin foil had been pricked and scratched by the needle-point. Then he put a funnel of paper into the mouthpiece, the sharp end open, and turned the handle again. Back replied the whole articulation in his own voice, speaking plainly and without the compression he had been compelled to use. It was not a ghostly voice, nor ventriloquization. It was his own natural voice, nearly as loud as life's voice, exquisitely sculptured out of echo as if a mirror had spoken to the face before it in complacent unison.

We four looked at each other in happy amazement. What was it? Whom? How?

> This is the rarest dream that e'er dull sleep
> Did mock sad fools withal!

Corse was a poet, and he answered the phonograph in the same verse the inventor had employed, contemporary Tennyson's:

> Thy voice is on the rolling air;
> I hear thee where the waters run;
> Thou standest in the rising sun,
> And in the setting thou art fair.
>
> Far off thou art, but ever nigh;
> I have thee still and I rejoice;
> I prosper, circled with thy voice;
> I shall not lose thee tho' I die.

After this appropriate verse-tasting Edison put his mouth again to the phonograph and said: "Ha-ha-ha! Ahem! Heck! heck! heck! (coughing). Halloo! Well, that gout and bronchitis catch the old man together. Whoa-a-a!"

Reversing the instrument, all the coughing, laughing, shouting, wheezing and talking came back perfectly, changed only as if in a rarer medium, but perhaps this was because we were not accustomed to dumb objects addressing us. Edison then ran the barrel faster, and however fast he ran it still the articulation was complete. Running it slow, it also repeated every emphasis. He scratched the tinfoil and the words came just as well, but with audible scratches, as if a woman was talking and scrubbing. Then he whistled in the mouthpiece and sang and reproduced both. General Barnum, who was a widower—both his sons present, one of them, named Malvern, having been born just after the battle of Malvern Hills—next tried his hand at "In Memoriam:"

> Yet if some voice that man could trust
> Should murmur from the narrow house,
>
> * * * * * * * * *
>
> Might I not say: "Yet even here,
> But for one hour, O Love, I strive
> To keep so sweet a thing alive,
> And I should turn my ears and hear?
>
> "Thou bringest the sailor to his wife,
> And travel'd men from foreign lands,
> And letters unto trembling hands,
> And, thy dark freight, a vanish'd life!"

The spirituality of the poetry thus wholly materialized was no mockery, but it took the added virtues of soul and body.

Said the inventor: "You see all those spaces between the grooves? Well, there is no need of all that waste. I shall have the needle pointed to gain the very finest articulation—point it with sapphire or agate, perhaps. In my perfected phonograph I substitute for the cylinder a flat plate with a circle, beginning at the centre, the needle traveling outwardly in volutes. Then I can put 14,000 words easily on a sheet of tin foil."

"That poem of In Memoriam," said I, "has only about 3,000 words."

"Well, I can put nearly the whole of the 'Princess,' or all that Poe has written in verse, on one of those sheets."

"What, then, is the utility?"

THE PHONOGRAPH AT HOME.

"Well, the phonograph will read poetry to you, if you are sick or your eyes are weak or you cannot stand the light. It will read in dark or light. It will read a whole novel and re-read it, so that ladies, sewing, can hear a story read off from one of those plates. Besides, I can furnish a novel pricked in that way for three cents instead of fifty cents, the price of a paper novel, because the composition is not in type, but in punctures."

"Yes," said Mr. Dimmock, "and the best elocutionists can read for the sheets. Booth's own edition of 'Hamlet,' Mr. Dickens' readings of his own stories, the speech of Ben Hill delivered to private families by himself, Longfellow's own recitation of the 'Psalm of Life,' our children kept in tin-foil albums, lisping on page one, prattling on page two, saucing on page three, reciting their school lessons on page four. Though dead they speak to us." And in the communion of memory, it being a poetic day, he gave us:

> For wisdom dealt with mortal powers,
> Where truth in closest words shall fail,
> When Truth, embodied in a tale,
> Shall enter in at lowly doors.
>
> And so the Word had breath, and wrought
> With human hands the creed of creeds;
> In loveliness of perfect deeds,
> More strong than all poetic thought.
>
> Which he may read that binds the sheaf
> Or builds the house or digs the grave,
> And those wild eyes that watch the wave
> In roarings 'round the coral reef.
>
> And I—my harp would prelude woe—
> I cannot all command the strings;
> The glory of the sum of things
> Will flash along the chords and go.

"That we should live to see this day!" said General Barnum. "Where is your witch of Endor, your oracle of Delphos, your Sybil? Are we looking at this man, or is it all ideality?"

The man looked substantial—about 135 pounds. He said to me:

"I have sent your reports of battles, speeches, wonders and things over the wire. I used to take press copy."

This was as if I had given orders to Sir Isaac Newton on a past occasion, or sworn by wire at Tycho Brahe.

"Does this invention strike at printing?"

"Well, yes; it under-cuts printing a little. You see, in dictating to a phonographer, it saves that cost, because you can talk your letters into this phonograph, and a cheaper, long-hand writer can wind them off at leisure. Then they can be verified, the machine re-reading them to you while you hold the copy."

AN IMPORTANT DISCOVERY.

He produced his new plate and said: "I don't like to go through the drudgery of mechanically perfecting a thing already accomplished in science and philosophy, like the phonograph. I want to be doing something different. If I could find a natural mechanic to go on with what I have done and get it ready for utility, my life would contain more experiments—discoveries perhaps. Because the phonograph is only an invention. In my telephone is a discovery."

"What is that?"

"Why, that the resistance of carbon to electrical transmission is varied by pressure. The voice affects it, when light or powerful. I discovered that power to reside in the carbon."

"How long ago did you get the idea of the phonograph?"

"Only last July. It is a mechanical invention, begotten out of an attempt to emboss an alphabet for telegraphy. I found that repeating the letter 'A' many times produced an ever varying puncture, all of unlike depth or size under the microscope. Then it was plain that the voice was its own recorder and measurer. The phonographic alphabet was impossible, but articulation was easy."

As that wondrous man sat there, in careless clothes, unblackened boots, partly shaven, modest, accommodating and unobtrusive, I felt the imperialism of brain. "Thou hast hidden these things from the wise and prudent and revealed *it* unto babes." How much of a kingly crown he had under his hat! He may shake the telegraphic stocks of the world to pieces. Property is threatened less from socialism than from sense, and yet property, brave amid its crises, is supplying this Cagliostro with money. Religion is hovering in trembling hope above this Luther. Science is dismayed at its own excesses, developed by this genius in whose head is a magnet sending off sparks at the proximity of truth. He turned the little barrels again and echo walked forth in the enamored arms of poetry:

> And strangely on the silence broke
> The silent-speaking words, and strange
> Was love's dumb cry defying change.
>
> * * * * * * * * *
>
> So word by word and line by line,
> The dead man touched me from the past,
> And all at once, it seemed, at last
> His living soul was flashed on mine.
>
> Æonian music, measuring out
> The steps of Time, the shocks of Chance,
> The blows of Death. At length my trance
> Was canceled, stricken through with doubt.

GATH.

No Decay of Poesy.

From Sunday Afternoon.

There are mourners going about the streets lamenting the decay of poesy. One would imagine, to hear these people talk, that the last poet was about to be gathered to the dodos in the limbo of extinct bipeds. A brief sojourn in the editorial rooms of a monthly magazine would dispel this gloomy apprehension. Other branches of manufacture may be dull, but the poetry business never was more brisk. The sad-browed postman stoops a little lower every day under the burden of song that he brings up the hill. From all parts of the land these tender missiles come flying at the editor's head, till it often seems to him that every several hair is a harp-string, and he dreams of iambuses and walks in anapests and talks in rather bronchial trochees. Whenever the nightmare seizes him it takes the shape of the frequent and too-familiar female of the pterodactylic variety, who has pens in her fingers and wings on her toes, and who *will* make verses wherever she goes. To him the notion that poetry is dying out in America is sufficiently absurd. In the midst of his perplexities he often finds a certain relief, however, in thinking of poor Mr. Allibone, and wondering how that hard-working man would feel about his Dictionary of Authors, that he toiled so long to make complete, if he knew how many poets there are in the land whose names are not in his Dictionary, and probably never will be.

Chester News

The Edison and the Combination.

Manager Mehaffey connected his telephone with a combination telephone in Philadelphia yesterday afternoon. The Combination telephone is also an invention of Philips, and its only difference from the one used by Mr. Mehaffey is that it has a larger magnet. After the Combination had been tried the Edison carbon telephone was put in operation so that the people at the end of the wire might note the difference between the two sounds. A music box made some sweet notes, which could be perfectly heard through the Combination phone, and when the Edison carbon was ready for work the music came as clearly and sweetly as though the box had just been wound up at your side. The operator at Broad and Chestnut, in the office of Mr. Bentley kindly explained through the telephone the cause of the rattling sound in the phone, which Prof. Sweney said reminded him of threshing machines. The noise is called an "induction." All the noises along the wire, in telegraph offices for instance, where there are many instruments, clicking steadily, are taken up by the wire and carried to the phone, where the sound causes the vibration of the diaphragm which gives it to the ear. The induction is sometimes so great that it is impossible to distinguish what is being said. On a private wire when all was quiet, this "induction" could be gotten over. Col. Hyatt, Prof. Sweney, Dr. Christ, George B. Lindsay, Esq., George Booth, Esq., and many other gentlemen were present at the trial of the two telephones.

Graphic May 10

People all over the country are naming their children after Edison, the inventor, of Menlo Park, New Jersey, and alleged poets are sending to him their burning effusions. (The adjective "burning" is employed only to foreshadow their probable fate in every case.) Mr. Edison writes to THE GRAPHIC that he has "received more than a hundred letters" inquiring about his machine for manufacturing food out of the inorganic elements (fully described in THE GRAPHIC of April 1), and a Texas man told him to "send one, C. O. D., if it don't cost more than $10."

Paterson Daily Press May 8

Edison, the telephone man, is said to be 31 years of age, shabby in dress, spare in form, but opulent in brains. If there are any great geniuses who are in much better condition than this we should be glad to hear telephone.

Washington Evening Star May 7

A MESSAGE BY PHONOGRAPH TO THE EMPEROR OF BRAZIL.—The City of Rio de Janeiro, the first of John Roach's Brazilian line steamers, which sailed from New York Saturday, took out one of Edison's phonographs, a present from Mr. Roach to Dom. Pedro, Emperor of Brazil. The phonograph was charged before its departure with the delivery of an address from Mr. Roach to the Emperor, of compliments and congratulations in view of the establishment of the new line. This is the first instance of the use of the phonograph for such a purpose.

Washington Star May 7 55

HOW THE NOISE OF THE GREAT CITY WAS FELT ON THE TOP OF A SILK HAT.—Mr. Edison's attention was called to what the *Sun* reported Captain Ericsson as having said about the phonograph, that is, "that the explanations given as to the causes that produced its wonderful results were not satisfactory: that there must be some factor which had never been made known and which alone could account for the phonograph's action." He said that he thought Captain Ericsson's observation was a very indiscreet one for a scientific man to make, for it was but a poor excuse for a person to say anything was not true simply because he failed to understand it. He expressed astonishment that any one should be at all mystified by anything so very simple as the phonograph. Having said this, Mr. Edison seemed lost in thought for a moment, and then suddenly taking off his well worn silk hat said, pointing to the crown:

"Put your hand there, and feel the rumble and the roar of the mighty city. The actual noise is so constant that you do not notice it, but the vibrations it occasions are unceasing and easily felt."

Accepting the invitation, the writer's hand was rested upon the top of the hat, and sure enough it thumped away as though a living heart were beating against it.

"That settles it, I think," said Mr. Edison, and, bidding the writer good day, he walked on in search of the photograph instrument maker.—[N. Y. *World*.

Baltimore Daily News Apr 29

WONDERFUL EDISON.

Proposed Novel Use of the Phonograph—Its Inventor's Latest Discoveries.

NEW YORK, April 29.—Kiralfy, the actor, has applied to Professor Edison to make him forty or fifty large phonograph cylinders, which he proposes to take to Paris. After securing the finest musical performers, each one will be invited to play into different diaphragms and the notes are to be recorded by the cylinders. The greatest prime donne, tenors, contraltos, and bassos are to sing, and their words and melody transcribed by the phonograph. After securing copper matrixes, Kiralfy proposes to bring the cylinders to this city and put them on the stage of the Academy of Music. They can be run by a Baxter engine a whole evening with fifteen cents' worth of coal, and operas can be given as produced in Paris without a musician or a cantatrice. Edison has now some new inventions on hand, including a new musical telephone, very astonishing, and an electrical instrument that makes cork-headed needles go through military manouvres.

Pittsburgh Telegraph

OFFICIAL PAPER OF THE CITY OF PITTSBURGH.

MONDAY EVENING, APRIL 29.

Kiralfy to Give Phonograph Operas in Paris.

Associated Press Dispatch.

NEW YORK, April 26.—Kiralfy, the manager, is in ecstacies over the phonograph, and wants Prof. Edison to make him forty or fifty large cylinders which he proposes to take to Paris. After securing the finest musical performers each one will be invited to play into different diaphragms and the notes are to be recorded by the cylinders. The greatest prima donnas, tenors, contraltos and bassos are to sing and their words and melody transcribed by the phonograph. After securing copper matrixes Kiralfy proposes to bring the cylinders to this city and put them on the stage of the Academy of Music. They can be run by a Baxter engine a whole evening with fifteen cents' worth of coal, and an opera given as produced in Paris without a musician or a cantatrice. Edison has now some new inventions on hand, including a new musical telephone, very astonishing, and an electrical instrument that makes cork-headed needles go through the greatest military marouvres.

He Is a Great Man Now.

Mr. Edison, as a young telegraph operator at Memphis, was known for his quaint sayings with which, in odd leisure moments, he illustrated the Southern passion for epigram. A saint was to convert the halls of his gi's and j's into faces, with the usual lugubrious expression imaginable. Another habit was to draw a railroad curve around the room, with a train of cars at full speed. At the first car was a T, on the second T. Then a figure 2, then the figure 3, and so on to the next, was spelled out, and the last car, being impossible to number, was "30," or "No more." On some occasions, some time, until a Memphis editor published a paragraph about the highest name he could think of, the latter proceeding to them on the ground that the thing was a hoax, up one night and in alarming numbers in trying to find appropriate cuss to represent the feelings. The man of the "illustrated name" in question was exceedingly sensitive.—*Buffalo Express.*

DAILY DERRICK.

TUESDAY MORNING, MAY 7, 1878.

STRAY SAND.

"In the bright lexicon of youth," mused grandfather Lickskillet, yesterday evening, "there is no such word as fail, but holy Moses! how the middle aged people are just more than rushing in their voluntary petitions 'before the Ax! Ax is repealed!"

EDISON'S LATEST INVENTION.

Yesterday a stranger man, carrying what appeared to be a small coffin, paused in front of the Oil Exchange. He was a sad-faced man and his black suit glistened in the sunlight like a coat of armor. He put down his strange burden, and leaned to the man standing around. Then casting his eyes up at the building, he began:

"Gentlemen, I congratulate you. You have reared here a structure which is second to none in the country. When you shall have taken to that bosom from whence no traveler returns," and he glanced sorrowfully at the little coffin, "this beautiful building will remain a monument to your energy and enterprise.

"But, gentlemen, pose as I may serm, great as the contest is between us, I have that in this little box before me," and he tapped the coffin reverently with his cane, "which I would not exchange for all the wealth of your Oil K ginos. It is, gentlemen, and he began to unscrew the lid, while the crowd involuntarily shrank back; "it is, gentlemen, a rat-trap which I am introducing for Mr. Edison, of Menlo Park."

The crowd closed up again.

"It is his latest invention and, as he says himself, his best. I have handled a great many rat traps in my life, and I can safely say that this one knocks the socks off of all of them. Don't crowd, too close till I show it to you," and he took off the top and exposed a box with a lot of spasmodic communicating with each other by little doors, windows and openings of one kind and another. "The great inventor named this the 'Cliche Rat-trap,' because it operates off the same principle as a savings bank.

"You see the rat reads the cheese and enters by the front door," that the trapman indicated the mystified with his cane; "thence in quest of the cheese, which is a sort of *ignis fatuus*, though that's none, which admits him to parlor A, or the Cashier's room. This door closes behind him, and he passes thence to parlor B, or the Directors' room; this door closes behind him, as before, and he proceeds to parlor C, as the President's private apartment. By an invention arrangement the closing of each little door removes the chairs into the next room, in this way always keeping it one room in advance of the rat that seeks it —until the last room is reached, (parlor D,) when it is seeing instinctively to the front apartment for the allotment of another victim. Once inside of a door, no rat can get out, but rats on the outside can get in, and do get in, until the trap is full."

"What's all that got to do with a savings bank?" asked a receiving teller who was in the crowd.

"Everything, my dear friend, everything," replied the strange man; "because, you see, when the trap is full it closes—likilities large; so nie nothing."

"THE TELEPHONE."

FRIDAY.....May10

1878

What is the Telephone?

We were surprised to hear this question frequently asked since our last issue, as we supposed every one was acquainted with the construction and uses of this wonderful yet simple invention. So wonderful, that the examiner a week in its presence, with no thought—Is there any limit to man's inventive powers? So simple, that a person will involuntary exclaim, Why didn't some one think of that before? Therefore in order to inform some, who as yet are not acquainted with this great *little* machine and to show the appropriateness of the "TELEPHONE" as the title of our paper, we will give a short sketch of the inventor and this, his most wonderful and useful invention.

Thomas A. Edison is rather under medium size, about five feet seven or eight inches in height. His face is smoothly shaven and his hair is soft, black and of a chestnut brown hue. A prominent nose stands over his large mouth, that wears a pleasant smile and is supported by a broad prominent chin. His skin is white and the whole is illuminated with the bright clear light of his grayish-blue eyes, that wear an animated expression in conversation. His manner is quiet and unostentatious; exhibiting none of that egotistical assurance that might be looked for, in a man who has so much of which to be justly proud. Mr. Edison might justly be styled, the Newton of the present day. He seems to have been born to harness and control that most potent of all forces, in the world of matter—Electricity. As a telegraph boy in a Tennessee office, he was so persistent in experimenting with the instruments and wires, that the principal discharged him from the office. But such was the fascination of the power of Electricity, that he put his whole life into its study, and ere long was the only man that could be found who could receive unbroken dispatches in a Boston office, from a noted operator in New York. His has been continually experimenting and inventing electrical machines; and now at the age of thirty two, he has taken out one hundred and seventy seven patents.

He resides at Menlo Park, New Jersey, where he has a laboratory and workshops, in which he has more than thirty men engaged in working out his ideas. The Telephone has been perfected already a year; but there are two reasons why they are not more generally known; one is that in explaining such things, scientific men use so many technical terms and uncommon expressions, that the ordinary reader cannot put the parts together to make a perfect whole; and another is, that the Western Union Telegraph Company, seeing its offspring, fearing that its general utility would destroy their immense business, leased the proprietorship of the Telephone for a term of years; and as they do not yet care to have it in general use, there has been no one to make a noise about it. And yet, there are more of them used on private lines than is generally supposed. The instrument consists of a mouth piece on iron disk or diaphragm and a delicately balanced bar with a platinum

TOLEDO BLADE.

WEDNESDAY EVENING, MAY 15.

THE PHONOGRAPH.

First Appearance of this Wonderful Invention in Toledo—A test at the Boody House last Evening—Wonderful Performances "et then Machine that is creating such a furorp in the scientific world.

Last evening a number of invited guests assembled in room No. 125, Boody House, to inspect the practical workings of Edison's Phonograph, the first one introduced in Ohio. The machine was exhibited by Mr. A. D. White, a gentleman well known to Toledoans and one in whose hands the machine was displayed to its best advantage.

On a table in front of about thirty ladies and gentlemen was a little oblong machine, the first, prominent feature of which is a little black mouthpiece, over a finely grooved steel cylinder, which is turned by a small crank at the end. After a brief inspection of the phonograph, the practical test began. Mr. White took a piece of bright tin foil, about the size of a sheet of note paper, placed it on the steel cylinder, the edge being long enough to just go around. Then, putting his mouth close to the mouthpiece, and turning the crank slowly with his right hand, Mr. White recited in a clear tone of voice, with great expression, the lines, "Now is the winter of our discontent," &c. These, the machine recited back to him, as he turned until the mouthpiece was directly over the starting point, and then, putting a finger to the mouthpiece, the crank was turned and slowly and distinctly came the words, "Now is the winter of our discontent, made glorious summer by this sun of York," every syllable just as Mr. White had spoken it, with the same inflections and peculiarities of voice reproduced exactly.

The effect was wonderful, and every one present declared that the phonograph was a marvelous invention. Then followed another inspection of the talking machine, the examination and trial being eagerly solicited by attendants. As the machine is thrown into the air as other could produce such results. There was a little piece of sensitive vellum, such as photographers use in taking the types. Back of this, connected with the frame by a small steel spring, was a diminutive piece of black rubber battery. On the plate this material was laying on the surface of a piece of steel, and about one-fourth of a square inch and about one-fourth its length. This needle passing along the grooves, over the tin foil on the cylinder is the cause of all the noise. As the voice is thrown into the mouthpiece it makes sound waves, which strike the tin foil, causing it to vibrate in accordance. The finest little indentations, scarcely perceptible to the eye. Then when the crank is turned again, the pin drops into these holes, agitating the disc or diaphragm, and making again the same sound waves, and consequently reproducing the same sounds. It sound almost impossible that a small piece of paper, a mouthpiece and steel, and diaphragm of soft iron, can speak, just as well as a man, and in fact reproduce, precisely, any sound that may be uttered. Yet the audience last evening was most fully convinced that such was the case.

Mr. Carrier, who had by request brought his organ with him, played a number of familiar airs upon it, the instrument into a manner recorded upon the mouth-piece. A few turns on the crank and the same tunes were heard again, each note, the runs, trills and even a false note purposely played, sounding with clear and distinct and plainly audible tone from the machine. A conversation in a natural manner was carried on, and the phonographic record of it in the most astonishing manner. In fact every conceivable test was made, and the machine was found to be there every time.

The principle of the foil has been found which has been adopted grooves, it is removed and the tin foil is placed in the cylinder. Any desired records may be obtained and preserved for hundreds of years. By placing them on a Phonograph at any time the conversation, music or poem, will be reproduced in exactly the same manner as when the record was made. When one stops to think in what a wonderful extreme this thing can be carried, it is almost incredible to what the inventor had never been born.

The Phonograph exhibited by Mr. White is the first one brought to Ohio, and he has the exclusive right of exhibiting the machines in this section of country. He rooms at 115 Summit Street, over Reuwe's book store, will be thronged to curious people anxious to see or hear, or witness the wonders of the talking machine, the marvel of the nineteenth century. The agents have secured a large number of engagements already in the towns of Northern Ohio, for he is well known and popular, and with his entertainment must of great interest as an actor, his dealings will always prompt and reliable, and as he has a very pleasant association to relate to the Phonograph, his audiences will always be entertaining and instructive. This evening there will be a private exhibition of the machine, and other interesting features.

Week Daily Bee, May 21

Edison's Speaking Phonograph.

AT SAALE HALL, MAY 21, 22, 23,

THREE EXHIBITIONS DAILY,

Commencing Tuesday, May 21st, 1878

Washington Capital, May 16, 1878

THE phonograph is coming and Washingtonians will soon have an opportunity of hearing Mr. Tyndall cuss "the mercy of the century."

Washington Republican May 22

EDISON'S SPEAKING PHONOGRAPH

TALKS, LAUGHS, SINGS, PLAYS CORNET SOLOS AND RECITES ANYTHING ALL MANNER OF SOUNDS.

Exhibited at Saale Hall, Washington, MAY 21 TO 23 inclusive.

Thursday evening, May 23d, at 8 o'clock.

NEWARK DAILY ADVERTISER.

MONDAY EVENING, MAY 20, 1878.

Mr. Edison, who, it will be remembered, is somewhat deaf, writes to a Boston gentleman that he has invented a new diaphragm which, attached to his ear, will so gather and concentrate sound vibrations as to enable him to hear ordinary conversation. Should even that of the drumming of the telegraph instrument in the future so apply its to the phonograph, so that speeches or debates may be registered at a distance from the speaker. At present one may apply it to his ear in a public assembly and catch the words of a speaker at an almost incredible distance.

60

Chicago Mon 10

The Tribune.

HOW EDISON AMUSES HIMSELF.

Cincinnati Saturday Night.

Edison, the telegraph man, is watched until he leaves half a dozen things every day. He doesn't look for mementos when engaged in business that's pressing. The other day he went out to the middle stroll and he thought out a plan for working on one key so as to rest the other, before he knew it he was there.

He lolled a little more and told the driver of a little invisible thought and passed through his head just that moment for delivering milk without getting out of his wagon or even stopping his horses. A simple screw-pump, with hose attached, worked by the milk would do the business. Milk-men who desire to halt for anything in their mad career, because they see them running over so many children as they might otherwise do, would appreciate this invention muchly. Here's sure but that messages and "sic" text could be delivered in the same way.

He stepped into a hotel office, and, observing the humiliations which guests encountered in order to obtain information from the Mahlstead desk, he sat down in the reading-room, and in a few moments had invented a device by which for machinery, warranted to stand behind the counter any knight of time desired, and answer all questions with promptness, correctness and gentlemanly demeanor, pick on and hair carried for a reasonable price.

Leaving the hotel-keeper, he was struck with the needless amount of cushions required in each coupe. Edison is fortunate; he thought of a better and more economical plan—sold it the Lake Shore Company, retired on a pretty cord and went to Washington aspiring for a career.

Catching a mint julip in the saloon adjoining, a brilliant idea flashed through his fertile brain, and he immediately set to work to invent an instrument that is likely to revolutionize the entire saloon business. It is a contrivance so attached that when a person has had just been partaking of some nutritious beverage beaten eggs and cream he would receive a peculiarly electrical sensation from the invention of Mr. Edison) made to revolve a small brush over a small comb, rather on an intermission, that by again applying the lips and turning the crank the person could have another of cream cobs. Edison continued his walk to Pennsylvania, and the saloons will be supplied with it shortly, as it would be useless to deprive the business of ninety-nine out of one hundred customers. Edison can mix his drinks just as well, himself, and then stock his telegraph key with a supply of beaten eggs and cream, unless he has lost a finger.

Edison is a genius, and seems to be no donor himself to death with it. He chiefly uses on the instrument not occasionally and never under recollections of their torrent by forming the crank and guide, a waist of the old man's breath.

A capital sensator the telegraph would be to the temperance cause. Often, where husbands are ready to say "don't drink, could have one ready to say "don't drink, could have one ready to say "don't drink, could have bone into at night. The wife, when they come home, could touch the key and say "Mary Jane, please reformation," and also be determined by it. And how every instance the fraudulent husband would be brought to it, it would be never of use to him to say "this is quarter at a mile of one.

When Edison arrived to go out he had to pass the barber-shop of the hotel, and as he was shaved he talked to them, with all his genius for invention, a suggestion, he could never keep so quiet that he could not hear a talking-machine. The suddenly he saw that his work done and wanted no more that day.

THE DAILY CRITIC.

Established August, 1868.

Saturday, May 18, 1878.

A CUE FOR THE ADMIRONDE.—We are, to-day discussed chiefly the dangerous of English commerce in view of Russia's preparations to assail it, and in the course of our article spoke of fleets of merchantmen selling under convoy of armed vessels. From ex port like New York, it would not be difficult for several steamers or for a number of sailing vessels to start at the same time and to keep so near together, under ordinary circumstances, that each one of them might always be in sight of one or more of the others and that a chain of communication might be maintained between them. In this connection Edison's invention for the augmentation of sound may possibly be put to so important, practical use. If an outgoing vessel found herself approached by a suspicious craft, the aeroplane could be used to communicate the fact to her nearest consort, and the word could be passed from one to another until it reached one or more of the armed vessels. The threatened merchantman could be told which way to steer for protection, and the man of war could be apprised of the quarter in which succor was needed. For additional security a countersign could be agreed upon before sailing, or the vessel would assist sight in enabling the companion ships to identify each other.

THE ADVERTISER

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TO CONTRIBUTORS.

Contributors are respectfully notified that all articles intended for publication should be accompanied by the name and address of the writer. Communications for the editorial department of the ADVERTISER should be addressed to the editor.

PARIS, MAY 9, 1878.

Edison's phonograph, which is shown four or five times a day at the Salle des Conférences, on the Boulevard des Capucines, is having a great success in society circles at Paris. The Prince Salm-Dieusaide and the fashionable clubs discuss the performance of which from the editorial the top is to crack.

Baltimore American.

TUESDAY, MAY 21, 1878.

AMUSEMENTS.

The Edison Phonograph.

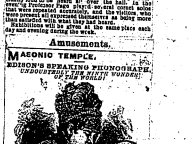
The first public exhibition in Edison's phonograph was given in the lower hall of Masonic Temple yesterday, and a large number of persons were in attendance. The instrument has already been described in these columns, and it is unnecessary further to speak of its appearance. In fact, the looking-at now nothing but a cylinder resting on a shaft, and a small mouthpiece into which the operator speaks, and which is connected with a diaphragm. By means of the cylinder the sounds impressed upon it are made with wonderful distinctness, and the machine will repeat them many hundred times. They will be heard with equal force, and the operator was told that at the last exhibition in Washington over one thousand persons had successively listened to the instrument without causing any injury to the cylinder. Mr. Edison's invention for the augmentation of sound may possibly be put to so important, practical use. If an outgoing vessel found herself approached by a suspicious craft, the aeroplane could be used to communicate the fact to her nearest consort, and the word could be passed from one to another until it reached one or more of the armed vessels. The threatened merchantman could be told which way to steer for protection, and the man of war could be apprised of the quarter in which succor was needed. For additional security a countersign could be agreed upon before sailing, or the vessel would assist sight in enabling the companion ships to identify each other.

Amusements.

MASONIC TEMPLE.

EDISON'S SPEAKING PHONOGRAPH.

UNDOUBTEDLY THE MOST WONDERFUL OF THE WORLD'S WONDERS.



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Open Daily from 10 A.M. to 10 P.M.
ADMISSION 25 CENTS. CHILDREN 15 CENTS.

EVENING JOURNAL.

THURSDAY, MAY 9, 1878.

VISITING MR. EDISON.

WHAT A PARTY SAW AND HEARD—PHONOGRAPH, TELEPHONE, ETC.

A day or two ago a party left Jersey City with the avowed purpose of visiting the laboratory of the great electrician, Mr. Edison, at Menlo Park. Among the party were Mr. Charles Watts, assistant superintendent of the New York Division of the Pennsylvania Railroad, and his accomplished wife, Mrs. Gilchrist, of New York; Mr. Wm. Eldner, division operator of the New York Division; Mr. R. A. Shultz and wife, Mr. A. S. Dahl, general manager of the D. Y. Transfer Co., Mr. Wolverton, President of the Company, Mr. B. F. Thorne, Mr. H. C. Rue, Col. Rose, Mr. Richards, a JOURNAL reporter and others. For the time thus the party arrived at Menlo Park, a small station just this side of Metuchen, and clambered up the hillside on the right of the road. On the summit of the hill a brick house was blowing, which invigorated the sight-seers amazingly. They struggled over the sprout field, cheering and laughing gaily. Across the field was a long, two-story frame building, with a big shed-like mounting guard on the piazza. Whether the numerical strength of the party awed the dog, or whether he was dead natured, was not known at first. He offered no objections to the ingress of the party. As soon as the party entered the building they ascended the stairs and at once surrounded a brown with cheerful gentleness, who sat at a bench like a carpenter's bench with a brass cylinder in front of him. The green coon thought it was Mr. Edison, and were about to make their salaam to the great inventor, when Mr. Ettinger remarked, "Mr. Bitchelor, allow me to introduce some of my friends." Mr. Bitchelor bowed politely, and that Mr. Edison was away on business, and turned at once to the cylinder. It was about a foot long and five inches in diameter, and worked from left to right, and back again by means of a screw shaft, worked by a belt and gearing attached to steam power beneath the table. In front of Mr. Bitchelor and between him and the cylinder was a little round piece of wood, disk-shaped, with a hole in the middle. On the sides of the wooden disk, opposite Mr. Bitchelor and nearest the cylinder was attached a disk of metal with a point in the middle of it. This Mr. B. said was a diaphragm, and every person present thought of the sensitive instrument which has been the purchase of their interest in a sewing machine. He put on a sheet of tinfoil six inches wide and ten inches long, and put it around the cylinder, pasting the ends together thus making a band of tinfoil. The cylinder was then fitted with groves an eighth of an inch apart, and Mr. Bitchelor put the point of the metal in the diaphragm against the tinfoil, in one of the grooves and started his machine. Then he began and into the little hole of the wooden disk, "Mary had a little lamb," and turned the crank for one or two on all the way through, the little point ran back to the beginning of the groove and the cylinder, and it moved up and down against the tin foil, making little indentations in it. When he got to the end of the words returning to Mary and her lamb, Mr. B. pulled the wooden disk with it back in a way, stopped the cylinder and put the point of the metal in the groove the plate. Started from, he put the point of the diaphragm against the tin foil, gazing it fit to fit the indentations it made. Then he placed the apex of a paper cone in the hole in the wooden disk, and the small end he inserted the machine again, then turned the crank long the words, "Mary had a little lamb, &c.," and sure enough, the first they could be heard all over the room. It was a grave ay moment to the green coon. That's all there is about the phonograph. Its simplicity is astonishing. It is a toy, but a wonderful toy. Mr. Edison has given to the world a ghost of toy, and made the ingenious public on the discovery. After the intended case of the seeing was over the boys in the evening club, "Old Uncle Nat." This he repeated, and from set the point of the metal in the groove, and turning the crank started the machine again, thus:

"Mary had a little lamb," &c. Running the New York Division of the Pennsylvania Railroad, and his accomplished wife, Mrs. Gilchrist, of New York; Mr. Wm. Eldner, division operator of the New York Division; Mr. R. A. Shultz and wife, Mr. A. S. Dahl, general manager of the D. Y. Transfer Co., Mr. Wolverton, President of the Company, Mr. B. F. Thorne, Mr. H. C. Rue, Col. Rose, Mr. Richards, a JOURNAL reporter and others. For the time thus the party arrived at Menlo Park, a small station just this side of Metuchen, and clambered up the hillside on the right of the road. On the sum-

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THE DAILY GRAPHIC

THURSDAY, MAY 16, 1878.

THE ORIGIN OF THE PHONOGRAPH.

[*To the Editor of The Graphic.*]

I read some time since the interview of your representative with Mr. Thomas A. Edison with much interest. Mr. Edison is represented as saying (in answer to the question: "How about religion?"; "That is a matter I have studied somewhat, but I haven't been able to get any clue to any first cause, or any hereafter."

I simply desire to say that Mr. Edison's own invention of the "Phonograph" is one of the strongest arguments in support of the truth of revelation that modern discoveries have contributed; and, moreover, it has clearly established, to my mind, beyond all doubt, its truth of a passage of Scripture which has been doubted or explained away by many who could not accept it literally, even while accepting the fundamental truths contained in the same Scripture. I refer to this passage: "But I say unto you, that every idle word that men shall speak, they shall give an account thereof on the day of Judgment."—St. Matthew xii. 36. Now if a mere man can discover the law of preserving human words for an indefinite period of time, for all future time, how can we doubt that if there is an Intelligence that can produce an intelligence that can discover the working of laws, and embody them in the phonograph, how can any one doubt but that that same superior intelligence can preserve every word emanating from the intelligence which He has produced? The fact was declared eighteen centuries before Mr. Edison's phonograph demonstrated it. The fact itself, as stated in St. Matthew, was known all these centuries, but only a few, perhaps, could faintly understand it, many more who accepted it upon faith as true, but many more who could not believe or understand it.

In the order of God's good providence Mr. Edison has been permitted to discover—not invent—to discover or obtain a faint knowledge of the working of Divine laws and apply them to the uses of mankind.

REV. MELVILLE M. MOORE.

The autograph letter of Edison, the inventor, which we reprint to-day, is a generous recognition of what THE GRAPHIC has done for the instruction of its readers. This peculiar penmanship is no affectation, nor is it adopted for an occasion; but it is the uniform style of all the inventor's personal letters. It does not look like the hand of an intensely busy and hurried man, but he explains to his friends that while his hand was still unformed, he chose this, because it was legible and because he found by practice that he could write it as fast as any other. He dashes off his letters with the rapidity of an accomplished clerk, but every one of them is a work of art.

FROM THE LABORATORY OF
T. A. EDISON,
MENLO PARK, N. J.
U. S. A.

To the Editor of the Daily Graphic

May 10 1878.

Dear Sir - I feel an inclination to thank you for the pleasant things you have said about me and the Phonograph in the Graphic. Your words and pictures have gratified me the more, because I had long since come to look upon your paper with pride and to regard such an illustrator of daily events as one of the marvels of the age. I am able to report to you that I am constantly increasing the sensibility and power of the Phonograph. I feel certain that it will soon justify all the hopes of its friends. By the way, Croffuts April-first hoax concerning my alleged food machine has brought in a flood of letters from all parts of the country. It was very ingenious. With congratulations on the great success of your journal I am

Yours Truly

Thomas. A Edison.

FAC-SIMILE OF A LETTER FROM THE INVENTOR OF THE TELEPHONE AND PHONOGRAPH.

Sentinel of Freedom,

AND WEEKLY ADVERTISER.

TUESDAY, MAY 21, 1878.

The Bores of Science.

The Sun tells a humorous story of a visitation to Edison, in which thirty supposed to be gentlemen headed by a man whose principal stock in trade was brass, took possession of the establishment, laboratory, operatives and machines, fairly drove the wretched proprietor into a hiding place, and, with the assistance of a bucket of punch, pushed their investigations of science to the verge of disintegration and chaotic uselessness. Mr. Edison had at the same time received information that a party of a hundred was on the way from Boston, without invitation or other announcement, and those who know the inquisitive nature of one Yankee, when in pursuit of knowledge, need only to multiply him by a hundred to imagine the great inventor standing, after their departure, on the verge of insanity.

There is a medium in all things, it is said, but things have come to such a pass at Menlo Park that there is hardly a choice between the utter exclusion of visitors and the erection of a theatre or amusement hall for their accommodation. The building in which Mr. Edison is supposed to work, but where in reality the most of his time is occupied in receiving visitors, is entirely unfitted for exhibition purposes, and even with its present props and braces there are some who have misgivings as to its safety under the pressure of a crowd. It is an ordinary frame workshop, nothing more, and it is impossible for even a few curiosity seekers to go through it without disarranging and disorganizing the labor going on there and the delicate machinery in process of construction.

Aside from this it is the duty of the press, especially of this State, to discourage such overwhelming visitations to Menlo Park. Mr. Edison is a pleasant, genial, self-sacrificing gentleman, never wishing or willing to say no to any one, but it must be borne in mind that he is the greatest of our present inventors, and that his brain is constantly filled with as yet unsolved problems, or with the perfection of those wonders which he has already given to the world. To keep him hours each day shouting and singing into a phonograph for the amusement of a crowd of unscientific people, is the refinement of cruelty and a gross injustice to science as well as to him. To relieve himself somewhat he is sending this last invention to various parts of the country for exhibition in its still crude and imperfect condition, but aside from this we appeal to the common sense and the sense of fairness of the people, to release him hereafter from mere visits of curiosity. When science makes a pilgrimage to the temple to worship or to inquire into sublime mysteries it is well, but Mr. Edison is not a showman, and he is of too much value to mankind to be used for such a purpose or to run the risks of having his mental balance overthrown in such a fashion.

St Joseph Daily Herald
Mar 19

EDISON, MUNCHAUNEN AND PLUTARCH.

The first notice of the phonograph in the HERALD was given on the 10th of February last, when we said:

The latest invention is the phonograph—the name of a machine and not of the Pitman manner of reporting. We have seen pictures of it, and many long descriptions, but have not read any of them. They have always reached our eyes in moments of incredulity, or when the mind was so taken up with other themes that it refused and rejected anything more, especially anything new. The phonograph, we believe, is a machine that listens to the voice and saves it; it preserves your words and tones in this city; taken to another city or another age, it is unlocked, or opened, and your words come forth. Plutarch first told the story, but Munchausen gives it to us, that a tune frozen in a flute in Siberia thawed and delivered itself when the flute was taken to Italy. Is that what they claim for the phonograph?

Since that date the readers of the HERALD have learned all about the phonograph. When the English papers arrived here with their first notices of the new invention we found that nearly all of them said that it was a realization of the Munchausen lie, but we have as yet seen no credit given to Plutarch or to writers of a still earlier date.

The Munchausen story is found in Chapter VI of the Adventures, and is as follows:

I traveled post, and finding myself in a narrow lane, bid the postilion give a signal with his horn, that other travelers might not meet us in the narrow passage. He blew with all his might; but his endeavors were in vain; he could not make the horn sound, which was unaccountable and rather unfortunate. . . . After we arrived at the inn my postilion and I refreshed ourselves; he hung his horn on a peg near the kitchen fire; I sat on the other side. Suddenly we heard a *tereng! tereng! teng! teng!* We looked round and now found the reason why the postilion had not been able to sound his horn; his tunes were frozen up in the horn, and came out now by thawing, plain enough, and much to the credit of the driver; so that the honest fellow entertained us for some time with a variety of tunes, without putting his mouth to the horn—The King of Prussia's March—Over the Hill and over the Dale—and many other favorite tunes; at length the thawing entertainment concluded, as I shall this short account of my Russian travels.

Baron Munchausen was a German soldier who was born in 1720 and died in 1797. He served as a cavalry officer in the Russian army, delighted in telling wonderful stories of his adventures, and gained the reputation of being one the greatest liars who ever lived.

The stories were written and published by a German refugee, Rudolph Erich Raspe, a man of letters, and first published in London in 1785. Only a man of genius could have told the stories so well, but most of them are much older than Munchausen. The horn story just quoted is found in Rabelais and is also used as an illustration by Jeremy Taylor.

Thomas A. E.

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In Goodwin's edition of Plutarch's Morals, vol. II, p. 466, in the essay, How a Man May be Sensible of his Progress in Virtue, we find the following:

This Antiphanes said merrily, that in a certain city the cold was so intense that words were congealed as soon as spoken, but after some time they thawed and began to come audible, so that the words spoken in winter were articulated next summer. Even so the many excellent precepts of Plato, which he published like the best coiners of his scholars, were scarcely understood and distinguished by many of those till they grew more and mellow'd the warm, vigorous summer of their age.

The original thought, it will be seen, is the best, and the application has a rare and poetic beauty.

Mad, do Stael, in Corinne, speaks of a monument as music forever, and Schilling said "Architecture is music in space, as it were, a frozen music."

So this thought has been circulating two thousand years or more, and Edison comes along and makes it an every day reality. He is called an inventor, while Manchanan was only a liar. The two are closely allied, the poet being their head of union. The new world in the West was the dream of a Latin poet but a reality with Columbus.

Chicago Tribune
May 21

THE PHONOGRAPH.

To the Editor of The Tribune.

GROVE'S LAKE, Wis., May 18.—The continued criticism of Mr. George B. Ives of the article on the phonograph I cheerfully accept. What is wanted is more and not perfect sense cannot be produced. My suggestions were based on the statement "that sounds are produced by purely mechanical force." I may be mistaken in supposing that this statement tegenerally believed, but would ask, however, was the effect produced by the phonograph be the result of waves, merely mechanical, of either air or ether?

I would now present my ideas in the form of queries, which would enable me to state the case with which would enable me to state as facts that which has been proved as truth by my critics.

1. Is there any reason why the diaphragm, vibrating in contact with the sharply defined edge of an excitrol current which conveys the sound in a telephone, will not produce sound?

The sound waves striking over indentations "to assist that they cause the diaphragm to vibrate with the effect of the same continuous vibrations of the diaphragm in the tele?

Does not the exhaustion of the electrical current produce the effect?

At set in motion cause the force, which is conveyed by the electric current to the receiver, and even "through the same force" produce the sound of the human voice. Cannot the force be conveyed by the electric current, air, or with a current of air, be made to produce sudden vibrations of the disk, producing sound?

When the phonographic sentences has been made over the phonograph, a subsequent record may be made over the first, and the first record will be reproduced at the same time, although less "sonic contrast, and a slight interference of the two records would be noted by adapting the proper receiver.

What the point first passes over the tin-foil an indentation is made, and the diaphragm, in passing over it the second time, will vibrate. By reading of the disk, a second connection is made, and the diaphragm is caused to vibrate. Thus, when the disk is spun and reversed, the same takes up and conveys both sounds at once.

Are not the workings of the phonograph and telephone on the same principle, involving identical motion?

Chicago Tribune
May 16

THE WONDERS OF THE PHONOGRAPH.

To the Editor of The Tribune.

CHICAGO, May 15.—In your paper of the 10th inst., "C." and George Lake, Wis., signing themselves, or Mr. Edison has not been practicing upon the credulity of the public by means of ventriloquism when exhibiting his phonograph.

Edison have a scientific fraud.

Your correspondent cannot have examined the evidence carefully or he would not have ventured upon such an insinuation.

Fortunately, the results accomplished with the phonograph do not now rest upon the testimony of Edison alone, nor upon his manipulation of the machine.

The successful exhibition of the first phonograph in this city was described in the columns of the *Scientific American*, which has repeatedly indorsed all that has thus far been claimed for the machine.

Favorable notices of all the New York papers, and others from other localities, have examined the phonograph, and have given their opinions as to its merits. Elaborate descriptions and indorsements have been printed in the leading periodicals. Many scientists have personally tested the phonograph to their entire satisfaction.

The phonograph has been exhibited to the leading scientific societies in the United States, Scotland, and France, and they have passed resolutions of thanks to the inventor. There are now in this city several machines in existence in the hands of different parties, and in this country, and it is daily exhibited in New York.

At least Edison people have seen and listened to the performances.

Mr. Edison has nothing to do with these exhibitions. He is at present fully occupied in his laboratory at Menlo Park, N. J., where he is preparing to be said, and even when in the room Edison upon deception; but all have a chance to examine for themselves until perfectly satisfied.

Mr. Edison has used the phonograph on several occasions. His words, spoken in a tone lower than ordinary conversation, have been accurately recorded and reproduced.

He has heard the phonograph talk, laugh and sing, and whistle.

It reproduces the sounds perfectly.

The words, tones, and inflections upon disks are being taken in an accurately manner.

When a sentence has been spoken to the phonograph, the record is removed, and the needle over the first, and the two utterances will be reproduced at the same time. Sometimes there is some confusion and a slight indistinctness.

A few simple experiments will satisfy any one as to the nature of the work.

Place a silk hat, and, placing one hand upon the crown, speak into the opening towards the bottom. The vibrations of the sound of the crown of the hat correspond to the movements of the phonograph's dial.

Place the hand on a glass or thin board while talking, and the effect will be noted. The vibration of the partition will be plainly felt.

3. Listen in a room separated by a brick partition from another in which a loud conversation is being carried on. Much that is said will be heard distinctly, and this can only be by the vibrations of the wall. In one room being imparted to the wall there, which are imparted then to the air in the next room.

Words, spoken with a powerful voice, will frequently cause the phonograph needle through its disk.

So delicate is the instrument that intelligible sounds will be made when the voice vibrates the disk and give out the original sound.

It is not strange that there should be some inaccuracy relative to the performances of such a wonderful instrument, especially when it performs the functions of the complicated mechanism by the human body.

There has probably never been an important invention made available for practical use in which there was not, thus as will be the case with the phonograph.

It is necessary, however, that a standard machine as near perfection as possible in all its details should be made before general introduction. Then the owning phonographs will be able to use them for communicating with each other, which could not be done if the machines were different. At present, the records made on a phonograph cannot be used after reproduction.

Mr. Edison's time is fully occupied in his method.

To perfect the phonograph will require some weeks yet. In the meantime, the Phonograph Company proposes to exhibit the machine as it now is in the various parts of the country.

If the public will possess a little patience for a short time, Edison will be able to vex the ear and tear and hear with their own ears what the phonograph can do.

GEORGE H. BLISS.

THE DAILY GRAPHIC

TUESDAY, MAY 21, 1878.

—Edison's "apparatus for the deaf," the New Haven *Register* says, "will enable them to denominate time to walking on railroad tracks."

Commercial Advertiser.

TUESDAY AFTERNOON, MAY 21, 1878.

The latest invention of Mr. Edison is a machine to rock a cradle. When the baby cries the sound is received by a telephone, which, operating through a battery and magnets, sets in motion a lever which rocks the cradle. This was done on the spur of the moment, and was the answer to a challenge.—*Rochester Express.*

MR. EDISON'S RECEPTION.

THE "WONDERFUL" HAVING GIVEN A PARTY, IT WAS MEET TO FIND HIS SHOP INVADED.

LADIES ASTONISHED AT BEING OUR TALKED AND PLEASED WITH A DEVICE FOR QUIETING THE BABY.

Mr. Bayard Taylor, now Minister to Germany, (in his novel of "Hannah Thurston," described his hero as styling an evening party "a large, bare room, lighted by candles, the hare, being poverty-stricken. A second visit whether occurred last night at the wonderful Edison's laboratory at Menlo Park, the difference being that Mr. Edison, thanks to his inventions, is not poor, and that the "evening" was opened by one of Mr. Edison's own contrivances. Mr. J. W. Tower, reporter of the *Scientific American*, had with the visitor's permission, arranged for a sort of reception to the phonograph, and Private Secretary Ash New York at 4 p.m. to invite a few friends to witness it. Among those who were W. W. Rossa, the well-known poet; Gen. Gilmore, U. S. Engs. Dr. Hahn, Henry H. Benn, of the New Jersey Mutual, J. W. McCulloh, agent, of the New York Associated Press, Mr. Bonelli, of the Telegraph Company; Clark Wargrave, Colonel of Internal Revenue at Toledo, and his son G. B. Mc. engineer of the Department of Docks; Mr. Sarony, Jacob Craig and Winslow Judson, of the Fifth Avenue Hotel; Edward Bleecker, Albert Weber, W. D. Sloak, a prominent engineer, and Mrs. White, of Brooklyn, with several other ladies.

It was strange that a reception should be held in a workshop, but Mr. Edison did not mind this fact, as he was busily engaged with some new idea when his guests arrived, and the latter made no complaint, as they were only too anxious to hear the phonograph. Mr. Bleecker, Mr. Edison's accomplished fiancée, and Mrs. Edison were the upper floor, and the ladies and gentlemen were left to themselves somewhat. Gen. Gilmore, always about the instrument, to add that they had heard a good deal about it, but that they had never seen it, and he intended to write to all his scientific friends and tell their they should go.

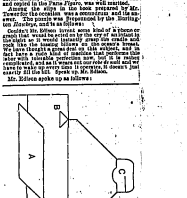
Then Mr. Bleecker took his seat before Mr. Edison's harp, as he called it, and sang, whistled and played on the violin, the machine reproducing "Mary's little lamb." Soon Mr. Edison was called for, and, with a look of mischief on the fact there was an evening party in his shop, he went up stairs and was heard to say, "Hannah Thurston, I'll be with you again." The proceeding called for a protest from Mr. Weber, and Mr. Edison and Mr. Bleecker then came down stairs, and the latter sang a song which sounded more than usual well. Mr. Ash was on an adjacent table.

"Now we march," said Mr. Cornish, of Cornish's Tavern, who dined with Edison on Saturday last, "to the tune of 'Yankee Doodle.'" "Hello, Ash," said Mr. Edison, "I'll be with you in two minutes." Then Mr. Tower produced a confidential container of a telephonic interchange between Edison and Ash, and read it to the astonishment of the company, that is to say, of "the wonderful Edison," confirmed upon him by THE WORLD and reported in the Tribune and Commercial.

Mr. Edison then set up the tone produced by Mr. Tower for the occasion was a concentrator and the assembly *Rondeau*, and he as follows:

"I have a little machine here, some kind of a thing or other that I had to send to the city of Washington to the other day. It would instantly grasp the cradle and rock it. It is a very simple affair, and I will show it to you. We have brought a great deal of this machinery, and in fact have a clock kind of machine that performs this work. It is a very simple affair, and I will show it to you in a moment, as I have not the rocker at hand and we have to make up every time it operates, it doesn't just exactly fit the bill. Speak to Mr. Edison.

Mr. Edison spoke up as follows:



A. Cradle.
B. Telephone.
C. Battery.
D. Wires, connecting magnets and connected with lever.
E. Weight, attached to lever.

The baby's cradle is to be moved by the telephone, which, when it receives the "music" and machine, sets in motion the lever, which rocks the cradle. When the baby ceases crying, the cradle is still.

After this there was nothing left for the guests to do but to wend their way out of their shop. Mr. Edison having disappeared, as they wended their way to the railway station.

N.Y. Evening Telegram
May 20, 1878

—Now that the phonograph makes it possible for sounds to be saved by the telephone, why not lobsters, fish, &c., whereupon sentence can be heralded and sent on the fresh fish to the table, ready for the table, instead of the inanimate article.

Boston Advertiser
May 11, 1878

—Do you want to make a sound investment? Then buy a telephone.

Nuove modificazioni al telefono. *Nota di* Bufquar. — Queste modificazioni sono dei signori Garnier e Pollard, ingegneri delle costruzioni navali a Cherbourg.

Una piccola lamina di latta, affatto analoga a quella del telefono Bell, è posta in contatto colla estremità terminante in punta di un lapis ordinario di grafite, e preme leggermente sulla parte centrale di essa lamina.

Il lapis da una parte, la lamina dall'altra sono, con due fili di linea ordinarii, in comunicazione coi due capi del filo del reochetto del telefono Bell, nel quale la calamita è rimpiazzata da un cilindro di ferro dolce. Una pila di dieci elementi Leclanché è interposta nel circuito.

Quando parlando si fa vibrare la lamina dell'apparecchio trasmettitore, l'estremità del lapis di grafite subisce una serie di modificazioni nel suo contatto colla lamina, senzachè per questo il contatto venga interrotto. Queste modificazioni danno luogo nel punto di contatto a variazioni nella resistenza del circuito, e per conseguenza a variazioni nell'intensità della corrente permanente della pila. È chiaro allora che questa corrente, la cui intensità varia coi movimenti elementari della lamina vibrante, produrrà, nell'elettromagnete del telefono ricevitore, delle alternative di attrazione e di non-attrazione. Queste alternative agiscono assolutamente come nell'apparecchio Bell, e permettono in conseguenza d'intendere la voce di una persona che da lontano parla nel trasmettitore. Noi crediamo che questi esperimentatori si avviano sopra un studi che potrà condurli ad un accrescimento d'intensità della voce, quale si ha ora dai telefoni ordinarii. (*Les Mondes.*)

The Evening Express.
No. 20 Park Row, New York City
The Best Evening Paper in the City.
PRICE TWO CENTS.
TUESDAY EVENING, MAY 14.

PROFESSOR JOSEPH HENRY.

The death of Professor Henry calls forth numerous tributes of deserved respect and regret. An eminent scientist himself, he probably did as much if not more than any other man to organize and forward scientific studies and research in the United States. Professor Agassiz had a contagious enthusiasm which made him more of a kindling and inspiring personal force in science than Professor Henry, who, though dignified and cautious and kind, somewhat lacked personal magnetism. He was very conservative and cautious, and his attainments were overshadowed by the achievements of men who had more popular gifts and the audacity to launch their combinations as demonstrated conclusions. He shrank from the sharp antagonisms in which so many scientists delight, and leaving them to fight the battles over contested theories of evolution and similar questions, pursued his own studies in quiet, and acted as a peacemaker rather than as a disturber of the peace. A religious man himself, he had such profound faith in religion that he could not believe its bases were shaken or undermined, he even likely to be, however they were assailed; and he deprecated the discussions which were calculated to weaken the faith of any in the religious ideas which he felt were as firmly established as any truths of science. His disinterested devotion to science, refusal to use his knowledge or discoveries for his own personal enrichment, contented to be poor while so many savants were rewarded as well as honored, deserves special notice. Last year, a few gentlemen, knowing how he had labored for science, and had built up an institution which is a real credit to the country, without saving a dollar for himself, subscribed a thousand dollars each, and gave him $40,000 as their tribute to his long life-service. He was overcome by the munificent act, and his modesty and diffidence in accepting the gift were almost child-like. America has few salient examples of the same rank as some European savants, whose fame is world-wide. But Professor Tyndall when here spoke in high terms not only of this great number of men of this power and great promise who are engaged in scientific pursuits, but also of the great mental and high European tone of many of the men who are not deservedly honored by our people, and among them he placed Professor Henry. The honor of such a life as his was in the being of it, and the institution he founded did so much to establish is his monument.

Chicago Tribune
January 14, 1879

SUNDAY EDITION. ATLT

Edison's Telephone.

New York Correspondence Cincinnati Commercial.

The city telegraph station is to undergo a change which is a revolution. Edison's telephone is the instrument. A meeting of telephonic stock is to be called immediately at the City-Hall and directors elected. Then the manager at the centre will connect and disconnect those wires according to call. For instance, Smith, who owns or hires a telephone, calls for No. 7, who has a telephone; the manager looks for the connection between the two parties, makes a secret circuit, without any assistance, and with no danger of being overheard by any third parties. The revolution is complete. And as every one who has a telephone will, for a merely nominal sum, be able to have interviews, the element of convenience will be very great. Those who have telephones in their houses or offices will have the benefit of public telephones or resort to the slow mercantile delivery of dispatches at present prevailing.

I may add here that the Western Union Company will add to its 7,500 offices at least half as many more during the next year, the extra facilities being rendered necessary by the telegraph service now in use. As there are too many underwriters to pay the dividends on the stock, the new communications will be by telephone. A mouthpiece will hang down from the counter, and receivers will be at the ears of the operators, and every one who wishes to send a message will talk it into the mouthpiece himself. The most enormous will soon be reduced on a large scale, and Mr. Orton, the new President of the Western Union, has lucidly confidence in the practicability.

THE PHONOGRAPH IN LAST DEVICE.

ENGAGEMENTS BOOKED FOR A LECTURE-TOUR THROUGHOUT THE COUNTRY.

At the office of the Phonograph Company, No. 203 Broadway, there are now many persons engaged in issuing the act of incorporating the latest articles. Twenty-two legislators were even yesterday detected by a Times reporter in the act of declaiming at the top of their voices into the mouths of the machines, so that no hour while so many were present at the office. Edison was interviewed all over the United States. Edison's plan investigated.

It seems that the Phonograph Company have been for a few days in possession of the secret of reading an accurate impression of electric sounds, and have hit upon the idea of making a tour throughout the country, giving a series of lectures, illustrated by the instrument. Edison's first lecture, delivered at the Academy of Music, netted a thousand dollars cash, and gave him $40,000 as their tribute to his long life-service. He was overcome by the munificent act, and his modesty and diffidence in accepting the gift were almost child-like. America has few salient examples of the same rank as some European savants, whose fame is world-wide. But Professor Tyndall when here spoke in high terms not only of this great number of men of this power and great promise who are engaged in scientific pursuits, but also of the great mental and high European tone of many of the men who are not deservedly honored by our people, and among them he placed Professor Henry. The honor of such a life as his was in the being of it, and the institution he founded did so much to establish is his monument.

Chicago Tribune
May 14, 1878

From this morning's *Tribune* we learn, that Mr. THOMAS A. EDISON, the phonograph inventor, writes to his acquaintances in Chicago as follows: "I am in New York. I have been here for a few days, many letters, but I only received on the subject of an injunction for the deaf, has overlooked me that I have been in New York. I have been here for a few days, two of my most exciting moments at work testing my inions. I feel sure that I will produce a practical speaking machine."

After Mr. EDISON has succeeded in this great undertaking, he certainly will, we want him to try his hand at an instrument for the deaf and dumb, which will be a blessing to all. We have an eye on him for the fields—dotted and Mindi, which is a word long felt at the *Tribune* office.

NEWARK DAILY ADVERTISER.

FRIDAY EVENING, MAY 17, 1878.

The Telephone in Newark.

The exhibition of the telephone at the Clinton Avenue Congregational Church, last evening, was very satisfactory. The apparatus, though perfectly simple in construction, transmitted messages and vocal and instrumental music in a way that demonstrated the importance of Mr. EDISON'S invention. The great hearing is to be improved in accordance with the suggestions which the audience was so large that the entertainment could not be repeated this evening, with an additional attraction in the shape of an orchestra.

The Phonograph.

Mr. P. L. Leedy exhibited Edison's Phonograph last evening to a select company of gentlemen connected with the press. We have said this to what we have said heretofore. The machine is in its infancy, and great improvements will be essential to bring it into household or common use, but so far it is just from the brain of man, but the mechanical genius of Edison. We will not attempt to describe the wonderful operation of the ingenious one. There is nothing theoretical about it. It is practical, and the time is not far off when it will be in the laboratory of every man who can afford it. Edison's plan investigated.

It seems that the Phonograph Company have been for a few days in possession of the secret of reading an accurate impression of electric sounds, and have hit upon the idea of making a tour throughout the country, giving a series of lectures, illustrated by the instrument. Edison's first lecture, delivered at the Academy of Music, netted a thousand dollars cash, and gave him $40,000 as their tribute to his long life-service. He was overcome by the munificent act, and his modesty and diffidence in accepting the gift were almost child-like. America has few salient examples of the same rank as some European savants, whose fame is world-wide. But Professor Tyndall when here spoke in high terms not only of this great number of men of this power and great promise who are engaged in scientific pursuits, but also of the great mental and high European tone of many of the men who are not deservedly honored by our people, and among them he placed Professor Henry. The honor of such a life as his was in the being of it, and the institution he founded did so much to establish is his monument.

Newark Advertiser, May 17

—The report about Edison having invented an instrument "capable of reading the very faintest whisper in a room and repeating it in any desired volume" is now confounded [illegible]

The Alliance.

CHICAGO, SATURDAY, MAY 11, 1878.

THE PHONOGRAPH.

The discovery that the waves of the atmosphere can be caught and reproduced no less than the waves of light is one of the great discoveries in the world. It marks a long step in advance and forms the basis for a strong prediction that the forces of the air will sometime be under man's control. It is a tribute to the strongest argument in proof of a personal Creator, since the machine cannot begin to rival the personality and talking ability even of a child. It proves that man is at the best an imitator and not a creator, for infinitely more wonderful than the phonograph is the meanest shoe-black whom as Carlyle says, even the Lord Mayor of London cannot commission to make lumps, for even a shoe-black is immortal. The phonograph, therefore, rather than an argument for man's creative power, is an argument against it and comes along as a proof that man, in his power of imitating his Creator, is ingenious, but not a formidable rival. Volitions, choices, affections are infinitely more wonderful than the phonograph, but excite less interest because less novel.

But the uses to which the phonograph may be put are of moment in their application to religion for a veritable talking ma-

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Hopkinton Star
May 16 1878

Edison's Last.

In an interview published in the Washington Post, Mr. EDISON says: "I have a machine in my room now which will record my voice, listen to it in my ears, pronounce it, and, if I am not satisfied with the pronunciation, I can go and put the record back and speak again. I have a new arrangement by which the motor of the machine will run for hours, and I can leave it to itself entirely. It is a curious fact that the words of a speaker almost always sound slow or solemn on the phonograph unless he has not seen it in advance."

Mt Sinai
May 16

Edison's Last.

In an interview published in the Washington Post, Mr. EDISON says: "I have a machine in my room now which will record my voice, listen to it in my ears, pronounce it, and, if I am not satisfied with the pronunciation, I can go and put the record back and speak again. I have a new arrangement by which the motor of the machine will run for hours, and I can leave it to itself entirely. It is a curious fact that the words of a speaker almost always sound slow or solemn on the phonograph unless he has not seen it in advance."

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The Sun.

THURSDAY, MAY 16, 1878.

Edison's Last.

In an interview published in the Washington *Star*, Mr. Edison describes a marvellous discovery recently made. He says: "Night before last I found out some additional points about the carbon which I use in my carbon telephone. It may be used as a heat measure. It will detect one fifty-thousandth of a degree Fahrenheit. I don't know but what I can make an arrangement by which the heat of the stars will close the circuit at the proper time automatically and correctly. It is a curious idea that the heat of a star millions of miles away should close a circuit on this miserable little earth, but I do not think it is impossible."

Chicago Tribune May 12. 1878

THE PHONOGRAPH.

To the Editor of The Tribune.

GENEVA LAKE, WIS., May 9.—It is stated that the phonograph works entirely by mechanical force; that the vibrations of the disk are conveyed by the point to tin-foil, here indentations are made corresponding to the vibrations of the disk. It is claimed that the pressing of this point over the indentations causes the disk to vibrate in the same way as when spoken to, and with nearly the same tone and form; and it is also claimed that different sounds can be made on the disk at the same time, and these different sounds be carried back, at the same time, to the disk, and be distinctly heard.

Let us examine this statement. Consider the force of the voice, which must be used with more than ordinary strength, which causes the point to make indentations in the tin foil. From the nature of the tin foil, it would be impossible to made deep indentations; consequently, the force which would come to the disk from the point would be very feeble. The point must be near enough to the tin foil to touch the lowest part of the indentation. Has the tin foil between the indentations resisting power enough to push back the point so as to cause vibrations which could be heard; and how could different sounds come from one indentation?

Speaking through the telephone is entirely different. There we have the intervention of a *force* which flashes the sound, or what produces it, along the telegraph-wire, and causes vibrations of the corresponding disk equal, or nearly equal, to those of the disk to which the person speaks.

Has not Mr. Edison, by means of ventriloquism, been testing the credulity, or rather faith, of those who have seen such wonders in Science that they are ready to believe the impossible if learned investigators and scientists should declare its truth?

C.

Liabilities Large—Assets Nothing.

Yesterday a strange man, carrying what appeared to be a small coffin, paused in front of the Oil Exchange. He was a sad-faced man, and his black suit glistened in the sunlight like an armor. He put down his strange burden, and bowed to the men standing around. Then casting his eyes up at the building, he began: "Gentlemen, I congratulate you. You have reared here a structure which is second to none in the country. When you shall have gone to that bourne from whence no traveler returns," and he glanced sorrowfully at the little coffin, "this beautiful building will remain a monument to your energy and enterprise. But, gentlemen, poor as I may seem, great as the contrast is between us, I have that in this little box before me," and he tapped the coffin reverently with his cane, "which I would not exchange for all the wealth of your oil regions. It is, gentlemen," and he began to unscrew the lid, while the crowd involuntarily shrank back, "it is, gentlemen, a rat-trap which I am introducing for Mr. Edison of Menlo Park." The crowd closed up again. "It is his latest invention, and, as he says himself, his best. I have handled a great many rat-traps in my life, and I can safely say that this one knocks the socks off of all of them. Don't crowd up too close till I show it to you," and he took off the top and exposed a box with a lot of apartments communicating with each other by little doors, windows, and openings of one kind and another. "The great inventor named this the 'Citizens' Savings Rat-Trap,' because it operates on the same principles as a savings bank. You see, the rat smells the cheese, and enters by the front door," and the trapman indicated the aperture with his cane; "thence in quest of the cheese, which is a sort of *ignis fatuus*, through this door, which admits him to parlor A, or the cashier's room. This door closes behind him, and he passes thence to parlor B, or the directors' room; this door closes behind him, as before, and he proceeds to parlor C, or the president's private apartment. By an ingenious arrangement, the closing of each little door removes the cheese into the next room, in this way always keeping it one room in advance of the rat that seeks it—until the last room is reached (parlor D), when it is swung noiselessly to the front apartment for the allurement of another victim. Once inside of a door, no rat can get out, but rats on the outside can get in, and do get in until the trap is full." "What's all that got to do with a savings bank?" asked a receiving teller who was in the crowd. "Everything, my dear friend, everything," replied the strange man; "because, you see, when the trap is full it closes—liabilities large; assets nothing."—*Oil City Derrick.*

DAYTON DEMOCRAT.

Office: Corner Fifth Street and Cana[l]

SATURDAY, MAY 11, 1878.

WASHINGTON NOTES.

Going to Gotham—Scenes on the Trip—The Lightning Bridge-Builder—"Tally Ho"—The Wizard of Menlo Park—Talking and Musical Clocks—Sextuplex Telegraph.

From an Occasional Correspondent of the Democrat.

WASHINGTON, May 9, 1878.

An eight hours' ride over the 250 miles between Washington and New York is no longer a matter of wonderment, but my late visit to the American Commercial Metropolis developed some incidents that may be of interest to the general reader. The first part of the journey is by the Baltimore & Potomac Railway, which tunnels out of Washington and then burrows under Baltimore, supplying a great need of the past and supplanting the old tin-horn cavalry that used to escort all railroad trains through the latter city. This enterprise was the achievement of Colonel Scott, who has proved himself a Napoleon amongst the railroad kings of the world. Passing beyond Philadelphia we strike the New Jersey extension of the Pennsylvania Central and see other proofs of the presence of the same master mind. The present railroad through New Jersey, via Trenton and Brunswick, is a vast improvement in structure, equipment and management, upon the old road of two years ago.

THE LIGHTNING BRIDGE-BUILDER.

It will be recollected how the railroad bridge over the Schuylkill in Philadelphia was destroyed by fire some two years ago, and the authorities of that city contracted with Colonel Scott to have it built within thirty days. With abundant resources of both mind and material he gave the orders, and two days before the expiration of the time the great bridge was completed. Last year the bridge over the Raritan, near Brunswick, N. J., was destroyed, and in sixty hours a substantial bridge of some two thousand feet was ready for the passage of trains. Within five months a new iron bridge has been built to take the place of the sixty-hour wooden structure. Give this man just half a chance, and he would bridge the continent with iron in three or four years, and add immeasurably to the wealth and prosperity of the whole country. The present outlook in Congress is that the chance will be given, and the great work of an open highway through the Southwest to the Pacific completed in the shortest possible time.

"TALLY HO!"

Returning from New York the other morning we caught a glimpse of the famous "Tally Ho" stage coach, its roof occupied by nine amateur whips of the great city on a twelve hours' trip to Philadelphia. They were bowling along at a nine-mile gait, but this looked like a snail's pace compared with our speed of forty miles to the hour. The sight reminded the writer of his first stage trip across New Jersey from Easton, Pennsylvania, to New York City, just fifty years ago. How we lumbered along over the rocky hill stand through the sand or mud, thinking four miles an hour good speed, and when the last stage of nine miles between Newark and Jersey City was made in an hour and a half it seemed next to a miracle. But the world moves, and the railroad has abolished the stage coach except in sparsely settled districts. It may be pleasant amusement for rich amateurs to revive the customs of the past; but this staging through New Jersey seems much like a fifty-year wedding, where there is an effort to kindle the flames of twenty in the dead ashes of four-score years.

THE CONJUROR OF MENLO PARK.

At the pleasant little village of Menlo Park, twenty four miles from New York, and directly on the New Jersey branch of the Pennsylvania Railroad, I stopped to spend an hour with one of the really great men of the age. Thomas A. Edison, whose name has already become a household word, has struck out in a new line of invention and discovery, and his present achievements are sufficient to give him immortality. If he had lived in the days of Galileo he would have been hanged or burnt as a wizard. But the old philosopher was right when he said, at the risk of threatened tortures, "Nevertheless, the world moves;" and the world has moved upward and onward in the career of intellectual achievement more since his time than all the ages before.

Mr. Edison is still a young man, modest and unassuming in manner, and courteous in deportment, with a pleasant face, with a good head filled with a brain as restless as the wind or the ocean's tides. I do not think he could live unless he was inventing something, or making some new discovery in the occult laws of nature. No sooner has he brought one invention

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or device to comparative perfection than he hands his highest energies of thought and study to achieve something else—something that might have been successful while improving the former effort.: While off on the new track, however, he does not forget the former work, but is constantly devising such

changes as will advance it towards perfection. The phonograph, or talking machine, was at first the conception of a great idea in a very crude state, and he has worked for its higher development until the new instrument has become a wonder of wonders to all who witness its operations. At first it only spoke in a kind of fantastic falsetto, somewhat difficult to hear; now it gives the volume, tone, inflection, emphasis and brogue, if any, of the voice which speaks through its mouthpiece.

At first this instrument was called a wonderful toy—literally and nothing more. But with the improvements being made, it promises to become one of the most valuable, practical and universally applicable inventions of the age. Connected with improved telephones by the same inventor, it will record messages hour-long distances over the wires, and these messages can reserved and heard to-him by bit one phonograph in his private house, and the other in his office containing them filed away for future reference.

TALKING AND MUSICAL CLOCKS.

The Phonograph and Telephone Company at 203 Broadway, New York, of which E. H. Johnson, Esq., is President, have in charge the manufacture and sale of these instruments. In a pleasant interview with Mr. Chower, one of the directors, he learned that they are got ing up an interesting clock with a phonographic attachment, which shall sing songs or utter words and sentences to suit the taste of the purchaser. This will leave the old-fashion clock quite in the shade, and give even the poor man a chance to have beautiful music in his cottage, warbled in the sweet voice of a Patti or a Nilsson. With such an attachment the Great Master and his twelve Apostles in the famous Strasburg clock might add the words of their faith to the usual hour of an empty parade. But the future possibilities of this marvelous [illegible] cannot be estimated now.

THE SEXTUPLEX TELEGRAPH.

The latest and most wonderful, if not the most practical of Mr. Edison's discoveries, is that of the sextuplex telegraph, by which six different messages are sent over the same wire at the same instant. Think for a moment of what railroads, electricity and Edison are bringing us to; then think of the millennium and be happy.

J. L. T.

Every Saturday, August 24, [illegible] [illegible] 18, 1878.

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MUSIC.

IMPROMPTU ON THE TELEPHONE.

Echo used to answer "where?"
In mountain glen or wood,
The prairie never heard its voice
Nor answered laid or good.
Reverberation came from shock
From violent explosion,
Unlike echo it never did mock
By atmospheric motion.
Now the cunning Edison
Has won reverberation,
And coaxes spirit that he has
His it cannot for preservation.
The thrilling tones of melody,
Our discords harshest sound,
In "safety phonograph deposit"
Alike are surely bound.—*Selah.*

THE PHONOGRAPH IN CHURCH.

Organs hereafter will probably be done away with in churches; we mean of course, except in a few instances, for example, that have got new ones, as it is found that by purchasing a large-sized phonograph, with a full stock of prepared tin-foil tunes, or tuneful tin-foils, which embrace a repertoire of the best music of the leading churches, together with the words, singers and organ can be dispensed with. The tones of the organ and music and words of the "*Te Deum*," "Mass" or Hymns, &c., are now readily re-produced and of a startling naturalness and also with sufficient loudness—owing to Prof. Edison's recent invention of the howlophone—to be heard in the most distant corner of a church and arouse the attention even of the deepest slumberer. It has recently been tried, as we learn, at a church in Hoboken, N. J., with eminently satisfactory results, and a company is already formed to furnish churches and other places, with phonographs giving the organ accompaniment and the voices of a quartette, soloists or chorus, either or all, combined or single, in fact, all the musical effects required. "The company (limited), have already pe-fected a number of tin-foil plates which have recorded on them the principal sacred solos, as the services of such singers as Kellogg, Thursby, Cary, Pappenheim, Remmertz, and many others, were engaged long ago to sing into the phonograph so that the demand for "I know that my Redeemer liveth," "On mighty Pens," "It is enough," "*Cujus Animam*," &c., could be supplied to churches *at all* and at once; also a list of pieces and the singers name opposite, so that purchasers can have a choice of singers as well as compositions. We expect soon to hear some of them in our Buffalo churches as the expense is small, not over a few hundred dollars, which will supply a phonograph and also a large number of pieces suited to every phase of the church musical service, and taste of music committees.

In the announcements hereafter given out by our enterprising leaders, organists and "directors." We expect to see something like the following: Next Sunday the "Inflammatus" will be produced as phonographed by Miss Thursby, especially for the church, with full chorus, as given by the choir of the "Old Zebra" of New York. Or, Sullivan's Grand "*Te Deum*" as sung at Crystal Palace, London, phonographed by the London Phonographic Company, and purchased for this church at [illegible] sheet. No more orchestras or pieces of one, in church.

The sad reflection forces itself on us, however, that these little uncomplaining tin foils, that never lose their temper, metalically speaking, and are never jealous of each other, and don't slip out of tune, or wear spring bonnets, &c., may drive out our choirs altogether, and "what will poor Robin do then?" And, horrible thought, perhaps a speaking phonograph may be put in the other end of the church, too, and only good sermons and sound reflections ground out—so to speak—to the assembled congregations. We look for farther and immediate developments in this line, and, we believe, that the great inventor will shortly "send a man" here to demonstrate that both ends of the average church can be better run phonographically, than as at present advised.

[illegible] 1878.

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Two Hours with Edison.

To the Editor of the Brooklyn Daily Times:

The following is an account of my visit to Mr. Edison's workshop, which, I hope, will be found acceptable to the readers of the Times, for whom it is written.

"Ticket to Menlo Park and return," I said, on entering the office at 6oot of Delaware street, at 2 P. M., last Wednesday.

"Seventy-eight, cents," said the man, "but answered, and in forty minutes I heard the call, "All out for Menlo Park!"

"Where is Mr. Edison's ?" I asked, and a well-behaved boy, fourteen years old, answered, "Up yonder; I work there;" and the boy and I moved forward, followed by those gentlemen who had gone up on the same train, and who, as I soon learned, did not need any guide. They were Mr. Blackman and two other of the principal officials from the office of the Union Telegraph Company, up there to look through and see how matters were progressing.

"Where does Mr. Edison live?" I said to my young guide.

"In that large house beside beyond the trees," said he, "and the shop is over there, on the west side."

"And how large a staff have you here?"

"Office and two dozen—fifty-five and boy—and every one busy as a bee."

"Are there any other bodies around here?" said I, referring to four or five substantial residences: "besides his own."

"The men that work for him."

"Does he employ many of them?"

"Sixteen regular and seven in the office-men and boys."

We had now reached the laboratory, so-called—two large wooden buildings, about thirty by forty feet, set of one side of which steam from the engine house was conducted.

Mr. Edison stood on one at the door, in a manner so frank, kind and cordial, that I would have known him anywhere, even if I had not seen his picture. I handed him a card, which he read, and, as my letter, which he read at a glance, and at the next moment was greeting me as an acquaintance of the Union office. I did not observe in Mr. Edison, either in his manner or appearance, anything that would have differed any from the description I had read of. He is thoroughly devoid of that [illegible] which characterizes the average inventor. He is a little thoughtful when not talking to you, but he is not one. But with this man, whose name and fame are known throughout the world, there is not a trace of self-consciousness. He is as unaffected as a child, clear and distinct, but not very loud; and this you must recollect of the man of whom I am writing. He knows the phonograph, however, and so did we, every one of us.

"I shall make it a point," I said, "to write and tell the folks this afternoon all about, how and better, and I shall tell them that I have seen and heard and shouted to the phonograph, and heard it shout back."

"Never, sir," said Mr. Edison, "never tell them that the talk this afternoon was heard, and that the shouting was heard, for I have been pestered to death with letters from people who have heard of it, and I have not time to answer them."

"I will make it a point to tell them that you have told me that you will not answer letters about it."

"Yes, sir," said Mr. Edison, "I will be much obliged to you if you will do so."

The instrument Mr. Edison had in position, and ready for operating upon, is only eight inches by four—consisting of screws, tin cylinder, made of brass, with steel mandrel, &c. Any one, I found, is to hold to be sound, or transmit the sound, proper to be recorded, and to reproduce it afterward.

The entire process is not short, as the reader may fancy, to-gether. Months of the genius, one sixty-fourth of the royal four sixty-fourths, or one-sixteenth of the whole.

Mr. Edison's laboratory is about three-quarters of the royal four sixty-fourths, or one-sixteenth of an hour's ride from the city.

Both the Times and its advertising agent cannot be spoilt four minutes' fast now, and I would direct the attention of the reader to the fact that the readers here, of every description, are not to be found in the office, but in the department itself; and yet the Times is the only paper that has the full and correct list of many words of the truth, and that up to the hour of going to press.

The Times has more than any one, than one-eighth of all local news, and nearly one-sixteenth of all the news of the world, and more than one-sixteenth of all the news of the world, and more than one-sixteenth of all the news of the world, and more than

"THE TELEPHONE."

FRIDAY.....May17.

Abor'ginals—The Wonderful Possibilities of Edison's Invention.

[*Yhe.A.Ellion in the North Amer.Re'w.*]

Of all the writer's inventions, none has commanded such profound and earnest attention throughout the civilized world as has the phonograph.—This fact is attributed largely to that peculiarity of the invention, which brings its possibilities within the range of the speculative imaginations of all thinking people, as well as to the almost universal applicability of the foundation principles, namely, the gathering up and retaining of sounds hitherto fugitive, and their reproduction at will.

From the very abundance of conjectural and prophetic opinions which have been disseminated by the press, the public is liable to become confused, and less accurately informed as to the immediate result and effects of the phonograph than if the invention had been one confined to certain specific applications, and therefore of less interest to the masses. The writer has no fault to find with this condition of the discussion of the merits and possibilities of his invention; for, indeed, the possibilities are so illimitable and the probabilities so numerous that he—though subject to the influences of familiar contact—is himself in a somewhat elastic condition of mind as to where to draw the dividing line. In point of fact, such line cannot with safety be defined in ordinary inventions at so early a stage in the development. In the case of an invention of the nature and scope of the phonograph, it is practically impossible to indicate it to-day, for to-morrow a trifle may extend it almost indefinitely.

There are, however, certain stages in the developing process which have thus far been actually reached; certain others which are clearly within reach; and others which, though they are in the light of to-day classed as impossible, may to-morrow become probable, and a little later actual achievements. * * *

If the reproduction of sound is to be made audible to an audience, considerable force is requisite in the original utterance; if for his individual use, only the ordinary conversational tone (even a whisper has been reproduced.) In both cases the original utterances are delivered directly in the mouth-piece of the instrument. An audible reproduction may, however, be had by speaking at the instrument from a distance of from two to three feet in a loud tone. The application of a flaring tube or funnel to collect the sound-waves and the construction of an especially delicate diaphragm and embossing point, &c., are the simple means which suggest themselves to effect this. The writer has not as yet given this stage of the development much attention, but sees no practical difficulty in gathering up and retaining a sectional part of the sound-waves diffused about the original source, within a radius of, say three feet, (sufficiently removed not to be annoying to a speaker or a singer.)

The stage of development reached by the several essential features of the phonograph demonstrates the following as *fully accomplish*:

1. The capacity of all manner of sound waves heretofore designated as "fugitive," and their permanent retention.

2. Their reproduction with all their original characteristics at will, without the presence or consent of the original source, and after the lapse of any period of time.

3 The transmission of such captive sounds through the ordinary channels of commercial intercourse and trade in unlimited form, for purposes of communication or as merchantable goods.

4. Indefinite multiplication and preservation of such sounds, without regard to the existence or non-existence of the original source.

5. The application of sounds, with or without the knowledge or consent of the source of their origin.

The probable application of these properties of the phonograph and the various branches of commercial and scientific industry presently indicated will require the exercise of more or less mechanical ingenuity. Conceding that the apparatus is practically perfected in so far as the faithful reproduction of sound is concerned, many of the following applications will be made the moment the new form of apparatus, which the writer is now about completing, is finished. These, then, might be classed as serviceable; but they so closely trench upon other applications which will immediately follow that it is impossible to separate them hence they are all enumerated under the head of probabilities, and each specially considered. Among the more important may be mentioned: *Letter-writing* and other forms of dictation books; phonographic music, family record; and such electrotype publications as books, musical boxes, toys, clock, advertising and signalling apparatus, speaking, &c., &c.

Letter Writing.—The apparatus now being perfected in mechanical details will be the standard phonograph, and may be used for all purposes, except such as require special form of matrix, such as toys, clocks, &c., for an indefinite repetition of the same thing. The main utility of the phonograph, however, being for the purposes of letter writing and other forms of dictation, the design is made with a view to its utility for that purpose.

The general principles of construction are a flat plate or disk, with spiral groove on the face, operated by clock work underneath the plate; the grooves are cut very closely together, so as to give a great total length to each disk of surface—a close calculation gives as the capacity of each sheet of foil, upon which the record is had, in the neighborhood of 40,000 words. The sheet being but ten inches square, the cost is so trifling that but 100 words might be put upon a single sheet economically. Still, it is problematical whether a less number of grooves per inch might not be the better plan—it certainly would for letters—but it is desirable to have but one class of machines throughout the world; and as very extended communications, if put upon one sheet could be transported more economically than upon two, it is important that each sheet be given as great capacity as possible. The writer has not yet decided this point, but will experiment with views of ascertaining the best mean for capacity.

The practical application of this form of phonograph for communications is very simple. A sheet of foil is placed in the phonograph, the clock-work set in motion, and the matter dictated into the mouthpiece without other effort than when dictating to a stenographer. It is then removed, placed in a suitable form of envelope, and sent through the ordinary channels to the correspondent for whom designed. He, placing it upon his phonograph starts his clock work and listens to what his correspondent has to say. Inasmuch as it gives the tone of voice of his correspondent, it is identified. As it may be filed away as other letters, and at any subsequent time reproduced, it is a perfect record. As two sheets of foil have been indented with the same facility as a single sheet, the "writer" may thus keep a duplicate of his communication. As the principal of a business house, the particular now dictate the important business communications to clerk to be written out, they are required to do no more by the phonographic method, and do thereby dispense with the clerk, and maintain perfect privacy in their communications.

The phonograph letters may be dictated at home, or in the office of a friend, the presence of a stenograph or not being required. The dictation may be as rapid as the thoughts can be formed, or the lips utter them.—The receiver may listen to his letters being read at a rate of from 150 to 200 words per minute, and at the same time busy himself about other matters. Interjections, explanations, emphasis, exclamations, &c., may be thrown into such letters, silhitime.

In the early days of the phonograph, as it has become universally adopted, a correspondent in Hong Kong may possibly not be supplied with an apparatus, thus necessitating a written letter of the old fashioned sort. In that case the writer would use his phonograph simply as a dictating machine, his clerk writing it out from the phonograph at leisure, causing as many words to be uttered at one time as his memory was capable of retaining until he had written them down. This clerk need not be a stenographer, nor need he have been present when the letter was dictated, &c.

The advantages of such an innovation upon the present, slow, tedious, and costly methods are too numerous, and too readily suggest themselves to warrant their enumeration, while there are no disadvantages which will not disappear coincident with the general introduction of the new method.

Dictation.—All kinds and manner of dictation will partake of the application of the mouth of the speaker to the mouthpiece of the phonograph may be as readily effected by the phonograph as in the case of letters. If the matter is for the printer, he would much prefer, in setting it up in type, to use his ears in lieu of his eyes. He has other use for them. It would be even valuable to compel witnesses in court to speak directly into the phonograph, in order to thus obtain an unimpeachable record of their testimony.

The increased delicacy of the phonograph, which is in the near future, will enlarge this field rapidly. It may then include all the sayings, of not only the witness, but the judge and the counsel. It will then also comprehend the utterances of public speakers. * * *

Books.—Books may be read by the charitably inclined professional reader, or by the readers especially employed for that purpose, and the record of such book read in the sayings of the blind, the sick chamber, or even with great profit and amusement by the lady or gentleman whose eyes and hands may be otherwise employed; or, again, because of the greater enjoyment to be had from a book when read by an elocutionist, than when read by the average reader. The ordinary record sheet, repeating this book from 60 to a 100 times as it will, would command a price that would pay the original reader well for the slightly increased difficulty in reading it aloud in the phonograph.

Educational Purposes.—As an elocutionary teacher, or as a primary teacher for children, it will certainly be invaluable. By it, difficult passages may be correctly rendered for the pupil but once, after which he has only to apply to his phonograph for instructions. The child may thus learn to spell, commit to memory a lesson or for it, &c.

Music.—The phonograph will undoubtedly be liberally devoted to music. A song sung on the phonograph is reproduced with marvellous accuracy and power. Thus a friend may in a morning call sing, as a song which shall delight an evening company, &c. As a musical teacher it will be used to enable one to master a new air, the child to tone its first songs, or to sing him to sleep.

Family Record.—For the purpose of preserving the sayings, the voices, and the last words of the dying member of the family—as of great men—the phonograph will unquestionably outrank the photograph. In the full multiplication of original matrices, and the indefinite repetition of one and the same thing, the successful electrotyping of the original record is an essential. As this is a problem easy of solution, it properly ranks among the probabilities. It comprehends a vast field. The principal application of the phonograph in this direction is in the production of

Phonographic Books.—A book of 40,000 words upon a single metal plate ten inches square thus becomes a strong probability. The advantages of such books over those printed, are too readily seen to need mention. Such books would be listened to where now none are read. They would preserve more than the mental characteristics of the brain of the author; and as a bequest for future generations, they would be unequalled. For preservation of languages they would be invaluable.

Clocks.—The phonograph clock will tell you the hour of the day, call you to lunch, send your lover home at 10, &c.

Speech and other Utterances.—It will henceforth be possible to preserve for future generations the voices as well as the words of our Washingtons, our Lincolns, our Gladstones, &c., and to have them give us their "greatest efforts" in every town and hamlet in the country upon our holidays.

Lastly, and in quite another direction, the phonograph will perfect the telephone and revolutionize present systems of telegraphy. That useful invention is now restricted in its field of operation by reason of the fact, that it is a means of communication which leaves no record of its transactions, thus restricting its use to simple conversational chit-chat, and such unimportant details of business as are not considered of sufficient importance to record. Were this different, and our telephone conversation automatically recorded, we should find the reverse of the present status of the telephone. It would be expressly resorted to as a means of perfect record.

"How can this application be made? will probably be asked by those unfamiliar with either the telephone or phonograph.

Both these inventions cause a plate or disk to vibrate, and thus produce sound waves in harmony with those of the voice of the speaker. A very simple device may be made by which the one vibrating disk may be made to do duty for both the telephone and the phonograph, thus enabling the speaker to simultaneously transmit and record his message. What system of telegraphy can approach this? A similar combination at the distant end of the wire, enables the correspondent, if he is present, to hear it while it is being recorded. Thus we have a mere passage of words for the action, but a complete and durable record of these words as the result of that action.—Can economy of time or money go further than to annihilate time and space and bottle up for posterity the mere utterance of man, without other effort on his part than to speak the words?

In order to make this adaptation, it is only requisite that the phonograph shall be made slightly more sensitive in record, and the telephone very slightly increased in the vibrating force of its receiver, and it is accomplished. Indeed, the "Carbon Telephone," invented and perfected by the writer, will already well nigh effect the record on the phonograph: and as he is constantly improving upon it, to cause a more decided vibration of the plate of the receiver, this addition to the telephone may be looked for coincident with the other practical applications of the phonograph, and with almost equal certainty.

The telegraph company of the future—and that no distant one—will be simply an organization having a huge system of wires, central and sub central stations managed by skilled attendants, whose sole duty it will be to keep wires in proper repair, and give, by switch or alarm arrangement, proper attention to subscriber No. 223 in New York when he signals his desire to have private communication with subscriber No. 1001 in Boston for three minutes. The minor and totally inconsequent details which seem to arise as obstacles in the eyes of the groove traveling telegraph man, wedded to existing methods, will wholly disappear before that tremendous Juggernaut, "the needs of man;" for will not the necessities of man surmount trifles in order to reap the full benefit of an invention which practically brings him face to face with whom he will, and, better still, doing the work of a conscientious and infallible scribe?

THOMAS A. EDISON.

Mr. Edison has patented an arrangement which it is found to supersede the screw-machine in time. Screws are manufactured in great number and with great rapidity, and the machine is also said to be cleaner and more exact. The editor is the most noted of Mr. Edison's inventions. It saw action, as great.—*Cincinnati Times.*

6e année. — N° 17. L'ARCHITECTE ET LA CONSTRUCTION PRATIQUE RÉUNIS Samedi 27 Avril 1878.

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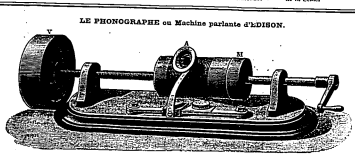
LE PHONOGRAPHE ou Machine parlante d'EDISON.



Dessin au sixième de l'exécution (Voir page 128).

CHRONIQUE

LE LIVRE D'OR DES ENTREPRENEURS.

Permettez-moi, chers lecteurs, et comme préambule, de vous donner connaissance des documents ci-après :

Les ministres des travaux publics,

Vu le paragraphe 2 de l'article 39 du règlement de comptabilité du 18 décembre 1877 contenant les dispositions suivantes :

« Les adjudications publiques relatives à des fournitures, à des travaux, à des exploitations ou fabrications qui ne peuvent être livrées sans inconvénient à une concurrence illimitée, sont soumises à des restrictions qui n'admettent à concourir que des personnes reconnues capables par l'administration et produisant des garanties exigées par les cahiers des charges. »

Considérant qu'il est de l'intérêt commun de l'Etat et des entrepreneurs que le choix des concurrents à admettre aux adjudications restreintes définies ci-dessus, soit entouré de toutes les garanties désirables ;

Arrêtent :

Art. 1er. — Il est institué une commission chargée d'examiner l'honorabilité, la solvabilité et la capacité des entrepreneurs qui se présenteront pour prendre part aux adjudications restreintes, du service des bâtiments civils et des palais nationaux.

Art. 2. — Cette commission est composée :

Du secrétaire général du ministère des travaux publics, président ;

Du directeur des bâtiments civils et des palais nationaux, vice-président ;

D'un délégué du tribunal de commerce ;

D'un délégué de la Banque de France ;

D'un délégué de la préfecture de police ;

D'un délégué de la préfecture de la Seine ;

D'un inspecteur général des ponts-et-chaussées ou d'un ingénieur en chef ;

D'un inspecteur général ou d'un architecte des bâtiments civils et des palais nationaux.

Les deux contrôleurs principaux attachés à la direction des bâtiments civils et palais nationaux remplissent les fonctions de secrétaires de cette commission, avec voix consultative.

Art. 3. — Cette commission dressera, dans la deuxième quinzaine du mois de mars, juin, septembre et décembre, la liste des entrepreneurs admis à prendre part aux adjudications pendant le trimestre suivant.

Les entrepreneurs qui désireront être admis seront tenus d'en faire la demande dans la première quinzaine des mois ci-dessus indiqués, en joignant à leur demande le certificat exigés par l'article 3 du cahier des charges générales.

Les entrepreneurs seront informés de la décision intervenue sur leur demande ; ceux dont le concours n'aura pas été accepté, pourront retirer immédiatement leurs certificats.

Art. 4. — Les dispositions du cahier des charges générales qui pourraient être contraires au présent arrêté, seront considérées comme de nul effet.

Versailles, le 9 avril 1878.

C. de Freycinet.

Ce qui précède ne nous prouve-t-il pas, dans une certaine mesure, qu'à la suite des abus qui se sont produits et se produisent encore journellement, il est devenu nécessaire pour tous, d'être à l'avenir renseigné sur le plus ou moins de capacité et d'honorabilité des entrepreneurs que nous sommes appelés à occuper, et que, lorsque le conseil de la Société nationale des architectes de France a, pour son usage personnel et celui de tous les membres de la Société, jugé opportune la création d'un livre d'or des entrepreneurs, il avait frappé juste.

Est-ce que ce que vise en grand l'arrêté précité n'est pas, dans une mesure plus modeste, aussi complètement utile.

Lorsqu'il y a trois mois, le conseil de la Société nationale des architectes approuvait la création du livre d'or des entrepreneurs, dont le but est tout autre retracé dans l'arrêté ministériel du 9 avril, n'allait-il double vue et pensait-il qu'en haut lieu on s'occupait d'établir les bases d'une commission d'enquête devant arriver au même résultat que celui qu'il se proposait d'obtenir.

Et cependant, un journal spécial, des plus sérieux même, tournait presque en ridicule, avec beaucoup d'esprit, je dois le reconnaître, la décision du conseil de la Société nationale et demandait même, s'il lui restait mémoire, comment la Société s'en tirerait si un entrepreneur se sachant inscrit commettait sur son livre d'or, venait attaquer la Société comme nuisant à son honneur et à sa considération.

Est-ce que ce n'est pas de bonne guerre? Comment, lorsqu'on n'est plus reçu aujourd'hui dans n'importe quelle société ou corporation sans un extrait du casier judiciaire, alors que société ou corporation s'engage cependant à bien peu, vous trouvez mauvais que, lorsqu'il s'agit de confier à un entrepreneur inconnu, des travaux importants et dont la plus ou moins bonne exécution peut entraîner la ruine de celui qui fait exécuter, on ne s'entoure pas de toutes les garanties morales, on ne recueille pas tous les renseignements commerciaux possibles. Alions donc ! C'est inadmissible.

Il devient, au contraire, en présence des rabais insensés, et disons-le, malhonnêtes qui se font aujourd'hui, et grâce auxquels des entrepreneurs inconnus et insolvables obtiennent des affaires qu'ils n'arrivent pas à terminer, de prendre au préalable toutes les entreprenons toutes les mesures que prescrivent la conscience et la dignité. Et lorsque, pour y arriver, ceci dans un cercle plus restreint, on n'a pas le pouvoir de promulguer d'un arrêté comme celui du 9 avril, il faut bien se défendre comme on peut, et, à défaut de commission d'enquête, se constituer un livre de renseignements.

J'attends la démonstration du contraire.

Léon Dumbeuil.

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de la part de M. Sabine.

CORRESPONDANCE.

Lettre de M. Reneau, informant le Conseil qu'étant juré en ce moment, il ne peut assister à la séance.

Lettre de M. Chasseriau, architecte à Alger, donnant officiellement sa démission de membre titulaire. Le Conseil accepte provisoirement cette démission qu'il soumettra à la prochaine assemblée générale en même temps qu'il la priera, sur la demande d'un membre approuvée à la majorité, de vouloir bien nommer M. Chasseriau membre honoraire.

Lettre de M. Jules Poitrinal, architecte à Provins (Seine-et-Marne), faisant acte d'adhésion à la Société. — Renvoi à M. le trésorier pour la suite. — Les titres de M. Poitrinal sont les suivants : Ex-sous-inspecteur des travaux de restauration de l'église de Saint-Quiriace, de Provins ; architecte dans cette ville depuis douze ans ; constructions importantes et diverses.

Lettre de M. Planat, ingénieur, adressant au Conseil plusieurs exemplaires d'une pétition à adresser à M. le commissaire général de l'Exposition en vue d'obtenir des cartes d'abonnement temporaire de quinze jours ou d'un mois, permettant l'entrée aux heures d'études. — Le Conseil remercie M. Planat ; mais il prie M. le président de l'informer que nous avons déjà adressé une demande analogue à M. le sénateur Krantz.

Acte est donné :

1° A la chambre syndicale des fabricants d'enseignes et stores, du dépôt sur le bureau du Conseil, de son tarif pour les années 1877 et 1878 ;

2° A MM. Jammet et Flamant, du don qu'ils ont à la Société du 1er fascicule de la série

M. Jammet offre sa démission de secrétaire général, basée sur de nombreuses occupations qui lui rendent impossible l'accomplissement de ces fonctions. — Le Conseil décide que cette démission sera examinée à la prochaine séance.

M. le secrétaire-général donne lecture au Conseil du rapport à présenter à la prochaine assemblée générale. — Le Conseil approuve.

La séance est levée à 4 heures 1/2.

AVIS.

Le Conseil de la Société nationale des architectes de France informe les sociétaires qu'on peut prendre connaissance, au bureau de M. Triboulet, trésorier-archiviste, 4, quai du Marché-Neuf, tous les jours de 11 heures à 2 heures, du programme officiel du Concours pour l'église Saint-Vincent-de-Xaintes.

Le Secrétaire du Conseil,
G. LEFÈVRE.

1re SECTION

ARCHITECTURE, — ARCHÉOLOGIE

Messieurs et honorés confrères,

Me continuant une confiance qui m'est précieuse, vous avez bien voulu me charger de la suite de l'étude de l'œuvre en cours de publication, due à la plume savante de notre collègue, M. Ern. Bosc (1).

Permettez-moi de vous le dire tout d'abord, cet ouvrage, qui a fait grand bruit dans la presse, non pas de moi, mais bien du grand académicien et professeur dont je vous citais le nom tout à l'heure.

Le 8e fascicule, le dernier paru, et qui sera prochainement suivi du 9e, continue la description du mot *étrusque* (art) et se termine au mot *fouille*. S'il fallait citer tous les mots remarquables contenus dans ce fascicule, ce n'est plus un extrait, c'est une copie *in extenso* de la nomenclature de ces mots qu'il faudrait faire ici. Toutefois, je vous indiquerai le mot *façade* dont la description, appuyée de bois et de gravures en noir et en chromo, est vraiment hors ligne ; le mot *faune*, très-savamment décrit et appuyé de dessins très-bien appropriés ; les mots *fenêtre*, *fer*, *ferme*, *flore*, *fontaines*, forum, fosse d'aisance, etc., très-complets tant au point de vue de l'art pur qu'à celui peut-être moins élevé, mais à coup sûr souvent plus utile, de la construction et de la pratique.

Ce qui distingue l'œuvre de M. Bosc de tous les dictionnaires qui l'ont précédé, dit M. Ch. Blanc, c'est que, bien qu'écrit pour les architectes et ceux qui savent, il n'est pas comme ceux qui l'ont précédé, hérissé de termes techniques qui semblent faits *pour dégoûter de l'étude de l'architecture ceux qui auraient voulu s'instruire*. En effet, tout dans ce dictionnaire : texte et dessin, est tellement clair, précis en même temps que bien équilibré par une méthode appuyée autant sur la science que sur la pratique, que chacun, architecte avant su et ayant pu oublier, élève encore à l'école, praticien et même homme du monde, tous comprennent et sont intéressés.

Une chose, Messieurs et confrères, que je crois être le premier à signaler, est la partie *légale* ou *juridique* du livre de notre savant collègue ; la Société nationale a, il y a quelques mois déjà, émis l'idée de publier un recueil des lois et usages du bâtiment applicables pour toute la France. M. Ern. Bosc a eu la même idée que nous et l'a mise à exécution dans son dictionnaire ; en effet, aux mots principaux, il nous donne la nomenclature complète des lois, arrêtés et ordonnances qui

(1) *Dictionnaire raisonné d'architecture et des sciences et arts qui s'y rattacheront*, par M. Ern. Bosc, membre honoraire de la Société nationale, membre de la Société centrale, etc., etc. Paris, Fidot, 1877-1878, grand in-8 illustré de nombreuses gravures dans le texte et hors [illegible]

(1) *L'Architecte* (année 1877, nos 49 et suivants).

LE PHONOGRAPHE D'EDISON

Après le téléphone le Phonographe !

Qu'est-ce que le Phonographe ?

C'est un merveilleux instrument qui enregistre et emmagasine la parole et la reproduit au bout d'un temps plus ou moins long. Une heure ou une année ! Il a été présenté à l'Académie des sciences, il y a huit jours environ, par ses inventeurs MM. Edison, Depretz et Napoli.

Les expériences qui ont été faites séance tenante n'ont fait que constater l'entière vérité de nos assertions et il a fonctionné à la satisfaction et aussi, devons-nous le dire, à l'étonnement général.

Voici du reste la description sommaire de cet instrument dont nous donnons également un dessin (1).

(1) L'article qui suit, ainsi que le dessin, sont extraits du journal *La Nature* et ont été mis obligeamment à notre disposition, par M. G. Tissandier, directeur de ce journal. Chez Masson, éditeur, boulevard St-Germain, au coin de la rue de l'Eperon.

Cet instrument extraordinaire, réalisé en Amérique et annoncé par les journaux, vient de passer l'Atlantique et d'arriver à Paris. Un exemplaire de cet appareil apporté par M. Puskas, concessionnaire des brevets Européens de l'inventeur, a été présenté, le lundi 11 mars, à l'Académie des sciences, et le vendredi 15 à la Société française de physique.

Le Phonographe remplit une double fonction ; son nom n'indique que la première ; il écrit les sons, ceux de la voix ou ceux rendus par un instrument quelconque, voilà la moitié ; il est capable de les reproduire après et d'en donner comme le portrait, voilà l'autre moitié. L'enregistrement des sons avait déjà été obtenu d'une autre façon, notamment dans le phonautographe de Scott et Kœnig, dont la description se trouve dans tous les traités de physique récents.

Mais la reproduction des sons au moyen de la trace qu'ils ont laissée dans l'enregistreur..., elle a été rêvée, cherchée, essayée par plusieurs ; elle n'a jamais été réalisée avant M. Edison.

L'appareil que nous avons vu est représenté par la figure ci-jointe ; il est d'une simplicité qui ne pourra pas être dépassée et qu'à certains égards même on sera obligé d'abandonner pour obtenir plus de perfection dans le rendu. Il présente une membrane toute semblable à celle des téléphones, tenue par sa circonférence dans une bague métallique A (voir fig.). Cette membrane porte, fixé à la surface inférieure, un petit style métallique placé perpendiculairement à son plan très-rigide. C'est devant cette membrane qu'on parle et c'est le style qui écrit les vibrations de la membrane.

L'enregistrement se fait sur un cylindre métallique M qu'on meut au moyen d'une manivelle, l'axe du cylindre est taillé en vis, ou, en terme technique, taraudé, et l'un de ses collets ou supports fontionne comme écrou ; de telle sorte que, quand on tourne la manivelle, le cylindre non-seulement tourne, mais encore progresse. La surface du cylindre présente elle-même un pas de vis de même hauteur que l'axe ; si bien que le point du style, pendant le mouvement du cylindre, se trouve continuellement dans la rainure pratiquée à sa surface.

Quand on veut employer l'instrument, il faut commencer par placer sur le cylindre un papier d'étain, pareil à celui avec lequel on enveloppe le chocolat ; on colle ce papier métallique avec une colle ordinaire suivant une des génératrices du cylindre, afin de l'envelopper complètement ; avec les mains on appuie de manière à faire pénétrer le papier dans la rainure qu'on voit se dessiner au travers de l'étain. On amène alors la membrane dans sa position d'action, on l'assujettit solidement au moyen d'une vis de serrage, le style appuyant légèrement sur le fond du canal hélyçoïdal présenté par le papier. On parle et en même temps on tourne le cylindre ; la membrane vibre, et le style fait dans le papier d'étain une série de marques plus ou moins profondes et de formes variées qu'un puissant microscope permettrait seul d'étudier.

Voilà l'inscription, c'est-à-dire la première partie de l'invention d'Edison ; voilà ce qu'on avait fait avant lui et voilà ce qu'on avait fait mieux que lui, quand on se proposait simplement d'écrire les vibrations pour en étudier les formes. Mais ce mode d'inscription a été l'idée de génie et, comme l'a fort bien dit M. Marcel Deprez à la Société de physique, l'emploi de ce papier d'étain a rendu possible la reproduction des sons, qui avait été cherchée en vain par d'habiles et savants expérimentateurs.

Voici comment on procède pour tirer de l'instrument, ainsi préparé, les sons qu'on lui a dits ou plus exactement criés à l'oreille :

On écarte la membrane, on fait tourner le cylindre en sens inverse jusqu'à ce qu'il soit ramené de la position qu'il occupait au début de l'expérience ; on rapproche la membrane et le style se retrouve au contract du papier d'étain. On tourne de nouveau et dans le même sens que la première fois. La membrane poussée par le style qui est lui-même guidé par les marques ou cavités antérieurement produites, la membrane, disons-nous, vibre et reproduit les sons qui avaient déterminé l'inscription. Ces sons amplifiés par une sorte de porte-voix placé contre l'anneau A, contenant la membrane, peuvent être entendus à distance.

On ne peut se rendre compte, sans l'avoir entendu, de l'impression singulière que cause cette petite voix grêle sortant de l'instrument ; jusqu'au dernier moment on doute et, quand les sons distincts, quoique faibles, viennent frapper l'oreille, on éprouve un étonnement et une satisfaction qui se sont traduits à la Société de physique en applaudissements et en rires des personnes qui remplissaient la salle.

Insistons sur les particularités de cet instrument, grâce auxquelles il réalise ce qu'il

était si difficile de produire. Le papier d'étain est comme suspendu au-dessus du vide formé par le pas de vis tracé sur le cylindre ; il présente une certaine rigidité à cause de sa tension, mais, comme il n'est pas soutenu par derrière, il présente en même temps une certaine flexibilité. Grâce à ces propriétés, la feuille d'étain est capable, d'abord, de recevoir les impressions qu'y fait le style inscripteur, et ensuite de les rendre à la membrane quand on fait passer une seconde fois le style devant la feuille écrite. Le papier d'étain n'est pas encore, pensait-il, ce qu'il y a de mieux pour cet usage ; M. Edison emploie maintenant des feuilles de cuivre, sans doute de cuivre rouge, très-minces et qui donnent les meilleurs résultats.

Nous avons supposé implicitement dans ce qui précède que la rotation du cylindre était uniforme; mais il est clair que le mouvement donné directement par la manivelle ne peut pas être parfaitement régulier. Pour atténuer ce défaut, on a mis à la seconde extrémité de l'axe un lourd volant V, montré sur notre figure, qui, dans une certaine mesure, corrige les diverses variations de vitesse produites par l'action de la main. Il est facile de comprendre des appareils d'horlogerie, grâce auxquels on obtiendrait un mouvement uniforme ; c'est un point sur lequel il n'y a pas à insister.

Quand il s'agit de reproduire des paroles articulées par la voix humaine, les inégalités de vitesse sont de peu de conséquence ; le son monte ou baisse légèrement, selon que le cylindre se hâte ou se ralentit. Mais quand on reproduit des sons musicaux, le défaut est plus sensible. On [illegible]

do, sur le cylindre, on le rendra juste, à la condition qu'on tourne tout à fait régulièrement, et pendant l'inscription et pendant la reproduction du son ; mais pour peu que la vitesse n'ait pas été uniforme l'une des deux fois, l'accord n'est pas juste.

On peut noter ici en passant que, avec le téléphone les sons musicaux sont plus aisément rendus que les articulations de la voix ; aussi que avec le phonographe, tel que nous l'avons entendu, c'est l'inverse.

Mais l'avons dit et nous ne pouvons que le répéter ; ces petites imperfections de détail seront corrigées par des appareils donnant un mouvement très-régulier. D'autre part, M. Edison a récemment annoncé à Europe qu'il était arrivé à reproduire exactement le timbre de la voix humaine. Ce serait une nouvelle merveille ou plutôt un parachèvement d'une merveille mécanique ; mais dès à présent on ne saurait trop admirer le résultat obtenu et la simplicité extraordinaire des moyens mis en œuvre pour l'obtenir.

Parmi les perfectionnements qui ont été déjà réalisés, disait-il, par M. Edison, nous en indiquerons un seul. Dans de nouveaux appareils, le papier d'étain ne place non plus sur un cylindre, mais sur une plaque dans laquelle on a tracé une rainure qui a la forme d'une spirale d'Archimède, ou, pour parler le langage vulgaire, la forme d'un limaçon ; le mouvement de cette plaque est combiné de manière que le style porté par la membrane trace ses inscriptions dans la rainure de la spirale. Cette disposition est certainement plus compliquée que celle qui a été montrée à Paris ; mais elle permet de placer plus aisément et plus promptement la feuille d'étain et surtout elle permet, la feuille une fois écrite, de la placer sur un autre appareil qui fera la reproduction ; ce second appareil pourrait être dans une autre ville du monde que le premier.

C'est dans ces conditions qu'il sera possible à la Société française de physique d'entendre une communication verbale de M. Edison, communication qui aura été confiée à l'étain quinze jours auparavant et qui aura passé l'Atlantique dans une enveloppe de lettre. Cette chose extraordinaire n'a pas encore été réalisée, mais elle le sera certainement pour peu que M. Edison veuille continuer de suivre la voie dans laquelle il est entré si brillamment.

Ajoutons en terminant que le phonographe peut être combiné avec le téléphone, et sans parler de ce qui pourra être fait, disons que des expériences ont été exécutées cette semaine à Bruxelles dans lesquelles la membrane du phonographe était mise, au moment de la reproduction, en présence d'un aimant de téléphone. Les vibrations produites dans la membrane par le style, commandé par la feuille d'étain préalablement écrite, déterminaient des courants d'induction téléphonique dans le fil qui entourait l'aimant et se trouvaient reproduites dans un téléphone récepteur placé à distance.

Bien d'autres expériences de cet ordre sont possibles, mais ce n'est pas ici le lieu de laisser courir notre imagination. Contentons-nous d'avoir fait connaître des choses que les gens les plus autorisés regardaient comme irréalisables, il y a peu de temps encore. Sachons nous étonner, sachons jouir de la surprise et envoyons tous nos compliments admiratifs à l'heureux et persé-

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Nous avons supposé implicitement que, qui précède que la rotation du cylindre uniforme; mais il est clair que le mouvement communiqué directement par la manivelle ne peut être parfaitement régulier. Pour atténuer ce défaut, on a mis à la seconde extrémité de l'arbre portant le fourreau V, monté sur [illegible] une certaine masse [illegible] de rivets [illegible] Il est

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tre part, M. Edison a récemment [illegible]
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Baillie, Captain William, 45, Norfolk-square, Hyde-park, W., and Dunsmore, Gravesend.
Lean, George, 19, Gloucester-place, W.
Mackay, Alexander, 3, Bolt-court, Fleet-street, E.C.
Mottram, Henry Wilton, F.R.G.S., Guernsey-lodge, West-end, Hilburn, N.W.
Smithers, Theodore, F.L.S., J.P., Beckwood, Nantwich, Cheshire.
Thornhill, John B., Bradford, Manchester.

The following candidates were balloted for and duly elected members of the Society:—

Addy, Jas., Peterborough.
Hiscock, Charles Henry, 19, Alexandra-road, Southport, Lancashire.
Hurlstone, George Thomas, Lord Chamberlain's office, St. James's Palace, S.W.
Jones, William Henry, 126, Mottram-road, Stalybridge.
Lowe, Col. Army Clothing Department, Pimlico, S.W.
Morton, Emile H., 56a, Piccadilly, W.
Remmington, Sir James, Barrow-in-Furness, Lancashire.
Styles, Thomas H., Cringle-house, Cheadle, near Manchester.
Wilkinson, M. A. Bazeo, M.D., F.R.C.P., Greenhays, Manchester.

The paper read was—

THE PHONOGRAPH.

By W. H. Preece.

The science of acoustics has taken most marvellous strides within the last few months. We have already had in this room a description of the telephone itself. We have, in addition to that, another instrument that has created a great deal of sensation, and which I shall have the pleasure of bringing before you to-night. But besides the telephone and the phonograph, there are other wonders in store. Thorpe's an instrument—which has not yet come from the other side of the Atlantic—called the seraphone. The seraphone is an instrument that combines the violin to be heard at a distance of four miles. On the other hand, we have within the last few days produced in England an instrument that will be brought before the Royal Society, the microscope again, which enabled the microphone. The microphone is an instrument which sets towards the ear as the microscope does to the eye. It will render evident to us sounds that are otherwise absolutely inaudible. We have heard myself the tramp of a little fly across a box with a tread almost as loud as that of a horse across a wooden bridge. There was a remarkable sound that accompanied the tramp of Mr. Fly, and a facetious friend of mine told me he thought the noise was occasioned by the weighing of the proboscis of the fly. Between the microphone on the one side and the seraphone on the other, we have accomplished a middle position, the instrument I have to bring before you to-night. All these instruments depend upon the operation of that marvellous agent, the electric current, which we call sensitive. If I ring a bell, blow a musical instrument, or strike anything, what is it that has happened, which passing from me to everybody's ear in this room has produced that all anxious to say the phonograph is operating, but I think it is just as well to make you acquainted shortly with the principles on which the phonograph works, for then you comprehend the principles, you will, to an infinitely greater extent, admire the instrument itself. So let us ask ourselves, what is this thing which we call sound? Sound of any kind is reducible, to motion. The motion of matter is necessary and essential for the production of sound, and the motion of the air, the air that surrounds us and which we breathe, that bathes everybody in this room, is essential for the production of that operation which is now taking place in my throat. I am rather sorry to find that it is still daylight to a certain extent, but I am in hopes if the gas is put down I shall be able to give you a little notion of what sonorous vibration is.

Our notion of waves is derived from what we see upon the water; we see there a motion of smooth and descent, accompanied by a motion of translation, but in this room, although at the present moment, while I am speaking to you the air is chased and engraved in the most exquisite manner by the undulations I am imparting to it, all this is invisible to us, and it must so remain. All that we can do is to give you a faint conception of how this air acts. If you could see a tube of air, for instance, coming from my mouth to any one of your ears, then that tube of air, by every sound that is uttered, is thrown into vibration. But it is not a vibration of secret and concealed like the waves of the ocean, but it is an excursion to and fro, and between me and the end of the room, for every sound I utter there is in every particle of air an excursion to and fro. Now, notice or sounds vary in three particular ways.

In the first place, we have the pitch of a note. The pitch of a note is that which determines whether it shall be A, B, or C, or any other note of music; and the pitch of a note is due to the number of vibrations that are made per second, or, in other words, the length of the wave. So that the first property connected with notes is that of their pitch, and their pitch depends upon the length of the sonorous wave.

The second property of sound is that of loudness. I can speak to you softly, I can speak to you aloud, you can hear the note of a piano gently played, you can press the pedal, and you can hear it loudly played. You can produce sounds that vary in intensity between great extremes, and the sonorous wave sound is greater than another is, that the amplitude of the excursions of particles of air are greater in one case than in the other; in other words, their velocity being different from the velocity of the ear with greater force. In the same way, if you take a common smooth-bore gun a few feet, and you take an Armstrong gun, which differs the ball with a velocity of 1,500 feet, in the one case you have the ball making an indentation, in a metal shield, while in the other case you have the ball went right through the shield. So when you utter sounds softly, the tympanum of the ear is struck gently; and when you utter sounds loudly, the ear is struck with greater force. The loudness of sound is dependent upon the amplitude to and fro of the particles of air.

But there is a third property of sound, which is distinguishes one voice from another, that distinguishes the note C on the violin from the same note on the piano; the cause of the difference between the sound of the drum and a cornet, and all the difference that occur between various sounds. All these differences are solely dependent upon the form in which the waves take their excursion to and fro. They may jerk to and fro, they may move gently forward and back again, with a high velocity or a low velocity, and as they may vary their mode of excursion to and fro in innumerable most and produce various shades of intonation and articulation. So that we have, first of all, the pitch of a note which depends on the length of the wave; secondly, the loudness of a note, which depends on the amplitude of the excursion; and, thirdly, the quality of a note, which depends upon the form of the wave.

I will endeavour to give you an idea of what a sonorous wave is. On the screen you will see a little spot of light. I am not sure that the light is visible to the whole of the room, but that little spot of light is supposed to represent a particle of air now in a state of quiescence in some part of this room. If we move the slide up and down, you will see it takes a motion backward and forward, which represents very roughly the movement to and fro of the particles of air between me and the end of the room. The next slide shows a portion of the suppositious tube of air, including several of these particles, and in this I have endeavoured to illustrate to you what takes place to form a wave. A wave means a succession of lines of compression and of rarefaction. Since there is no up and down movement like the waves of the sea, but there is an excursion to and fro, which excursion results in a series of compressions and rarefactions. Now, if we move that slide up and down, you will see passing over it a series of waves, and the waves are simply a series of condensations and rarefactions. They are very regular, and after a moment I should be very sorry indeed for anybody to imagine that what you see on the screen is an actual representation of what takes place in nature. Nature is far more beautiful, but in order to make an attempt to illustrate her laws, we have nothing but what is crude and rough. It is, however, an attempt to bring before you what is taking place in this room. That shows what takes place in air, but between my mouth and my ear in this room. But there are millions upon millions of particles going through the same operations of condensation and rarefaction, which you see. When the mind attempts to fix itself upon what takes place in this air, when you endeavour to picture what is going on in nature, you become lost in the effort.

I am now going to show you how matter itself vibrates when you put it in a line of these moving particles. Here is another rough attempt to show you what really occurs, but this is not an effort to endeave you to exercise your imagination, but to show you actually what takes place when one species of matter is struck. Now, Mr. Strah has in front of him an India-rubber diaphragm, upon which is placed a mirror, and this mirror will reflect upon the screen a spot of light. You will see that, as no sounds a note, the diaphragm vibrates, giving evidence of its vibration by the motion of the spot of light. If while he sounds the note, he moves backwards and forwards, the spot of light is thrown across the screen, and you first there is an illustration of what I told you, that the note is simply dependent upon the number of vibrations per second; for, if he sounds a low note and then a high note, the difference in vibrations will be apparent to you.

I do not know whether those experiments were sufficient to illustrate to you two facts—first, that sound is produced by the vibration of the particles of air; and, secondly, that objects placed in those paths of vibrating air can themselves be vibrated. It is said that Lablache could sound a note so loud and strong that he could crack a tumbler; and in the Midland Counties there is a sergeant-major of a volunteer corps who is often brought into the room after mess to crack a tumbler in this way. So far as regards the production of sound.

Now, one or two words about the transmission of sound, before we come to the phonograph, which, doubtless, you are all anxious to see. The transmission of sound is twofold: we can have the mechanical transmission, and we can have the transmission by electrical means. In the earliest days of civilization, the ancient Greeks acquired the art of transmitting sound, and there were actors who addressed the audience through speaking-trumpets. With these they managed to put down t. e stage, directing their speeches by this means to the furthest end of the theatre. I do not think in the present day we could stand Mr. Henry Irving reciting "To be, or not to be," through speaking trumpet.

Amongst the proposals to transmit sound, there is one very interesting record of that marvellous old man, Roger Bacon, who some 300 years ago, Mr. Robert Hook, and invented what we know now as the tay telephone. He found that sounds could be transmitted round corners, and to a distance of a hundred yards, by means of stretched cord and wire. Whenever, within our memory, produced his telephone, which succeeded in transmitting from the lower to the upper regions—from the cellars of the house to the garrets—the gentle murmur of voices. Wheatstone, within our memory, produced his telephone, which succeeded in transmitting from the lower to the upper regions—from the cellars of a house to the garrets—the gentle murmur of voices. Wheatstone, within our memory, produced his acoustic telegraph, by means of stretched cord and wire

side of the Atlantic had made, and when I went there I fully expected I should have the pleasure of exposing the telephone. I had not been there long before I met Professor Bell. I saw his telephone, and I became a convert. I say mention that it was my special pleasure to be the first person to bring this instrument to England; I exhibited it at the meeting of the British Association at Plymouth, and gradually the fact has dawned upon every one, that it is possible to convey the human voice from one spot to another. Well, others have worked in this field. Edison has worked in the footsteps of Professor Bell, and as the outcome of it, he has produced the phonograph. Professor Hughes is the gentleman who has succeeded in making us hear the fly walk, and others are working in the same line. What I want you to clearly understand is this, that all these instruments, whether it be the microphone of Professor Hughes, the telephone of Professor Bell, the speaphone of Mr. Edison, or the interesting instrument behind me, the phonograph, they all depend on this one simple, wonderful fact, which, to my mind, is one of the greatest discoveries of this age, namely, that a mere vibrating diaphragm can produce all the articulations and all the variety and beauty of the human voice. I am sure there is scarcely a man in England who would have believed six months ago that it was possible for a diaphragm of thin hard to reproduce the human voice. Certainly, men like Sir Charles Wheatstone and others, who described the best part of their lives to perfecting the speaking instrument, would have thought us stark staring mad if we had told them that the whole beauty of the human voice would ever be reproduced by a plain, simple diaphragm.

Now, in some of the instruments which I have mentioned to you, I have referred to the use of electricity and the use of magnetism, but in the phonograph, to which I am coming, we have neither electricity nor magnetism; and I want at once to destroy your minds of the idea that there is any electrical need with it, because one of the first questions which is usually asked me is, where is the magnet? There is nothing of the sort here; it is simply a mechanical contrivance. We have merely to insert a diaphragm in the centre of the concave vibrations emitted from our mouths, to produce motion. Philosophers have taken advantage of this motion to record sound, and to produce an instrument called the phonograph.

Mr. William Henry Barlow, one of our most eminent engineers, produced what is termed the logograph, that being an instrument which recorded the sonorous vibrations properly of the mouth, but the variations of the air pressure in the immediate vicinity of the mouth. On the diagrams to your right there is an enlarged representation, on Mr. Barlow's logograph, of the line, "The mistletoe bay to the war has gone—In the realm of death you'll find him." There you will see depicted the very different sounds uttered by the voice. They give you, in their angularity, the loudness of the sound; in their length, the pitch of the sound; and in the French call it. From this we come to the finder, or the phonograph, of which we have now all the elements before us. The phonograph was discovered, like many other things, by mere chance. Edison himself was experimenting with the telephone, trying all kinds of experiments, as all of us have been doing, to improve the telephone: in doing so, he pricked his finger, and, dreading it rapidly away, a kiss was made on his finger. This gave him the notion that if the diaphragm of a telephone could mark his finger, why should it not mark paper, and if it marked paper, why could the sound not be reproduced? So he took a piece of Morse paper and inserted the diaphragm of the telephone, where the ordinary style of the Morse instrument is, and there he found on the paper, when he uttered the words, "Hallo! hallo!" distinct marks—varying dots and dashes, or a series of dots. Then he took this strip of paper and allowed it to pass back again. He simply reversed the process, and instead of making the diaphragm vibrate with his voice, by passing the paper back again in the reverse direction, he caused the paper to make the diaphragm vibrate, and the result was, he heard a faint "Hallo! hallo!" come out of the diaphragm. This was a glorious triumph for Edison. It occurred on a Wednesday afternoon. He worked at it all the Wednesday, all Wednesday night, all Thursday, and Thursday night, all Friday, and Friday night unfortunately, without eating, drinking, or sleeping, until on Saturday morning he produced his first phonograph. I have on this diagram a drawing of this first phonograph. His difficulty was, having secured the principle of the vibrating diaphragm, to procure some substance which would retain those marks. By a happy inspiration he showed at once lighted upon tinfoil. Tinfoil is in itself a highly inelastic substance, and is not only very inelastic, but is a very yielding substance. Any mark made on tinfoil remains impressed there, and will remain there for an indefinite period. He then made a cylinder of brass, which he covered with a sheet of tinfoil. The cylinder was centred on a screwed axis supported by uprights, and was actuated by a handle at the extreme end. A heavy fly-wheel was attached to it to secure uniform velocity, and there you have all the mechanical contrivances required to make a phonograph. The needle in which it moves is shown in this section on the lower part of the diagram, which is a section taken through the diagram of the cylinder. It shows here the centre of the phonograph with its point behind it, the rough end of the cylinder depicts the vibrations, and the forms that are marked on the tinfoil somewhat similar to the forms that are marked on Mr. Barlow's logograph. The great difficulty that persons at first have in following the description of the phonograph is this. We can all very readily see how the vibration of a diaphragm can make marks upon tinfoil, but it is not so easy to see how it is that when you reverse the process these marks on the tinfoil reproduce or repeat the same vibrations. We fancy that the effect of reversing this process, and passing the tinfoil under the diaphragm, would be not to make the diaphragm vibrate, but to rub out the marks on the tinfoil. But the marks are not rubbed out. It appears that the resistance which the diaphragm makes to the vibrations caused by the marks on the tinfoil is very slight, and the same piece of tinfoil can be used over and over

again. I have used the same piece as many as 20 times, with a very slight difference in the intensity of sounds produced. The fact remains, that when you pass this marked tinfoil a second time beneath the point at the back of the diaphragm, it there causes the diaphragm to vibrate in exactly the same way as it vibrated under your voice, and the result is if you cause the diaphragm to vibrate in the same way that it vibrated under your voice, you get precisely the same notes, at the same pitch, and in the same quality as were contributed to it by your voice. I do not know whether I have made myself clear, but if I have not the instrument shall speak for itself. Here we have the latest form of instrument. It is made by one of the first mechanicians in this country, Mr. Stroh, for the London Stereoscopic Company, who have secured the right of using the phonograph in England, and to whose courtesy and kindness we are indebted for its exhibition to-night. It differs considerably, as you see, from the instrument I have described to you, viz., Edison's first instrument, although it is essentially the same in principle. One great defect in the instrument shown on the diagram, is that you cannot ensure the same velocity of rotation in the cylinder when the sounds are repeated as it had when the sounds were given to it. It requires great delicacy, and a great deal of experience to rotate an instrument of the kind with uniform velocity by the hand, although aided by a fly-wheel. Here, by an exceedingly pretty contrivance, there is a fusee weight, which, by an endless chain, and two or three wheels, imparts rotation to the cylinder, and it has this governor above it, those expanding wings, which, by their resistance to the air, give to the instrument what it wants, namely, uniform velocity. The result is, that when you speak into this instrument, you obtain very nearly a reproduction of the sounds emitted—very nearly, not quite. The instrument has not quite reached that perfection when the voice of a Siddons, or the speech of a Gladstone, or the sermons of a Liddon, can be faithfully reproduced; it has been exhibited as a buffoonery or parody of the human voice. You have heard me speak into it, and you have heard it; you will be able to judge how far the instrument will reproduce my own voice. It gives off musical sounds admirably, but unfortunately I am not a musician. I do not know a note of music, and I know two songs, one of which was "God save the Queen," and the other was not. I do not know the song that was not, so I will presently give you "God save the Queen," but before we come to that, we will try some poetical quotations, or some learned aphorisms, and see what the effect will be.

[Various experiments were made with the instrument, which repeated some lines of a nursery rhyme, some remarks made by the Chairman, a verse of "God save the Queen," sung as a duet, the notes of a bugle, and imitations of animals, &c.]

I dare say many of us have thought to ourselves, what uses can this instrument be put to. Now, it is quite evident to you that though the production of a voice is very wonderful, it is not very perfect: it fail, there are some consonants that are wanting altogether. The s for instance at the beginning and end of a word is almost entirely lost—is entirely lost, although it is heard slightly in the middle of a word. The d and the t are exactly the same; and the same in m and n, same and some are not distinguishable. Hence, it is extremely difficult to read what is said upon this instrument; if a person is put out of the room, and you speak into it, he can with difficulty translate what it says. Still, I read distinctly on the first instrument sent over from America to me, a message that was sent to me by its inventor, Mr. Edison. He said distinctly, "How do you do? What do you think of my phonograph?" Those words were spoken into the instrument in New York, were carried across the Atlantic, and more than a fortnight after they were uttered, I heard and translated them. But the principal purpose to which it was thought that it could be applied, viz.: to dispense with our friends the shorthand writers, is, I am afraid, still very far in the future. It has been proposed to fill libraries with speeches, with sermons, with plays recited by eminent actors, but the instrument has not yet reached that stage when such a thing is probable. It remains an extremely interesting scientific toy, a wonderful novelty. But it is only a chick. It is only three months old, and if it can do what you have heard to-night when three months old, what will it do when three years old? One of the purposes to which it is proposed to be applied is this. This is what Edison says—"I see the President of the American Philological Society the other day, and he had a conversation with a Portuguese who was in the room through the phonograph. He wants one of my improved phonographs to preserve the accents of the Grassiguayed Tecacurua, who are dying out. He did not mean speaks the language fluently and correctly, and he is afraid he will die. You see, one man goes amongst the Indians and represents the pronunciation of their words by English syllables; another represents the same words differently: there is nothing definite. The phonograph will preserve the exact pronunciation, and the President of the Philological Society means to have it shown to posterity this piece of tinfoil.

I do not think I can show you any more of the wonderful performances of this instrument collectively, but we will bring it to a close for your amusement for some time. I am much obliged to you for the attention you have bestowed, and I must say I have felt great pleasure in bringing the phonograph before the British public. I am the inventor of it was kind enough to send me the second instrument that was ever made, and it has been my privilege as well as my great pleasure to bring his wonderful invention before the British public.

The Chairman said he had two duties to perform; one to invite discussion on the paper, which seemed almost impossible, for very few present could have sufficient knowledge of the machine, or the principle upon which it was constructed, to discuss it; and the other, to ask the meeting to return a cordial vote of thanks to Mr. Preece, for the exceedingly able manner in which he had brought the subject before them. If, however, any one should desire to ask for any further information, he was sure Mr. Preece would be happy to answer any

questions which might be put. It was a great privilege for the Society of Arts to receive, as it had done that session, two papers upon such novel and interesting subjects as the telephone and phonograph. If any Dining were wanted to show the appreciation of the Society, and the respect to which it was entitled, it was supplied by the fact that such subjects were brought forward, and held before the public in the manner in which they had been by Professor Hall and Mr. Preece. Great praise was due to the latter gentleman for the quiet, unassuming, and lucid way in which he had treated his subject. It was another step in the knowledge of nature, and in those discoveries in which the present age had been so fruitful.

The vote of thanks having been passed,

Mr. Preece, in returning thanks, remarked that one peculiarity of this instrument seemed to be that it possessed great intensity of sound, and whether it were used in a small room or a large one, it seemed to fill up the whole space. He had used it in rooms twice or three times the size of that, and every person present had heard it as distinctly as they had on that occasion.

ADDITIONAL LECTURES.

EXPLOSIONS IN COAL MINES.

By T. Wyr, F.C.S.

Lecture III.—Delivered Feb. 17th, 1878.

The four forms of safety lamps described in the last lecture are types of a very large number of lamps which have, from time to time, been introduced; each form of lamp has its own advantages, but no lamp is to be found the use of which, under all circumstances, is quite free from danger.

Lamps of the original "Davy" form are the most liable to permit the passage of the flame through the wire gauze.

In the "Stephenson" lamp a danger is apt to arise from the irregularity of the holes in the plate, of which although all sky enters; these holes are drilled by hand, and under these circumstances little accuracy cannot be ensured to the same extent as in the machine-made wire gauze. A "Stephenson" lamp requires to be held in a nearly vertical position.

In the "Clanny" form of lamp the imperfect supply of air is a difficulty, as it is attended with a loss of light. That this is the case is well illustrated by comparing a "Clanny" with a "Museler," in which the former, the two bottle air supply in the "Museler" is coupled with an increased amount of light.

The following comparative experiments, which were made with a view to these features, exhibit the relative photometric value of these four lamps; surrounded by the gauze, or gauze and glass:—

A Sperm Candle burning 120 *grains per hour* = 1 *Oil Lamp.*

Loss or gain in light as surrounding the flame with the upper part of the lamp, per cent.

"Davy"	Naked	= 39
	Complete in 24 hrs.	= 43 loss.
"Stephenson"	Naked	= 36
	Complete in 24 hrs.	= 64 loss.
"Clanny"	Naked	= 42
	Complete in 24 hrs.	= 21 loss.
"Museler"	Naked	= 36
	Complete in 24 hrs.	= 4 gain.

The observations were made by means of a Bunsen photometer, and they need were not many working lamps, but new.

In this table it is seen that, when the naked light is enclosed within the lamp, there is a considerable loss of light in each case, except that of the Museler, and this remarkable difference in this instance must be attributed to the more perfect supply of air in this lamp. Practically, the placing of the glass and gauze round a Museler lamp makes no difference in the amount of light obtained.

Occasionally, for special purposes, shields or reflectors are placed entirely or partially round the lamps on a level with the flame, but their advantage is very doubtful. Before quitting this subject, a form of lamp, which is in extensive use in Scotland, must be mentioned. This lamp is called a gauze lamp, and is of a somewhat primitive construction; it is much larger than the other forms of lamps, the outer case consisting entirely of superposed gauze. This gauze cylinder is about 8 inches high by 3½ in diameter; a lamp with a flat wick is used, and more light is obtained from it than from the ordinary Davy, but its safety is not so great; the considerable space within the lamp forms an element of danger in the event of its being exposed to an explosive atmosphere. This description of lamp was in use at the Blantyre Colliery when the terrible explosion took place last October.

Vegetable oils are mostly used in lamps, but in some cases the rock or mineral oils have been substituted; there is a prejudice against these latter which has prevented their common adoption, although the saving in cost, the cleanliness in use, and the much greater amount of light obtained, are decided advantages; it is probable that these important considerations will eventually lead to their more general use.

All gives more than twice as much light, under the same circumstances, as one of the vegetable character. Some lamps burning the lighter mineral oils are constructed without wicks, a small piece of cotton wool or sponge serving the purpose of a wick for an indefinite length of time. When lamps are used with these oils, care and caution must be exercised in the storage of the material and in the filling of the lamp.

Although the introduction of the Davy lamp marks a very important era in the working of coal mines, it singularly happened that the number of cases largely decreasing the accidents from explosion, those in the immediately succeeding years became greater. The Davy lamp was introduced and adopted in 1815, in the 21 years previous to which the average annual loss of life by explosion was 20, but in the 21 years subsequent to its invention there was an increase, the yearly destruction being 28; this fact, although remarkable, is accounted for by the false notion of absolute security in the use of a Davy lamp which was held at the time, and which led to the immediate sparing up and working of dangerous places which had previously been abandoned.

Dangers Connected with the use of Safety Lamps.

From what has been already said it will be gathered that safety lamps can be by no means implicitly trusted to prevent an explosion; much care is required in their construction and use, as

CHRISTIAN AT WORK

NEW YORK, THURSDAY, MAY 23, 1878.

ALL ABOUT THE PHONOGRAPH.

A Visit to Mr. Edison and What Came of It.

Epicurus—The Value of Speech—Mr. Edison—Experiments—Prose and Poetry—Singing and Whistling—Gray's Elegy—Annabel Lee—Rare Tests—The Phonograph—What it Is—All about It—A Wonderful Thing

BY RANDAL H. BRIGHT.

"DOES any man," inquires Epicurus, in his discourse on the Faculties,—"does any man say that there is no use or excellence in the speaking faculty?" And then he answers his own inquiry by replying, "That would be foolish, impious, ungrateful to God." That was before the days of the printing-press or the telegraph, the telephone or the phonograph. Every year gives increased importance to speech: words uttered by the lips have caused war, brought armies together in the shock of battle, procured peace, made the stories of loves and friendships which will never die till history itself perishes; in brief, speech has made the world what it has been and is from the time when Adam first heard the Lord's voice in Eden till now, when a single speech in Parliament or a single utterance of one man in St. Petersburg may bring together two of the mightiest empires of the world in the conflict of arms. Anything, therefore, which tends to perpetuate speech must have an important effect upon the civilization of the world; and hence it is that the printing-press is regarded, and justly, as an invention which is important next only to that of the alphabet itself. But what place shall be given to our later Phonographic—an instrument which not only records the articulated words of speech, but, as it were, stereotypes them, handing them down to the ages, and not only this, but actually records the distinguishing quality of the voice, so that it can be literally said of one when gone that "he being dead yet speaketh"?

The Phonograph: who has not read about it, heard about it, talked about it, and—shall we not say,—doubted? The writer confesses to having done all these; and so, not having quite so much confidence in any one's eyes and ears as his own, he determined to go and see and hear for himself; and so it was that one pleasant May morning one of the Editors of this journal and a friend, whom we will call the Astronomer—for he has a way of looking at the stars, calculating eclipses and transits, etc.,—got their tickets for Menlo Park, New Jersey—a little hamlet on the line of the Pennsylvania Railway, at perhaps one hundred inhabitants—which they reached about noon, after an hour's ride. "Go right over the hill yonder till you come to a long two-story frame building, covered with lightning-rods and wires, and that's Edison's place." These were the station-master's directions; and following them the building was soon reached. Entering, various philosophical apparatus, electric machines, batteries, telegraph machines, clock works, met caught the eye, while the further end of the building was devoted to a machine-shop, some fifteen lathes—the monotony all highly finished—being run by a compact, lively little lathe en gine. In this shop some fifteen men are employed, making phonographs and telephones, and working away at some of Mr. Edison's inventions—for invention with Mr. Edison is both a business and profession, he having already over two hundred patents at Washington. Ascending the stairs, a young man was noticed sitting by a long table, his hands covered with acid stains, and giving other indications of being one who manipulated the chemicals pretty freely—for there was a laboratory in the building that would have delighted a Liebig or Horsford. Approaching him the Editor inquired for Mr. Edison. "I am Mr. Edison," was the quiet reply, "and happy to see you." Mr. Edison who had been invited beforehand of the proposed visit, and extended an invitation to "come on any day," [illegible] reader] at once sat down to his Phonograph, and placing his lips close to the mouth-piece, and his hand upon the crank of the cylinder, which he turned, repeated in a loud voice: Mary had a little lamb, its fleece was white as snow: And everywhere that Mary went the lamb was sure to go. Jack and Jill went up the hill to get a pail of water; Jack fell down and broke his crown and Jill came tumbling after.

Then reversing the cylinder back to the starting point, he withdrew his lips from the mouth-piece and loosened the crank. In a tone not unlike that of the falsetto, but having all the characteristics of Mr. Edison's voice both as to quality and emphasis, back came the reply clear and distinct: "Mary had a little lamb, its fleece was white as snow; and everywhere that Mary went the lamb was sure to go: Jack and Jill went up the hill to get a pail of water; Jack fell down and broke his crown, and Jill came tumbling after." We had heard that the Phonograph would do such things, but it must be confessed the speech was a surprise. The Astronomer looked as if he had just discovered a planet. Putting on another sheet of foil, Mr. Edison sang in the mouth-piece:

"Who will shed a gentle tear
For a wandering refugee?"

Reversing the cylinder, the Phonograph repeated the inquiry, the melody being rendered as distinctly as the words, "Who will shed a gentle tear for a wandering refugee?" Then came the Editor's opportunity, and applying his lips to the Phonograph he repeated:

The curfew tolls the knell of parting day;
The lowing herd winds slowly o'er the lea,

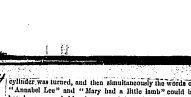
"*Louder, louder if you please,*" interrupted Mr. Edison. So the Editor raised his voice:

The ploughman homeward plods his weary way
And leaves the world to darkness and to me!" Then the Phonograph so unexpectedly repeated Mr. Edison's interpolation, which was spoken away from the instrument, the Editor was taken all aback, and a strange light dawned in the Astronomer's eye. Then came the Astronomer's turn, who repeated four lines of a *verse de société*, which came back with all the peculiarities of his enunciation. Mr. Edison then opening a volume of Poe's poems proceeded to read, interspersed with coughing, laughing, etc.:

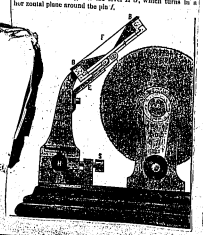
It was ahny and many a year ago ha! ha!
In a kingdom by the sea,
That a—coughmaiden lived whom you may—cough—know
By the—whistle—name of Of an—ahh—Annabel Lee;
And this maiden she lived with no other thought—thought
Than to—ha! ha!—love and be loved by me!

The verse, it need scarcely be said, was repeated verbatim with the coughing, laughing, and whistling, as interpolated. Wonderful as this all was to novices, more wonderful things were to follow. "Do you sing?" inquired Mr. Edison. The Editor confessed he had tried to sing tenor occasionally. "Well, I'll sing the air of 'John Brown's Body' while you sing the tenor." Right lines were sung,—Mr. Edison and the Editor joining their voices in a duet,—the cylinder reversed, started again, and then came out the two voices as clear and distinct as if singing in a choir. Then calling two assistants, Mr. Edison repeated a verse of "Annabel Lee," an assistant at the same time repeating right lines of "Mary had a little lamb," while another turned a little music box which played a waltz. Back to the starting point the

cylinder was turned, and then simultaneously the words of "Annabel Lee" and "Mary had a little lamb" could be heard, accompanied by the music of the waltz! Mr. Edison continued his experiments: when he shouted the Phonograph shouted, laughed when he laughed, coughed when he coughed, and whispered when he whispered, quoted Virgil, spoke German or French as he gave it occasion. And now we come to the question which the reader has doubtless asked a dozen times as he has been reading this article,—How is it all done? That question we will now endeavor to answer. And here let it be said that while the fact that articulation and all the peculiarities of human speech should be recorded and repeated is puzzling beyond degree, the machine itself is a marvel of simplicity:



Edison's Speaking Phonograph—of which the above is a perfect representation—consists of a brass cylinder, *G*, about six inches long and four inches in diameter, turning on a screw-axle which passes through the standards *A* and *B*. On the right end of the axle is the crank, *D*, and on the left the fly-wheel, *E*. The portion of the axle to the right of the cylinder has a screw-thread cut on it which, working in a nut in the standard *A*, causes the cylinder to move to the left as the crank is moved from you,—the direction it is given when speaking. To reverse the cylinder the crank is of course turned toward one, when it moves back to the right. On the surface of the cylinder, running entirely around it, are scored the same grooves as in the thread of the axle, and about fourteen to the inch. *F*—shown in end-half scale in Fig. 2—is the mouthpiece or diaphragm to which the lips are closely applied when speaking. Just below the small hole in the centre of this mouthpiece is a tiny plate of iron only one one-hundredth of an inch thick, which is sensitive to the slightest concussion of air. This plate can be moved toward and from the cylinder by pushing in or pulling out the lever *H D*, which turns in a horizontal plane around the pin *I*.



Underneath this thin iron plate *A* [Fig. 2] are two small pieces of rubber tubing, which lie between the plate and a spring attached at *K*. To the end of this spring is fixed a rounded stylus or steel point, *P*, which bears slightly into the grooves scored on the cylinder, and which are cut much as the threads are cut on a screw. The distance of this point, *P*, from the cylinder is regulated by the set-screw, *S*, and the sliding lever, *H G*, in Fig. 1 as previously stated. Over the iron plate, *A*, is a disk of vulcanite, *B H*, with a hole in its centre. The under side of this disk nearly touches the plate *A*. Its upper surface is cut into a shallow, funnel-shaped cavity, leading to the opening in its centre.

To operate the Phonograph the cylinder is first wrapped around with a sheet of the foil slightly overlapping and gummed at the end. The mouth-piece *F* is then moved close up to the cylinder, till the point *P* bears against the tin foil sufficiently to make a slightly depressed line on the cylinder as it is turned. The cylinder is at this moment placed to the extreme right so that the point pursues the outmost left groove. The mouth is now placed close to the opening in the vulcanite disk, *B H*, and *the metal plate is talked to* while the cylinders revolve, moving uniformly towards the left. The plate, *A*, vibrates to the voice, at the rate of *five hundred vibrations to the second*, more or less according to the "pitch" of the voice. The point, *P*, indents the foil, impressing in it the varying numbers, amplitudes, and durations of those vibrations. If the vibrations given by the voice are those causing simple sounds, and are of a uniform, regular character, continued without intermission, then similar regular, continuous, undulating depressions are made in the foil. If the vibrations are those causing complex and irregular sounds (like those of the voice in speaking) then, similarly, the depressions made in the foil are complex and varying. Thus the talking and inelastic foil receives and *retains* the mechanical impressions of those vibrations with all their minute and subtle characteristics.

Supposing the speech or whatever it is to have been made it now remains to secure from the phonograph *the same vibrations which made their impressions on the foil.* Nothing is simpler yet nothing more wonderful. Pulling away from the cylinder the mouth-piece *F*, with its plate *A* and point *P*, you reverse the cylinder till you have the beginning of the impression back to the point *P*, as it was when you commenced your speech. Now bring the point *P* against the cylinder, so it will rest on the very first indentation which it made. Place in the mouth-piece *F* a large funnel or cone of paper or the to act as a sounding board, and then steadily turn the crank *D*. The stylus or point *P* at once traverses the indentations already made; these cause the point to vibrate precisely as before; it communicates its motions to the iron plate *A* which gives out its vibrations to the air; the Phonograph *talks back precisely what you said to it, and you can hear your own voice repeating your own words.* This is the sum total of what the Phonograph is. Of course much more might be said as to the various experiments which have been made for perfecting this marvellous instrument, but enough is given to afford the reader an intelligent conception of the working of the Phonograph, and if it be asked *what is it good for?*—what endeavor is served by it?—the answer is one which may only be limited by the imagination. The cylinder of Mr. Edison's present machine contains sixteen grooves or threads to the inch. With fifty words to each revolution the present ten-inch cylinder contains 800 words to the inch, or eight thousand to the sheet. Mr. Edison says he can score 1600 threads or grooves to the inch, which would give 8,000 words to the inch, or 60,000 to the entire sheet of foil, equivalent to nearly an *entire issue* of THE CHRISTIAN AT WORK, advertisements and all! With larger cylinders why may not whole volumes be printed on one sheet of foil, those multiplied by stereotyping on copper, so that books can be preserved in this form and by being placed on the Phonograph the entire story be told to the listening ear! In like manner some of the great singers—a Kellogg, Nilsson or Cary may be, we believe will be, induced to sing in the ear of the Phonograph and the electrotyped cylinders be transferred so that we can at pleasure have the actual voices of the gifted daughters of song in our own homes. The Phonograph, too, may dispense with letter writing; for, instead of the usual four page letter to be read in five minutes, you can sit down to your Phonograph, and in half an hour or longer to your friend, take off the foil and mail it or some more durably prepared duplicate to your friend who will put it in his Phonograph and listen to your discourse. Sermons, editorials and lectures, and literary work of all description can also be prepared in this way, and one be enabled to do in half an hour with the Phonograph what the pen might require a day to accomplish. The Phonograph will be invaluable to the lawyer, will *sit away* with the stenographer and save the cost and the trouble of an amanuensis. But it is idle to *speculate* in a field whose horizon is so boundless; but it may be said that the Phonograph will undoubtedly supplement and perfect the telephone and revolutionize—as Mr. Edison claims in an interesting article in the last *North American Review*—the present system of telegraphy. Certainly by connecting the telephone with the Phonograph, the speaker will be enabled to simultaneously transmit and record his own message—and no system of telegraphy does that. It only remains to be said that Mr. Edison is a born inventor. He is furthermore a quiet, retiring, modest gentleman, very young indeed for one who has leaped into enduring fame, yet not leaped, exactly, for he had seen hard times; but courage, pluck, persistence and rare genius have done their work, and he is reaping a reward as deserved as we are glad to know it is substantial. His Carbon-Telephone and Galvanometer which were kindly exhibited and explained by Mr. Edison's accomplished assistant, Mr. Bartlett—are marvels in their way and would require another and more extended an notice which we may hope to give on some future occasion. Mr. Edison told the writer the other day that America had nothing relating to telegraphy to learn from England; but he did not add that it was his own discovery of the quadruplex telegraph which had given America pre-eminence in that field. Mr. Edison's genius is only equalled by his modesty.

The Evening Post.

New York, Friday, May 14, 1879.

POLITICAL TOPICS.

We Dom Pédro: Greeting!

"CAPTAIN" COLMAN SENDS AN ADVANCE REPORT OF MR. JOHN MARSH'S PHONOGRAPHIC SERMON.

To the Editors of the Evening Post:

On the arrival at the steamship Bay of Rio de Janeiro at her destined port the phonograph which Mr. Roach had loaded with 10's' congratulatory message will be duly forwarded to the palace of St. Christoph. We may imagine the machine to have been placed in working order for the entertainment of the imperial family and the assembled guests.

"Your Imperial Majesty," the instrument begins, "I congratulate you on the success of an American enterprise. I have built an American ship of American iron, with American workmen on an American shore, and launched her into American waters. She is owned by American citizens and will be sailed by American sailors. She won't carry any but American passengers, nor any goods but American goods. If you want to write a letter to send by her it must be in the American language. Not a drop of whiskey will you get aboard of her but American, and the wine will be the pure juice of the American grape. You see, your Majesty, I'm a protectionist. I believe that every true citizen of yours ought to protect one man, and that's me. I've blarneyed and bulldozed Congress for years, and I've made 'em believe that they ought to subsidize only American built ships for the benefit of American shipbuilders, just as you only subsidize Brazilian built ships—eh, dear, I forgot! when you get a word into the confounded phonograph you can't gainsay it; and now here's I got my celebrity from Brazil?"

At this point the instrument began to wheeze and cough and contrived in such an extraordinary manner that all attempts to complete it as meaning were ineffectual.

J. C.

New York, May 12, 1879.

N. Y. Clubhouse May 25

LYDON'S PHONOGRAPH will be exhibited in Mechanic's Institute, Baltimore, commencing May 27.

MADDI LAVERNE and stereopticon at 20 opera, and views illustrating every subject for 25 cents. Admission to the theatre included with the lecture. Ask for circulars.

ROBERT HILLES is to give entertainments at Bellevue, Ohio, on Monday, New Haven 28, Hartford 29, Meriden 30, Ansonia 31.

HUNSICKER & HUNSICKER'S BALLOON SHOW exhibited in Bucks Co., Pa., on Saturday, Kennett 11, Abingdon 12, Penn Square 13, Lancaster 14, and Carriage 15. They close in Maryland June 1, and will be at Newark, Del., Kansas, Arkansas and Texas.

SOLAR TANNHÄLLA is to commence a concert-season at Steinway Hall, New York, on Sunday afternoon, June 4. Signor Tannhäuser of the 5th Cavalry Circuit and Philadelphia Literary Society, will be present, and will be invited to be heralded in Broadway St., Bridport.—The finest Social Society of the day.

PROFESSOR ——, Investigationist, Mass., can be engaged for a limited time until Sept. 15. It will be a great literary treat. Address, Box 1.

THE NEW NATIONAL THEATRE, Philadelphia, is offered for sale, or it can be leased thereof. Apply to Messrs. Smith, Brown & Co., whose address may be easily found.

THE HIBBON SEVARIN PHONOGRAPH was exhibited in Cincinnati, Ohio, Toronto, Miami, the past week will be continued [illegible] next week.

Boston
EVENING TRANSCRIPT
THURSDAY, MAY 25, 1876.

THE MORNING'S NEWS.

EDISON'S LABORATORY.

A DAY AT MENLO PARK WITH THE GREAT INVENTOR—THE CHIEF PHONOGRAPH—THE AUTOPHONE, PHONOMOTOR AND OTHER INVENTIONS—HOUSEHOLD MUSIC.

By the courtesy of the management of the phonograph exhibition at Horticultural Hall, represented by Mr. Lyon, the Boston press passed yesterday at Menlo Park, New Jersey, with Mr. Thomas A. Edison, the young man who chose leisure through the telescope pointed toward the towers of the Brooklyn Bridge, dimly seen in the horizon. Through the glass the wire cables were clearly discernible. But Mr. Edison is now returning across the field with the particular object of our visit.

THE PHONOGRAPH.

They pause by the telegraph pole, and in its shade, for it is all blaze elsewhere over the sandy soil, Mr. Edison lights a cigar. He is an inventor, and consequently not a dilettante, believes in no narrow ideal, and declares that Yankees get their many inventions because they have other people's ideas to make kinds of fools of. He approaches with an easy gait, and above his head we hear the voice of his companion, for, as he walks on, the great inventor in the field of acoustics is slightly deaf. While the party is being introduced we will scan him more closely.

He is in form athletic, graceful and slightly above medium height. A more pleasing combination of voice and eye are not often encountered. The photographs and periodical portraits may be considered good and at least caricatures, for they represent him as a cupcordial, listless and consequential. The eye is dark, smooth nevertheless and is bagged and pale, and the face coarse and almost straight hair radiates from a head with not his large head, rotundities, eye and mouth; that his thin eye looks weary with night work and artificial sleep. But as kindly and youthful an expression, as frank and clear a countenance, and as noble and withal graceful a head are rarely met with. When in conversation his face and eyes light up with a peculiar glow of earnestness that stamps him as no common man.

Apologizing for not having arisen sooner, with the remark that he expected to at ten o'clock, he seated himself in a armchair before

THE PHONOGRAPH,

the first practical one ever made, and adjusted a

The cylinder had not been evenly cut, and when first placed in position would not work, not being properly balanced. The rear room is the machine shop, containing at least a dozen lathes, dies and other machines. About fifteen men are employed here from eight o'clock in the morning until eleven in the evening, but nothing is made except for experimental purposes. The room above is the laboratory proper. As we enter, a card with an order in the top, square hand of Mr. Edison. "No admittance except on business. This rule must and shall be enforced," with the "must" and "shall" doubly underscored, looks us in the face.

Nevertheless, we have been invited, and therefore enter. In the large hall everything appears in place. The wall is lined with more than 200 books. Every chemical that is known is here, said an assistant; everything in the botanical line also—roots, herbs and seeds. Indeed, we found not only everything, from "dragons' blood" (a vegetable substance) and Brazil wood to Iceland moss and gold wire, but preserved snakes, and, in a case in a corner, watches, razors, and many common and uncommon mechanical contrivances; conical paper funnels, six feet high, a big galvanic battery, the sound and music box.

Of course, the whole laboratory fixtures and experimental apparatus, electrical batteries, instruments, an air pump, translators, [illegible] pressure, etc., were present. But an induction coil, which is in disuetor and eighteen inches long, was a novelty. It is a recent addition, cost originally $100, and is capable of flashing a spark ten inches long—quite a scrawn of lightning.

The patent-office model of the phonograph, a miniature machine about three inches in length, and the first experimental phonograph, a clumsy instrument with cylindrical box drums upon each side—rests recently discovered and waiting to suit its—was examined. Beside the first practical machine, which we have at home, Mr. Edison exchanges about calling by a well-handled copy of the poems of Edgar A. Poe, very effective by Mr. Edison's favorite.

It opened readily to the "Shonest to Science," one of Poe's youthful poems, beginning—

"Science! true daughter of old time thou art!
Who alterest all things with thy peering eyes."

We had no need to read further, Passing to the phrase, those who chose looked through the telescope pointed toward the towers of the Brooklyn Bridge, dimly seen in the horizon. Through the glass the wire cables were clearly discernible. But Mr. Edison is now returning across the field with the particular object of our visit,

THE PHONOGRAPH.

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Apologizing for not having arisen sooner, with the remark that he expected to at ten o'clock, he seated himself in a armchair before

THE PHONOGRAPH,

the first practical one ever made, and adjusted a new sheet of tinfoil upon the cylinder. The phonograph in motion must be familiar to all. The Transcript has already published an accurate description of it, and most of its readers have doubtless seen the instrument. The cylinder of the machine at which Mr. Edison is seated is of brass, and is received by steam power sent up from the starting below. The rod, therefore, has a small balance wheel. The mouthpiece or [illegible] is of iron, and that attached to the later machine is simply a plate capable of receiving a small diaphragm, sound vibrators, with a short needle or point glued to its centre and resting in the groove of the tinfoil sheet. Edison lets on the power and again into the machine, "The dying soldier faltered as he took that [illegible]'s hand, and he said, 'I never more shall see my own, my native land. Take a message and a token to some distant friends of mine, for I was born at Hoppor, fair Bingen on the Rhine.' I am singing to this machine." Returning the cylinder to its first position, he placed a paper funnel at the speaking end, and then too wide a dispersement of sound, adjusting the cylinder again reproduced his speech with a remarkable variation in tone and distinctly audible over several feet distant. This is the work of the invention with which the public is already familiar. Now over the same piece of tinfoil he whistled "Auld Lang Syne," and reproduced the poetry and whistling together, yet eachas distinct as though one person were whistling while another spoke. Then over the same sheet he whistled, sang, and reproduced, as before, the three pieces. Again and for the fourth time he went over the foil, this time calling in base tones and talking, "Rub-a-dub-dub, three men in a tub, the butcher, the baker, the candlestick maker, all turned out of bed to eat pease porridge hot, three, four, five, six, seven, nine, ten." The phonograph operates now beyond "dingen on the Rhine," whistled, cackled, and called "Rub-a-dub," all together, and with nearly as much distinctness as four different voices speaking at the same time could be done it. Then the whole was given in reverse order, beginning with the whistling, through somewhat shortened, was distinct. Another piece, "Yankee Doodle" was whistled and given backward, producing a different tune. Mr. Edison has not yet succeeded in giving a consistence tone to the phonograph, but is confident, during the afternoon, one of his assistants mildly called in a "good day" and during the cylinder backward was answered in a shockingly profane manner.

THE PHONOMOTOR.

This property of repeating sounds backward is considered a great acoustic value in the phonograph. "John Brown had a little Indian, John Brown had a little Indian, John Brown had a little Indian—the Indian died, John Brown had a little Indian—the Indian died, and he sings," was sung as fast as the words could be read, and then in reverse direction and a note was lost. Attempting to reprise the song of "Annie Laurie" the cylinder stopped and how the work. Installed a screwdriver readjusted the "arm" and the "Wandering Refugee" was sung in a fast bass waltz. Then, over the same foil, Mr. Edison sang it again in a different tone, and the phonograph repeating both parts, treated the company to a duet. "There," said Mr. Edison, "it is it's every one that can

SING A DUET ALONE."

Then upon a clean sheet Mr. Edison he sang and whistled, and another duet was given, though there was a want of harmony, for this reason, and is given a musical property in the instrument—As the sound waves are received by the diaphragm and pushed the needle point to the right location, and this is heard through the same vibrating plate that he is speaking upon. Thus the same plate is passing vibrations for registration upon the foil while it is receiving, or speaking, from the same foil the first record. In this instance, the whistling being so much sharper, produced the ear of the whistler hearing perfectly the foil, and thus unison or harmony was not obtained.

Mr. Johnson laughed into the instrument to [illegible] as to drive the stylus through the tinfoil, performating it for several inches. Nevertheless it returned the laugh. It also reproduced Mr. Edison's coughing, blowing and blasting. Mr. Charles Batchelor, the inventor's principal assistant, was served. The diaphragm was capped

with a double mouthpiece, and placing their heads close together, Mr. Edison and Mr. Batchelor sang "John Brown's body lies a-mouldering in the ground," etc. No poorer tones or clearer harmony could be asked in a concert room than that with which the phonograph re-sang the duet. Excepting the mouthpiece, it were a musical treat to hear the singing. Another time keep away this piece of foil as a rare [illegible].

The little wonder—for astonishment was re newed at each different performance—was then made to speak in German, French and Latin. "We get the best results in Latin," said Mr. Edison, "and the poorest in English." Then he attached the foil and the diaphragm, which he called "oscillating the record." The voice in the reproduction was not so distinct, but each word could be understood. "I make it talk inaness, this way," said Mr. Edison.

THE PHONOTYPE.

"Blow for once a word received on the foil?" "Why not, sir," was Mr. Phonograph. There, that extends once round the foil, and there are 600 vibrations for that word."

Then Mr. Edison spoke through the funnel—about a foot in length; then off a foot from the funnel, or two feet from the instrument. The repetitions were clear. "With a pasteboard diaphragm," said he, "which is much more sensitive than the brass," and took from a drawer a piece of pasteboard and an India inst it twelve feet. I think I shall use it hereafter in place of the 'regular' machine." Turning the crank by hand he spoke into it again, and then went back to the foil that the sound became a mixture instead of articulate speech.

"We had two machines together here the other day," said he, "and connecting the diaphragms by a long rubber tube, ground of three or more miles, so that the words were whistled through the tube and reproduced at the other end. There was considerable speech from the second machine, tearing it that two rubber tubes were needed to two revolutions. Then the same were connected with three half a revolution. That was at the rate of forty-five words a revolution; there are sixteen threads to an inch, and the diameter is eight inches.

This calculation allowed for 2700 words upon one plate of foil, 1,782 inches, or about three cubic feet. Multiplying by ten, "I can do it in a day now," said he, "I will take fifteen hundred threads to an inch and double the speed, and I can record twelve times as many words—about 32,000. That is equal to the matter of a 250 page book."

THE AUTOPHONE.

When Mr. Edison was showing some results of his investigations in Philadelphia, some one in the crowd remarked, "Why don't you invent a machine to talk a fish through a hose?" It brought a sarcastic and replied, "I guess I can." He returned home and constructed a small phonomotor which the company now turned to look [illegible] and which comes from a battery plate with a bar at each connecting the centre of it with the centre of the other plate. Over the plate moved the cabinet wheel and another wheels attached upon the same shaft. Several of the wheels are cut with a screw, and each has a wheel whistling at a rapid rate. Neither blowing nor any other force except the human voice would move it.

THE MOTOPHONE,

or second engine, was a curious musical instrument. It was based on the same principle as the former. A spiral was cut on the face of a brass [illegible] the top end of a bench. To the centre of its face was attached a [illegible] upon which was placed a [illegible] and to the other end of about fifteen pounds upon the rim of a small wheel. Over the wheel and the spirally-prepared paper was passed from a spool. A current of electricity was given to the wheel. Mr. Batchelor, below, sang several airs through a telephone, and they were repeated by the harp—the musical tones only. At the same time Mr. Edison revolved the small wheel and gradually drew out the electrically-prepared paper, which was received by the spool, and was acted by the current of electricity increasing and decreasing the friction upon the strip of paper. When there was no current passing, the paper was moved with difficulty, and consequently, as it was drawn out, it slightly drew out into the air attached to the sounding-board. A current immediately reduced the friction, and the [illegible]

springback, shuttling into sounding-board. The machine is capable of 30,000 vibrations a second. It should be remembered that the Edison telephone is merely the increasing and decreasing of the force of an electric current by sound vibrations. Why electricity disinclined to follow the vibrations of sound. The solution on the paper was bluestone and water, which acted the best, but he had tried 20,000 different kinds of chemical combinations. Some of these increased the friction against the paper. Only salts were found to work well, and the more alkaline the better. The same principle was shown in other electrical apparatus. For the practical purposes,

THE SPEAKING PHONOGRAPH.

"What is this speaking machine?" said one of the party, pointing to a horizontal cylinder, a bent bar of iron fore and aft of it, and a mouth-piece. "It is a perfected wireless telegraph," said Mr. Edison, "and a harmonic engine," said the inventor, with a fatherly smile, "it is really a large tuning fork. I can utilize its vibrations by connecting it with a battery of four cells so as to make it pump three barrels of water, three' electric lungs, twenty-four hours. I mean to apply it some day to the pumping of water for gentlemen's country residences. I can make it run at one of three rates a day—at one of four notations." He set the large bar into vibration by means of connecting the circuit. It was then an electromagnetic motor of double action, and of about the force of a man's arm. The oscillations were almost at sight of an inch in breadth, and they caused and closed the electric current in unison. The vibrations, in this case available as to be called oscillations, were at the rate of thirty-five a second.

Mr. Edison declared he could make it drive a sewing machine with the quickest possible means, or rather he was setting to get out of order, the magnet opening and closing the electric circuit. But he said he would be obliged to have two sewing machines—one, if accident to the other, to be kept in steam power, so as to preserve the harmony of vibrations. The machine requiring greater power were attached to one end than to the other, the result would be the destruction of vibrations in proportion to the inconvenience of the powers, just as in a musical instrument the harmony is destroyed if the sets of keys are not evenly weighted. For the pumping machine the pumps might themselves be the tuning forks. Edison said that theoretically he got nine-tenths of the power of the battery with this machine. All other machines get but one-tenth of the possible power of the battery, theoretically speaking.

Mr. Edison now instanced his visitors with a practical application of one of his late inventions, the electric pen. This is a pen which, even if quite unconnected over the paper, prints a line by means of a needle moved rapidly up and down in the pen connected with an electrical motor. From this stencil-paper sheets are taken by the common printing process. The inventor's autograph and a picture framed from an illuminated wreath, all done quickly before our eyes, were handed to each one of the party.

THE EDISON TELEPHONE.

was next exhibited and explained with the utmost freedom. It is entirely different in principle to the Bell telephone. Both inventions worked on the same lines on different principles, and precisely. Bell's telephone really makes simultaneous magnet or electrical impulses strike a permanent magnet, and the permanent magnet, and the disturbances of the magnetism by means of extra force. Edison merely allows it to vary in regular—increase or diminish—the force of a current already existing. This is done by means of placing a disk of prosaic carbon, about the size of a dime, between two platinum disks, behind a diaphragm or vibrating, plate, and the pressure of the waves of the voice concentricity, and producing the same compression, reproducing the sound. The carbon disk-plates was spoken through, the speaker standing six feet from the plate. According to the inventor's explanation, it is conveyed that the telephone will reproduce a sound giving but six times more force than the Bell telephone. Mr. Edison showed other apparatus utilizing the sensitiveness of carbon to heat and pressure. Attaching a battery to a galvanometer he pressed the fingerpoint with his finger and registered several degrees of pressure, raising the needle from twelve, increasing the weight of the plate on the carbon disk, to fifty-five. Mr. Edison started experiments in this direction in 1875. In his first telephones he used rubber, but the heat of the voice sensitive was the carbon, made it necessary to substitute iron, and then he used a handle altogether. Steam was found to be more sensitive than iron; thin iron plates will be used in the photograph-harmonic of brass. The thermopile is a usual instrument for measuring heat, and Mr. Edison is now research as sensitive as the carbon. With it and

THE HEAT OF A STAR

of the first magnitude, he could detect an and close a telegraphic circuit. Once he listened to the Mary once playing on a piano and also explained, which, though they did not weary the writer, might weary the reader.

THE TELEPHONOSCOPE,

to do for the ear what the telescope does for the eye, and upon somewhat similar principles—the vibrating waves of sound for the waves of heat, was explained. With them—the receiver and transmitter—he said he would be able to see—instantaneously—pictures that have been carried "on a rifle. The scene is shot out of a bore found like a bullet from a rifle barrel, and must be almost correctly to produce an effect. Mr. Edison pointed to a tree, at the end of a mile distant, and said he had heard the click of a watch over water on his telephonoscope wireless.

After a pleasant visit to the Edison family, the party left for the depot, expressing their appreciation to Mr. Edison in the heartiest manner and with his many friends here as soon as he returns from Europe. Mr. Edison will be accompanied by his children, Dr. Ludwig, he said, he could be glad to.

Thomas Archer is the name of the boy, the manager of Mr. Edison's two magnets. Edison, in this city, for the pleasure and instruction of the reporters mentioned in the Herald.

Boston Daily Globe.

FRIDAY, MAY 24, 1878.

A VISIT TO EDISON.

How the Greatest Inventor Lives at Menlo Park.

Other Art Works and Cares.

On Tuesday evening last the representatives of the Boston press, through, the courtesy of Mr. William Mitchell, manager of the Edison phonograph exhibition at Horticultural Hall, started on a visit to Menlo Park, New Jersey, twenty-four miles from New York, the home of Thomas Alva Edison, whom the Hall Telephone Company, of Boston, have the honor to represent in this section. The party numbered about two dozen in all, the ages, for the most part, of the editorial fraternity, but there were also present Mr. W. H. Forbes and G. Johnson of New York, the business manager of the Phonograph Company, Mr. Mitchell, Mr. Edison's agent, Mr. Batchelor, and several Mr. Edison's personal friends, including Mr. Batchelor, Mr. Edison's personal friends, including agreeable. On Wednesday the assembly met at the Hall, and at 10 o'clock the party started on a special car for Menlo Park, which was reached at 12:30 o'clock. Mr. Edison's residence, laboratory, and electrical manufactory are all within a stone's throw of each other, and the whole establishment is surrounded by a high fence, through which the photograph was put in operation, and the party were shown the wonderful results being attained. The phonograph was then put in operation, and the party were shown the wonderful results being attained. The phonograph was then put in operation, and the party were shown the wonderful results being attained. The phonograph was then

of wealthy, farmers. In the immediate vicinity of the station are several quite extensive dwelling-houses, forming the village proper. One of these houses is the settlement's store. It is two stories in height, painted red, and in front has a wide piazza, extending to the platform. Directly opposite the station, at the foot of which is the railroad station. It is a wooden building, about 100 feet long by 40 wide, and two stories high. The entrance is at the end which is flanked with several large windows. Over the entrance is a modest little sign of the appearance of being a watchman. On entering the building we were informed that Mr. Edison, after receiving a call there, and saying, 'I can't work now, it's 3 A. M., had gone home to obtain a little sleep. Mr. Johnson went to call him, and meanwhile we turned ourselves in an examination of the premises. On the right of the entrance is a private office, containing nothing of particular interest except a blank book and a letter-press. The latter bears the inscription, 'No. 101,' 'Laboratory Stock,' 'T. A. Edison, Menlo Park, N. J.' We suggested that the inventor's address, Mr. The next apartment entered consists about two-thirds of the first floor, and among the contents were cases containing numerous kinds of telegraphic keys, Morse sounders, galvanometers, a thermo-pile, self-clocks, and other articles connected with electrical or mechanical science. Two brick piers afforded support to the ceiling, from down upon a solid bench, and among the more curious articles was a pneumograph in process of construction. It consisted of a glass, a weight, and clock-work carrying the cylinder around, and a receiving pneumon with cardboard tube representing the nostrils. Against the apartment is the stop, where six or eight men are at work under Mr. Edison's direction. A small engine supplies power for the operation of the various machines which are in constant use beneath the floor. These machines are of the most first quality, as are the many tools that are used, and it is evident that those which seem at least too delicate to come in contact with the metals which they cut to those which are used for the most rough work are of the best kind. The workmen, who are mostly young, appear to enjoy their labors very much, and while they appear to have a commendably easy time are quick to understand and execute Mr. Edison's orders. Returning to Edison's private room, we found a gigantic safe in front of which the upper part of the building is used as a fire-proof room, occupying its entire floor. It presents a strange appearance at first sight. Its walls are hexagonal, and the walls are lined with shelves containing chemicals, each plainly labeled. In all directions, from the floor, wires hanging from the ceiling, the ends of to which instruments stands from one direction or another. Mr. Edison's desk is very torn by machines or parts of machines, some familiar and some novel. Only two or three persons were in the room when we entered, and each had access to work in hand. Questions asked of any of them elicit courteous replies, and any remark complimentary to Edison is sure to meet with a hearty indorsement on their part. Mr. Edison, who was very much occupied by all the workmen, was not able to judge by a moment of a few interviews, but we proposed to glance the name of the place from Menlo Park to Edisonville in his honor. In the laboratory, members of our party did not see any interesting in regard to keeping their desks off the articles on the floor and tables. Leading into the office. Even a small pipe organ that stood in one corner with a Moody and Sankey tune book on its desk and a few of the most carefully inclined to indulge in sacred music. There was nothing in the surroundings which said that would make inconvenient business operations. So a large lounge, one call, three chairs, a desk, a table, pen, ink, mouse, phone or medical house, the invention of Mr. Edison, the pneumograph itself, and a few other articles completed with. The floor is quite clean in appearance and admirably lighted, and there is no reason why it does a favorable opinion of the room before he entered. After looking the upper floor before he retired, we went down to the basement, where the boiler, engine, &c., are all in one compartment, and near this is a large wire cable to the car-house, which is to look over the cable to the car-house, which is now building between New York and Brooklyn.

MR. EDISON.

It was not yet 10 o'clock, when, with a quick step, Mr. Edison came in and took a seat at his desk. After meeting the building, we received by all of the party with a consideration of respect, but was by no means reserved, but was in consultation upon, and having greeted each of us in turn proceeded to business. He table on which he placed the phonograph which he now, and which is run by pulleys connected with the machine in the room beneath. The movement of a lever to the right or left gives the cylinder of the instrument a forward or backward movement, and the ordinary motion of the machinery gives smoother effects than the somewhat irregular motion secured by turning a crank by hand. While Mr. Edison is preparing a sheet of the foil to place upon the cylinder we will take a look at him. He is a hard man to describe, and on description yet stress of aim seems exactly correct. He looks young and yet old—years and yet fresh. His face is full of lines, and yet is remarkably free from them. A round head, a high shaped head is that features somewhat scarcely shock of hair, well sprinkled with gray, which projects over, but does not overhang, a fine shaped forehead, that bears several well defined though not deep lines. His countenance is open, his gray eyes are bright, his nose and mouth are well shaped, and he is in face very far from being a beauty man. Close shaven, his flesh is pale and unhealthy in appearance. When he is contemplating he wears a thoroughly serious look, and as he speaks his countenance lights up with animation. His voice is not what is one of weight or of pleasantry. In light he is about 5 feet 7 inches, and excepting a very slight stoop of the shoulders is of good figure and is fairly hale. He is not so-and' as has been described, and it is not a fact that he has never heard the voice of his own invention. He is very hard of hearing, but by placing his ear close to the sounder of the telephone he hears readily, and is very quick to detect false tone or false cause. His voice is soft and pleasant, and he is something of a singer. With a very retentive memory for tunes, he can remember a song after to repeat many pieces from memory, and in doing so delivers the lines with good taste and expression. He has been described as being careless and slouchy in his dress, but the Station party found this description scarcely justified. There was little of carelessness in straight-on, but there was no evidence of elegance. With Mr. Edison's previous history the public is already more or less familiar. He was born at Milan, Ohio, Feb. 11, 1811. His ancestors never came to this country in 1730. The Edisons are a Dutch family. Mr. Edison's father, who survives, lived to be 82 years old, and his grandfather lived to be 103. Mr. Edison's father is still living at the age of 76, hale and hearty, and visiting his son at the other day across. His is a stout footstep. Edison's mother was a Miss Elliott, and was a native of Canada, and was an Scotch descent. Edison's mother died when her son was almost more than two months in age. Mr. Edison's boyhood was passed in Michigan, Indiana, and well settled, and traveled extensively and across. His early years were spent as a newsboy, as train boy, typesetter of a newspaper, editor, newspaper publisher, telegraph operator and inventor. He was married in 1871, and has three children by his present wife. His children are all young, but are particularly fond of their father becoming a telegraph operator he has been a telegraph operator for many years. He has, however, seen to enable him to devote himself entirely to duties or appear more efficient than he really was. He is a thorough master of his profession, and has never taken the first rank in his chosen field. Questions are asked him in the test him best and understand the answers given. Mr. Edison is a believer in the theory that Edison knows to work for his own benefit, and among them are the electric pen and the telephone, the former of which has been in operation for about five years.

THE PHONOGRAPH.

We bid Mr. Edison more necessary ago, preparing the tin-foil to place on the cylinder of his phonograph. It is a very valuable tool, some of our readers may be not aware of the construction of the instrument. It consists of a metallic cylinder, which is covered with tin-foil, and which is run by a crank. Around it runs tool to form a screw-thread. The metallic being very close to each other. The cylinder is covered by a sheet, which by means of a lever can be brought into correspondence with the spiral groove carrying the tin-foil. The sheet is pierced with holes, and on one side of the other. To the sheet is fastened either a mouth or a puller. On the last upon which the cylinder is placed a diaphragm, and to the center of it is an arm which carries a needle point. This arm, moreover, so that the needle-point can be brought in contact with the tin-foil. The mouth-piece is then a disk of thin sheet-iron, which is taken in diameter, on the under side of which is cemented a small piece of hard rubber. Each of the needle-points on the end opposite to the mouth-piece is a small piece of hard rubber, to which is cemented a piece of tin foil is placed on the cylinder, the mouthpiece a few inches from the mouth, and the needle-point on the tin-foil opposite a groove in the foil. The cylinder is made into the mouthpiece the vibrations of the air are communicated to the diaphragm. When these are brought again under the cylinder they reproduce the vibrations of the disk by which they were originally produced, and in reaction on the sounds, articulation or inflection of voice, which, having once been a mere memory, are now a fact. Such is the theory. Mr. Edison reduced it almost applied a little tin-foil to one of the caps, and drawing the steel

assembly across the barrel, pressed the mouthpiece and drew close and as secured it. The examiner then handed it to notice. Edison, placing his mouth to the mouthpiece, recited a verse from 'Hamlet,' as the Editor was then afterward reciting very distinctly for the phonograph. Mr. Edison then set the machine in motion, and all saw the lever move. Turning the cylinder back the operator next attached a 'Yankee Doodle' to the mouth-piece, and as the machine moved the familiar air was heard. The new notes of Indianolive time in three slow music. The result was what the new, and the phonograph of the future all that was claimed for it. Mr. Edison then

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BOSTON POST.

FRIDAY MORNING, MAY 24, 1878.

EDISON AT HOME.

A Boston Delegation Visit the Father of the Phonograph—The Wonders of His Workshop.

Through the courtesy of Mr William McMahon of the phonograph management now conducting the exhibition at Horticultural Hall, half a dozen representatives of the Boston press were taken to New York Tuesday night, [illegible]d on the following day they proceeded twenty-four miles into New Jersey [illegible] Menlo Park, where Mr Thomas A. Edison resides and has his workshop. Mr Edward H. Johnson, the General Agent of the Phonograph Company, accompanied the party from New York.

The laboratory used by Mr Edison is a narrow, two-story wooden building about 100 feet long. About fifteen men are steadily employed here, but only on experimental work. The building is crowded with machines and the usual laboratory fixtures, and near Mr Edison's favorite seat were noticed copies of Longfellow and Poe, his favorite authors. Mr Edison received the party with great cordiality, and surprised them all by his lack of resemblance to the current cuts of his countenance. He is of medium size, with a smooth, kindly face, a shock of slightly wavy hair, and with an evidence of earnestness and activity in all that he does. His age is 31, but he [illegible] an older look, and there are tinges of gra[illegible] his hair. He gave a great variety of experiments tending to show the power and capacity of the phonograph. With a paste-board funnel he could speak into the machine at a distance of six feet, and a halloo was perfectly registered at twelve feet. When the machine was made to speak very rapidly the sound became a whistle, but if another phonograph was made to record this whistle and was then turned slowly the sounds were resolved into the original words, showing that the tin-foil had faithfully preserved every vibration. Mr Edison explained a number of his other inventions to the party. The phonometer was a machine by which the action of a phonograph vibrating point on a ratchet wheel gave motion to a series of wheels when spoken to. The motophone, which for practical purposes he declared was "not worth five cents," illustrated how a harp could be made to give out musical tones by the agency of electricity, and also how a current of electricity reduced the friction of a chemically prepared strip of paper. He said he had tried 20,000 chemicals and chemical combinations in these experiments. The harmonic engine he described as a large tuning fork (a horseshoe magnet four and a half feet long), and said he could utilize its vibrations by connecting it with a battery of four cells, so as to make it pump three barrels of water three stories high in twenty-four hours, at a cost of three cents a day. The vibrations of the magnet were about an eighth of an inch and thirty-five to a second. Mr Edison declared that he could make the thing drive a sewing machine in the simplest sort of a way, as there was nothing to get out of order. The Edison telephone and the electric pen were also shown and explained. The former was claimed to have thirty times the force of a Bell telephone, and incidentally in this connection the wonderful sensitiveness of carbon to heat was demonstrated. This carbon is obtained by burning benzine and rigoline, and the heat of a star will almost influence it. The telephonoscope, by means of which Mr Edison, who is somewhat deaf, had heard a cow chew at a distance of an eighth of a mile, was next exhibited. Conversation has been carried on by this aid when the parties speaking were more than a mile apart. The party were introduced to Mrs Edison and saw the great inventor's two children, and came away from the little town with the pleasantest of memories of their visit to Menlo Park.

BOSTON DAILY ADVERTISER, FRIDAY MORNING, MAY 24, 1878.

EDISON AT HOME.

A VISIT TO THE BIRTHPLACE OF THE PHONOGRAPH.

How the "Phonograph Man" Appears in the Midst of his Experiments and in his Home—His Laboratory—The Original Working Phonograph in the Hands of Its Inventor—Mr. Edison's Other Inventions and Discoveries—A Glimpse of the Home Circle.

The late Professor Henry, of the Smithsonian Institution, said of Mr. Edison, when the latter's invention of the phonograph was first announced, that he was undoubtedly the greatest genius not only of this but of any age. This is strong language, but the user of it was a man not likely to exaggerate in a publicly expressed opinion of this kind. It may readily be imagined, then, that the opportunity of spending a day with this genius whose name is now, perhaps, more frequently on the lips of the public all over the civilized world than that of any one else, and of seeing him in his own workshop in the midst of his experiments on his marvellous devices, would be an occasion to remember with pleasure and pride for a life-time. Such an opportunity has just been afforded to a representative of the Daily Advertiser and others, through the manager of the phonograph exhibition in Boston, Mr. William MacMahon, who, by the way, was the first person to place one of Mr. Edison's phonographs on public exhibition. The party left Boston by the Fall River line on Tuesday evening, and reached Menlo Park, a flag-station on the Pennsylvania road, about half-past nine the following morning. Were the natural impulses of the members of the party alone to be considered, much space would be required to enlarging on the pleasures of the trip, due to the kindness of their host; but as the public cannot be supposed to be interested in these personal matters, it must suffice to say that every attention was rendered which a thoughtful courtesy could suggest to a free-hearted host for the comfort and enjoyment of his guests, and these were seconded by the attentions of the officials of the Fall River line.

The party was peculiarly honored, too, by the patient attention given by Mr. Edison himself, considering his necessary absorption in his varied scientific experiments. He had been up all the previous night experimenting on the new plate machine which is to be exhibited at the Paris Exposition, and the arrival of his guests being earlier than he had expected he had to be summoned from his matutinal slumbers by his New York manager, Mr. E. H. Johnson, who had joined the party at New York. The visitors eagerly awaited his coming at the laboratory at the summit of an eminence within a few yards of the inventor's home. When once in the presence of his guests it need not be said that he was the object of a most eager and searching scrutiny, and perhaps no man in the country could have received it with less evidence of self-consciousness. Mr. Edison's personal appearance is hard to describe. Only thirty-one years of age, he has the maturity of countenance and presence of a man full forty, while his entirely unaffected, easy manners are those of an artless boy. Certainly no country lad in exhibiting to his companions a fine string of fish he has just caught could exhibit less trace of suspicion that he was of any peculiar importance among his fellows than does Mr. Edison in showing the wonders of his phonograph to the humblest visitor who may be so fortunate as to win his attention from his work. He is about five feet seven inches in height, naturally athletic in physique, but apparently by excessive devotion to mental work somewhat over-developed in brain to the neglect of the maintenance of physical vigor, this showing itself also in a tendency to round shoulders. His countenance is broad and open, and when at [illegible] with a dreamy, absorbed look that a superf[illegible] observer might mistake for vacancy, but one [illegible] of conversation with him calls forth a light and intelligence in every feature that makes his countenance a fascinating study. His features are large and regular; a rather long, well-formed nose, full, arched and eloquent lips an[illegible] intelligent gray eyes, overshadowed by a noble brow and straight, unruly brown hair, already plentifully sprinkled with gray, all combining to reveal the genius of which they are the outward expression. His face is shaven, and his complexion of that sallow, almost sickly hue that sedentary habits, continued after long into the night, almost necessarily produce. He walks up the hill with Mr. Johnson, plainly but neatly attired, and his head covered with an old, broad-brimmed felt hat without a band, which, however, later in the day was replaced by a silk hat which had evidently not felt the hatter's iron or brush for days. On being introduced to the guests he apologizes for his tardy appearance and at once sets himself before his phonograph—the first practical machine, by the way, ever produced—and begins a series of experiments illustrating its powers. The machine is essentially the same as that now on exhibition in Horticultural hall, except that it has the fly-wheel noticed in most of the pictures of the machine, but which has been found to be superfluous. The machine is turned by a belt from the machinery, at a uniform speed, and thus is gained an accuracy, particularly in the reproduction of music, that cannot be obtained from the hand machine.

The exhibition given by Mr. Edison was similar to those with which the public is now generally familiar, and need not be reported in detail. There was, however, a peculiar interest to the visitors in witnessing the inventor's enthusiasm in working the product of his own brain, his manner being much like one's fondling a pet, for the phonograph is evidently Edison's pet invention. One of his illustrative experiments deserves notice for its novelty. This was what he called "mutilation of the record"; that is, a record having been put on the foil, Mr. Edison scratched across it in several places, tearing perhaps forty or fifty holes in the foil. The effect was to mar the reproduction only about as much as hoarseness in a speaker would mar his speech, the utterance of the machine being hardly less distinct than usual. So interested was Mr. Edison in showing the phonograph that it was with some difficulty that he was induced to leave it in order to give his guests explanations of some of his other inventions, only less marvellous than the phonograph. These may be briefly noticed. One of them is the "motophone," a device for reproducing musical tones thrown into a telephone at a distance and connected with it by a wire. The tones are reproduced by harp strings set in vibration by a device depending in its action on the property of a chemically prepared paper in instantaneously losing its frictional, or "biting," property, by the passage of a current of electricity through it. On being asked if the device could be put to any known practical use, Mr. Edison artlessly replied, "No, it isn't worth five cents for any practical purpose."

The "phonomotor" is a simple instrument for converting the acoustic vibrations of a diaphragm, when spoken against, into a motive power for running light machinery, and the device is simple in the extreme. It was produced merely as a curiosity, in acceptance of a challenge once made to him, in a bantering way, to invent a machine that would "talk a hole through a pine board," and sufficiently proves the feasibility of this seemingly absurd idea. The "harmonic engine," is an immense tuning-fork, vibrated by galvanic batteries, the power of these vibrations to be utilized in producing actual work. This is truly a beneficent invention, for it can be used for pumping water for household purposes, the running of sewing machines, and for other domestic purposes. It requires hardly any care, and the expense of working it is but a few cents a day. By its means, nine-tenths of the battery's power is made available, where but one-tenth can be utilized by any previously invented machine. The electric pen, a device well known to the public, for producing writing or drawings in stencil on paper, from which copies can be rapidly reproduced by means of a common printer's ink-roller, was also shown, and, through its instrumentality, each member of the party was furnished with Mr. Edison's autograph. The principle of the Edison telephone was also fully explained, and its powers fully tested, but with this invention the public is already familiar. Much has been said in the papers about a device which Mr. Edison is working on for the benefit of deaf persons, and much curiosity was felt by the party in investigating this. The most that Mr. Edison hopes to accomplish in this direction is the production of a device which one may carry to the theatre or any public place, and, holding it in his lap, where it will not be conspicuous, collect sounds that would otherwise be lost to him, and which will be conveyed to the ear through a small tube. Its action depends on a law which he has discovered, that acoustic vibrations may be best caught and concentrated by a funnel or trumpet, having the shape of a cone of light rays proceeding from their source through the small aperture of the funnel. In other words, it will be a suitable employment of cone-shaped receivers, with which it has been found one may catch very slight sounds from a surprising distance. Mr. Edison tells us that by putting one of these receivers to his ear he has heard a cow munching the grass a quarter of a mile away.

Mr. Edison's combined laboratory and machine shop contains many more illustrations of his [illegible] satile genius, these embracing chemical as well as mechanical inventions, but time did not permit the visiting party to linger longer, save a flying visit to Mr. Edison's home. It needed but a glance inside the cosey, tastefully furnished rooms to prove that the traditional home life of an inventor here found one happy exception, and this influence was confirmed by the appearance of the lady of the house, a noble woman physically, a real blonde, with fresh complexion and an unaffected manner that was all the more charming from the entire absence of the conventionalisms of many a lady who has the reputation of "shining in society." Two sweet children bless this home, a girl about six years old, and a boy,—Thomas Edison, jr.,—of two. Mr. Edison added to the compliment of his patient attention to his visitors during the day by accompanying them to the station to take the train shortly after three o'clock, on the return trip, and in bidding him farewell all took occasion to utter what is certainly the wish of all Boston people, that he might soon visit the city and receive the hearty welcome which is awaiting him in his former home.

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EVENING TRANSCRIPT

THURSDAY, MAY 23, 1878.

ENTERTAINMENTS.

EDISON'S LABORATORY.

A DAY AT MENLO PARK WITH THE GREAT INVENTOR—THE ORIGINAL PHONOGRAPH—THE AEROPHONE, PHONOMOTOR AND OTHER INVENTIONS—[illegible]LECULAR MUSIC.

By the courtesy of the management of the phonograph exhibition at Horticultural Hall, representatives of the Boston press passed yesterday at Menlo Park, New Jersey, with Mr. Thomas A. Edison, the inventor, whose name has within a few months become a household word almost throughout the world.

The party started from Boston on Tuesday night, and, by way of the ever-popular Fall River line, reached New York the next morning. Here Mr. Edward H. Johnson, the general agent of the Phonograph Company, joined the party, and at a few minutes after [illegible] o'clock the Philadelphia express train left [illegible] at the flag station of Menlo Park, twenty-four miles from New York city.

This quiet retreat, which it is now proposed to name Edisonville, was chosen by the inventor for his home and workshop, more for its seclusion than for its natural beauty, though it by no means discredits its name. The laboratory, which was soon reached, is a narrow two-story white wooden building about a hundred feet in length, situated upon high ground. There are no buildings in the immediate neighborhood except those occupied by Mr. Edison and his assistants, and these are tastefully built. Entering the laboratory, Mr. Johnson inquired for "Tom," as he familiarly termed him. "Oh, he is n't up yet. They worked until five o'clock this morning," said the clerk at the office desk, who files Mr. Edison's papers and looks after his correspondence. "All right, I'll get him out," said Mr. Johnson, and away he bounded for the house, some three hundred yards distant. Awaiting the appearance of the host, we will introduce the reader to the much-talked-of

LABORATORY OF MENLO PARK.

The office at the entrance is succeeded by a room occupying about half the first floor. On either side of it are tall glass show cases filled with delicate electrical and other apparatus, and beyond is a large-sized cylinder phonograph, with clock-gearing attachment. This was the machine destined for the Paris Exposition, upon which Mr. Edison had been at work all night.

The cylinder had not been evenly cut, and when first placed in position would not work, not being properly balanced. The rear room is the machine shop, containing at least a dozen lathes, dies and other machines. About fifteen men are employed here from eight o'clock in the morning until eleven in the evening, but nothing is made except for experimental purposes. The room above is the laboratory proper. As we enter, a card with an order in the neat, square hand of Mr. Edison, "No admittance except on business. This rule must and shall be enforced," with the "must" and "shall" doubly underscored, looks us in the face.

Nevertheless, we have been invited, and therefore enter. In the large hall everything appears in place. The wall is lined with more than 2000 bottles. Every chemical that is known is here, said an assistant; everything in the botanical line also—roots, herbs and seeds. Indeed, we found not only everything, from "dragons' blood" (a vegetable substance) and Brazil wood to Iceland moss and gold ore, but preserved snakes, and, in a case in a corner, watches, razors, and many common and uncommon mechanical contrivances; conical paper funnels, six feet high, a

fair-sized pipe organ and a small elastic bow."

Of course, the usual laboratory fixtures and experimental apparatus, microscopes, lens measurements, an air pump, insulators, spark generators, etc., were present. Not an induction coil, a foot in diameter and eighteen inches long, was a novelty. It is a recent addition, cost originally $500, and is capable of flashing a spark ten inches long—quite a streak of lightning.

The patent-office model of the phonograph, a cylinder covered with tinfoil, some inches in length, and the first experimental phonograph, a stubby instrument with cylindrical brass cylinder and mica sides—one is not to be sound and another to emit it—was examined. Beside the first practical machine, the one at which Mr. Edison experiments almost daily, lay a well-handled copy of the poems of Edgar A. Poe, though Longfellow is Mr. Edison's favorite.

It opened readily to the "Sonnet to Science," one of Poe's practical poems, beginning—

"Science! true daughter of old Time thou art!
Who alterest all things with thy peering eyes."

We had an need to read further. Nearby to the piano, those who chose looked through the telescope pointed toward the towers of the city, upon Bridge, down Nassau, and across the water. Through the glass the wire cables were clearly discernible.

But Mr. Edison is now returning above the fold with the particular object of our visit,

THOMAS ALVA SPEAKS.

They pause by the telegraph pole, and in its shelter, for the air blows smartly over the hill, Mr. Edison lights a cigar. He is in a boisterous humor as well as his dialect, for there is no narrow diet, and declares that Yankees get their name from an Indian tribe that subsisted chiefly on pie by eating many kinds of food. He approaches with an easy gait, and shows the wind we bear the voice of his companion, for, as is well known, he is somewhat deaf, but in the field of acoustics is slightly past. Indeed the party is being interdicted we will not have overheard.

He is in force almost, and slightly above medium height. A genial, prosperous appearance, voice and air are often observed. The photographs and periodical portraits do not do him justice, for they are not at all prepossessing, for they represent him as ungraceful, listless and concentrated. "I'm true Mr. smooch nevertheless face is haggard and rude, and his coarse and almost repulsive features suggest a canine all over his large head, particularly from a canine all over his blue eye looks wonderfully light work and intellectuality. But as kindly and youthful an expression, as frank and clear a countenance, and as noble and refined a head never was met with. When in conversation his eye lights up with a peculiar glow of earnestness that stamps him as no common man.

The phonograph not having arisen sooner, with the caveats that he expected us at ten o'clock, he seized upon it as a particular before

THE PHONOGRAPH,

the first practical one ever made, and adjusted a new sheet of tinfoil upon the cylinder. The phonograph in outline rest in familiar in all the telegraph that has already published an accurate description of it, and most of its readers have doubtless seen it in operation. The cylinder of the machine, as Mr. Edison is seated is of brass, and is revolved by hand power sent up from the shifting below. The cylinder, therefore, has a small balance wheel. The mouth piece or tube pasaes in like those attached to the later machines—simply a plate capable of receiving and transmitting sound vibrations, with a short nozzle or spike glued to its centre and running in the grove of the cylinder. Mr. Edison then turns the power and spoke into the machine, "The dying Indian suffered as he took his comrade's hand, and he uttered," it never more shall see my own, my native land," as a message sent a token to some distant friends or relatives, for I was born at Niagara, fair Niagara on the Hudson, in very borne the morning." Returning the cylinder to its first position, he placed a paper thin diaphragm over it to prevent too wide a dispersion of the sound, and turning the cylinder again reproduced his words without a noticeable variation in tone and distinctly audible several feet distant. Then, to the work of the invention with which the public is already familiar. Now over the same piece of tinfoil he

whistled "Yankee Doodle," and reproduced the poetry and whistling together, yet each as distinct as though one person were whistling while another spoke. Then the same sheet he cackled and crowed and reproduced, as before, the three notes. Again and once or fourth time he went over the foil, this time calling in base tones and rolling "r's," "Hub-a-dub-dub," and to a rich, the fellow, the baker, the candlestick maker, all jumped out of a rotten potato; one, two, three, four, five, six, seven, eight, nine, ten." The phonograph quartette now repeated "Singer, on the hills," whistling, cackling, and called "Hub-a-dub-dub," all together, and with nearly as much distinctness as four different voices speaking at the same time could have done it. Then the whole was given backward—a frightful medley! Yet the whistling, though somewhat diminished, was distinct. Alternately and "Yankee Doodle" was whistled and given backward, and the effect was ludicrous.

Mr. Edison has not yet completed his experiments in the phonograph, for in the absence, during the afternoon, one of his assistants mildly called it a "mad dog" and turning the cylinder backward was answered in a shockingly profane manner.

This property of repeating sounds backward will doubtless be of great acoustic value in the future. "Once, when I had a little Indian, John Brown had a little Indian, John Brown had a little Indian boy." was sung so that in the words would be repeated, and in its reproduction the words would be heard in their proper order except backward, as the sound struck the drum and tore the tin foil. Immediately a screwdriver readjusted the machine and the "Wandering Refugee" was sung in a fine bass voice. Then, over this sheet, Mr. Edison sang it again, in a different tone, and the phonograph repeating both parts, imitated the company in a duet. "There," said Mr. Edison, "it is it's every one that can

SING A DUET ALONE."

Then upon a clear piece of tinfoil he sang and whistled, and another duet was given, though there was lack of harmony, for this reason, and it shows a most wonderful property in the instrument—As the operator sings the second tone he hears the first one, which he has by the force of vibration, and this runs through the same vibrating plate that he is receiving the new tone. The same plate is passing vibrations by repulsion upon the foil while it is transmitting, or speaking from the same foil the first record. In this instance, the whistling being so much sharper, prevented the use of the whistling hearing exactly the first air, and thus unison or harmony was not obtained.

Mr. Johnson laughed into the instrument so that the machine would laugh through the tinfoil, perpetuating it for several inches. Nevertheless it returned the laugh when reproduced Mr. Edison's coughing, blowing and sneezing. Mr. Charles Batchelor, the inventor's assistant, now entered, and Mr. Batchelor was engaged with a double mouthpiece, and placing their heads close together, Mr. Batchelor and Mr. Edison sang "John Brown's body lies a-mouldering in the grave," etc. No purer tones or clearer harmony would be asked in a concert room than that with which the phonograph reeled off the song. Regarding the mechanism, it were a musical treat to watch the machine at work. The writer bore away his piece of tinfoil as a trophy.

The little wonder-working instrument was re viewed in each different performance—was then made to speak in Greek, in French, in German, in "My get the best reading Latin," and in English, "and the poorest in English." Then he scratched on full after the explanation, which he called "scrutinizing the record." The voice in the reproduction was not so distinct, but each word could be understood. "I make it talk hoarse, that way," said he.

ITS CAPACITY.

"How far does a word extend on the foil?"

"Well, let me see. Phonographic words, that extends once around the cylinder, and there are 600 utterances for that word."

Then Mr. Edison spoke through the funnel—about a foot in length; then off a foot from the funnel, or two feet from the instrument. The repetitions were clear. "With a pasteboard diaphragm," said he, "which is much more sensitive than iron, I can speak into it from a distance of six feet and can talk into it twelve feet. I think I shall use a paper diaphragm on the regular machine." Turning it slowly by hand he spoke into it again, and then worked it fast so that the sound became a whistle instead of articulate speech.

"We had two machines together here the other day," said he, "and connecting the diaphragms with a rubber tube, ground off from one machine, the sound was taken up and whistled through the tube and registered on the other. Then we reproduced the speech from the second machine, turning it slowly. When it was turned the cylinder slowly that tenor-three words were recorded in two revolutions. Then the same were recorded in less than half a revolution. That was at the rate of forty-five words a revolution; there are sixteen threads to an inch, and the cylinder is eight inches.

This calculation allowed for 2100 words upon one cylinder foil, that covering, or about three columns of the Transcript. "I can do that as it is now," said he, "and can have two hundred threads to an inch and double the length of the cylinder, twelve times as many words, or 25,200. That is equal to the matter of a fifty-cent novel."

THE PHONOGRAPH.

When Mr. Edison was showing some results of his invent'gations in Philadelphia, some one jocosely remarked, "Why don't you invent a machine to talk a hole through a board." He thought a moment and replied, "I guess I can." He ordered boxes and constructed a small phonometer, and when the company now turned to look at the card on shown was a vibratory plate with a hole through the centre. Into the centre of it with a needle point like causes of the plate moved the ratchet wheel, and the ratchet wheels attached upon the same shaft. Several of the visitors spoke against the plate, and sent the wheel whirling at a rapid rate. Nothing being nor say other force except the human voice would move it.

THE MOTOPHONE,

or sound engine, was a curious musical instrument. A harp had been set up with an almost square frame upon the end of a bench. To the centre of its STRING[illegible] board was attached a bar which brought its centre in contact with the centre of a small disk. Upon the end of about fifteen pounds upon the foot of a lever, which, when it struck a string of the harp, sent the disk whirling. The passed from a motor. A current of electricity was then sent through the wheel. Mr. Batchelor, being several miles through a telephone, and they were repeated by the harp—the musical tones only. At the same time Mr. Edison revolved the small wheel and gradually drew out the electricity-prepared paper. He explained that this machine was vibrated by the action of electricity increasing and decreasing the friction upon the strip of paper. When the paper was drawn out slowly the motor was set up a vibratory motion, and the sounds given out were low and deep. If drawn out, it slightly, the sounds were the same reflected in the semitones. A current being suddenly reduced the friction, and the bar sprang back, vibrating the sounding-board. The machine is capable of 30,000 vibrations a second. It should be remembered that the Edison telephone is merely the increasing and decreasing of the force of an electric current by sound vibrations. Why electricity diminished the friction, and why it increased it, no one knows, but the fact is that a piece of potassium, which acted on the paper, but he had tried 28,000 chemicals and chemical combinations, and none increased or took the "friction against the paper. Only salts were of use. It will work well, and the more alkaline the better it is. The same principle was shown in other electrical apparatus. The practical purposes, however,

THE HARMONIC TELEGRAPH.

"What is this, Mr. Edison?" said one of the party, pointing to a horseshoe magnet with a bent bar of iron four and a half feet long—with a tiny dress-pound weights on each end. "Only that, my dear harmonic anglus," said the inventor, well pleased with the question. "It is really a large tuning fork. I can utilize its vibrations by connecting it with a battery of four cells so as to make it pause a dozen bursts of water three stories high, in a sky-four hours. I mean to apply it some day to the pumping of water for gentlemen's country residences. It can do as a matter of three cents a day—the expenses of four batteries." He set the bar into vibratory motion, by connecting the current. It was then an electro-magnetic instrument. A motion, and of about the force of one-horse power. The oscillations were about an eighth of an inch. The bar was not long-opened and closed the electric current in unison. The vibration, in this case as visible as the eye could oscillations, were at the rate of thirty-five a second. Mr. Edison declared he could make it run by sewing machine in the ordinary possible manner, for there was nothing to get out of order, the longest opening and closing its own circuit. But he said he would be obliged to have two [illegible]-bars—one, if necessary, a "dummy"—being an equal power, so as to preserve the [illegible] vibrations, for if reached to one end than to the other, the result would be the destruction of vibrations, in proportion to the unevenness of the powers, just as the tuning fork the vibration is destroyed if the ends of the fork are not evenly weighted. For the pumping machine the two pumps might sometimes be said to be tuned. Mr. Edison said that theoretically he got nine-tenths of the power of the machinery with this machine. All other machines, he said, lost two-thirds of the power of the battery, theoretically speaking.

Mr. Edison now turned to the visitors with a practical application of one of his inventions, the electric pen. This is a pen which, even if quite rapidly moved over the paper, cuts a line by means of a needle moved rapidly up and down in the pen case by an electric motor. From this almost impression are taken by the common printing process. The saver's telegraph and a picture traced from an illustrated weekly, all done by the electric pen or stylus, were handed each one of the party.

THE HUGHES TELEPHONE

was next exhibited and explained with the utmost frankness. It is entirely different in principle from the Bell telephone. Such inventors worked at the same time on different principles, and produced the same practical results almost simultaneously. Bell's telephone employs either a permanent magnet or an electro magnet, and the vibrations of sound are transmitted by means of a disturbance of the magnetic field, as in the magneto fork. Edison's method depends on variations in resistance or diminish—the resistance of passing galvanic electricity. The latter is by means of placing a disk of pressed carbon, about the size of a small quarter, between two platinum disks, healed a tympanum or vibrating plate, and the pressure of the loose at the voice compressing the carbon disk regulates the current of electricity passing through it, and the sensitiveness of a disk at the other end, vibrates another tympanum, reproducing the sound. Mr. Edison's telephone was spoken through the mouthpiece attached to the battery of four cells. According to the laws of the sciences, it is conceded that the Hughes would reproduce a sound giving it at times more force than the Bell telephone. Mr. Edison used other apparatus utilizing the sensitiveness of carbon to heat and pressure. Attaching a telephone to a galvanometer he pressed the tympanum with his finger, and the needle moved, the pressure increasing the resistance and diminishing the current. The weight of the plate on the carbon disk, to produce. Mr. Edison started experiments in this direction in 1875. In his first telephones he used rubber, but the heat of the hand, so sensitive was the carbon, made it necessary to substitute iron, and then to discard a handle altogether. Brass was found to be more sensitive than iron; then iron plate to be used in the place of the soft instead of brass. The thermopile, the next instrument for measuring heat, said Mr. Edison, is as sensitive as the sensitive as this carbon. With it and

THE BEAT OF A MAN

of the first magnitude he can almost open and close a galvanometer circuit. When he leaves the room the needle moves. He can detect the heat of a person after he talked to Mr. Batchelor through the. The latter called out, "What are you doing there? Where do you get that music?" "Here's it got any music," said Edison. But a clear musical tone was heard about once in every five seconds by Mr. Batchelor. Investigation showed that the contraction of the molecules in cooling produced what had probably never before been heard—molecular musical tones, then caused molecular music.

The carbon is obtained by burning benzine and rigolene. Benzine is, lampblack is not black at all. Many more things were shown and explained, which, though they did not weary the writer, might weary the reader.

THE TELETHERMOPHONE.

to do for the eye what the telephone does for the ear, and upon which the introduction to the astonishing waves of sound for waves of heat, was explained. With three-the receivers and communicators must be different—conversation has been carried on a mile. The sound is shot out of a bore formed like a bullet from a rifle barrel, and must be aimed correctly to produce an effect. Mr. Edison pointed to a tree an eighth of a mile distant, and said he had heard the clamour of a row under it from his laboratory window.

After a pleasant visit to the Edison family, the company took its departure, joining in a regular "Tiger" for the "Wizard of Menlo Park." As many friends as room, if possible, the mind that wears its head concealed his Exposition manner, and the "Tiger" was given with a will.

Thanks are due to Mr. William McMahon, the manager of the Edison Phonograph Exhibition Company, for the courtesy and instruction of this entr'acte-to-be-considered visit to Menlo Park.

Boston Journal.
WITH SUPPLEMENT.
SATURDAY MORNING, MAY 29, 1878.

EDISON AND HIS INVENTIONS.

MORE ABOUT THE "WIZARD" AND HIS LABORATORY.

One full article describing the Menlo Journal of Thomas A. Edison at Menlo Park would be a volume of itself. Edison at Menlo Park would be a volume of itself. Nearly to a description of the principles of the phonograph, the telephone, the microphone, with the latter there are also experiments, revealing to be presented. In regard to it it is now made there are 16 threads or gratings of the cloth, and as each thread is 100 wires, or filaments, that, through, or, rather, over 1,600 wires, or filaments, help to speak the voice. The whole cloth is about two inches square, and the telephone is complete. The receiver is also improved, and it is now so arranged that in an extended distance the words would not be unintelligible, the message, and coupled, therefore, but one-tenth of a millionth. The strange result of the experiment is that the articulation is clearer at a distance than when the receiver is held close to the mouth. Words which may be recorded upon a cylinder phonograph before upon the metal disk, reproduce, as a matter of fact, by drawing the cylinder-record lever before the cylinder eight inches instead of a record of eight words would be spoken. The two pictures above, as reproduced on the photograph, are modified representations of two of Edison's latest inventions of the cylinder. One record is made into a tin very fine sheets and the reading is done by a phonograph exactly like that with the metal is but a fraction of a millimeter thick, so that any have been spoken, and the production of a whistling sound. The machine, however, is a source of a similar connection between the mouthpiece of the speaking instrument and that of a receiving one will make a record that can be similarly spoken. Edison has also invented a new form of the original Morse alphabet for the use of telegraphers, requiring, however, only a rapidity when used by skilled hands. This is what Mr. Edison himself says: "I would like to talk to each other." One of the greatest difficulties Edison finds in connection with the phonograph is that of getting the cylinder exactly and the letters in which the sound is recorded are distinctly shaped to the ear. The cylinder per makes a record, and if the slightest variation occurs, and the phonograph is at all at work receiving, the produced will cause a record that would sound like a confused mixture of sound of thing. The latest information, and that personally given, is all derived from Edison himself.

WHAT IS DONE NOW WITH THE PHONOGRAPH.

If only half that has been told were true the phonograph would be a great curiosity, but as it is at present can be demonstrated with exactness not enough that the inventor should be a 'valuable article' for entertainments. Though the idea of a megaph company has been in existence but a few months, it has already had a large number of applications for the use of the instrument which to exhibit it. In many places in America, in Canada, in Australia, and in other parts of the world exhibitions are already at work, reaping a percentage of their profits to the company, and in a few months the number will be greatly increased. This is the only way to utilize the invention for the present, save to the company, but the return is a profitableness. Edison has also received from the Emperor of Germany addressed here a facsimile, the message addressed at Hartlebottom itself since Mr. Wilhelm Siemaltin service of the whole nation, and the correspondence per day. The phonograph has been to unite a good deal of the time of Mr. Edison's performances to the representation of current playing.

THE MICROPHONE.

After having shown what could have proved to him a thousand times of experiments upon the phonograph, and answered a thousand questions, Mr. Edison next proceeded to show the microphone, which were invented him several times in various forms. Mr. Edison took his visitors into the room where the telephone apparatus was. As described, this instrument is a sounding board, over which are stretched wires representing the notes of a piano. Underneath the wires are magnets. To the sounding board is a speaking tube, through which any one may talk a sounding wheel. The connection with the wheel and the apparatus is maintained by a platinum point dipping into a cup of mercury. The wheel is revolving, the mercury flowing this point in the cup, and the current is broken. Now, when the instrument is in use, and the key projecting from the sounding board, a sawyer strikes at other, the vibrations are carried to the wires, and the magnets are sent such that the motion is somewhat approximating under the bar causes the sounding board to vibrate, whose force should be so adequate to the current, at which time the sender alternatively and broken alternately by vibrations in the telephone. The vibrations in the sounding board correspond, and are exactly like those of the speaker's voice, and the receiving ear or ear of the attached wire. Mr. Edison was seen with what we may call the sympathy of those who have not seen it, and the instrument is connected to the outside wire. The experiment discerning that was a pleasing one, Mr. Edison's voice was heard in the room through the telephone, and the instrument under inspection reproducing the words with much distinctness. Mr. Edison then explained to his visitors that Mr. Edison made no invention capable of expectations in the progress of developing the idea which is to be a telephone, and that the instrument is the invention of no person that wants to use, or to use his own words, "not worth five cents, except as a toy or a thing."

THE LOUD-SPEAKING TELEPHONE.

Another invention being of Edison established to his genius of great benefit of practical value, but to be a loud speaker, sensitiveness, and modified from an ordinary telephone. Mr. Edison has made a number of these of Edison's devising to the public, asserting that "no one is either deaf or being deafed, the receiver of the loud-speaking telephone is something of a disposition to hear." He seems disposed to be taking as they are considered, and the receiver is not to be used in connection with these principles that he intended as a speaking one, but that it is not to be used in connection with the phonograph. "I would rather be rolled," he said, "than to be deafened." There are probably few persons who have seen the record of the phonograph, or a series of disks, following the experiments given below the fact, for the sake of convenience, whether he desired to have words with half a millionth. One of these words which may be recorded upon a cylinder dressed of the cylinder during the experiment

catching the sound, conveying it through the air-chambers and increasing it at every stage until it reaches the ear. Edison's description of it was, "it makes one's ear feel as big as a house." The speaking apparatus consists of a long tube reaching into an air-chamber, and through the ce" "rth of this tube is run a spiral wire. At the end of the tube is placed a large" "l-shaped fennel. The action of the spiral wire is to give to the sound, as emitted from the mouth, a revolving motion, similar to that given to a ball shot from a grooved rifle. By this means, and also passing through the air-chamber, he is enabled to throw the sound to an almost incredible distance. Two men, each with one of these machines, have talked with each other two miles apart, and a person talking in the trumpet in an ordinary tone of voice can be distinctly understood at the distance of a mile. Mr. Edison repeated several instances of the performance of this machine, which I will not have space to narrate. There is one thing that can be relied upon, however; this is not to be the last of the many wonders that spring into reality through the skillful ingenuity of the wonderful Edison. The man seems to have no end of ideas, and when he once gets the idea it is sure to be carried out.

There is a lively interest shown by the New York public at present, as to the probabilities of a war between England and Russia, and I must confess that a large majority show a strong feeling of friendship toward Russia, and many expressions of satisfaction are heard upon every hand that she has succeeded in maintaining her position in the diplomatic negotiations which have been carried on during the past six weeks. Russia has taken pains to have it distinctly understood that in case of war the first blow will be struck at England's commerce, and her transactions in this vicinity show that it is no idle threat. During the last week Russian agents have completed negotiations for the new Pacific Mail steamer, "State of California," the "Columbus" of Clyde's line to Havana, and the celebrated schooner-yacht "[illegible]." The "California," was launched at Philadelphia May 16th, and was originally intended to be placed on the Pacific Mail line, running from San Francisco. She was built expressly for speed—the builders guaranteeing six-teen knots an hour—for the purpose of beating the "State of Oregon," of the opposition line. She is now being plowed for guns, and will make a dangerous cruiser for British shipping interests. The "Columbus" is one of the fastest steamships that runs from this port. The Russian agents paid $110,000 for her. She is to be brought to this city and work commenced immediately. Of the short and tragic career of the "Mohawk" there is more to say. She was built about three years ago by the late Commodore William T. Garner, of the New York yacht club, and cost, complete, $175,000. This yacht is 144 feet long and carries the enormous spread of 22,000 square feet of canvas. In 1870, while at her anchorage opposite Staten Island, through the negligence of the sailing-master, who allowed her sails to be hoisted while at anchor and the centerboard up, she was struck by a squall and careened suddenly over. From the fact that the lead ballast was not properly secured, it was impossible to right her and she went to the bottom, drowning Commodore Garner, his wife, Frost Thorn and Miss Hunter, who were in the cabin. The yacht was afterward raised, but has never since been used. Notwithstanding this accident, she is considered a remarkably seaworthy boat, and will go into the dry-dock immediately and be cleaned and painted. An auxiliary screw will be put in her and then sealed for sea. The price paid was only $25,000. The yacht is capable of carrying two heavy guns, as she is very solid, and it is not very probable that any English war-vessel could overtake her either in fair weather or foul.

It is evidently the intention of James Gordon Bennett to return to this country before long, for the true story of his duel with Fred. Mc" who publicly cowhided him, has lately been made public by one of the seconds of the affair. It seems that at the first fire both Bennett and Bennett's pistol only escaped; then Bennett's second then demanded a return fire, which was accorded by Mc" and his second. Bennett then fired into the air, and the principals shook hands and left the grounds in different directions. Fred May proceeded to Washington and James Gordon Bennett to Europe, and so ended the duel. There comes a whisper from over the Atlantic that his sister, Jennette, who has been doing the honors of his establishment in Paris, is engaged to be married to an Irish peer [illegible] complications. The year is quiet on Broadway, and Commodore Bennett is a bachelor, but it is to be presumed that there will not be wanting in this case those mutual concessions so necessary for the happiness of the married state.

QUIVER.

Cape Ann Advertiser

FRIDAY, May 24, 1878.

An Hour With the Phonograph.

Last Friday afternoon we spent a very pleasant hour in Horticultural Hall, Boston, listening to the wonderful speaking phonograph, recently invented by Mr. Edison. It is indeed a wonder, and rivals the telephone in its claims to be the most wonderful invention of the past few years. It is marvelous that a thing with nothing not much larger than an apple-corer can repeat what is said to it with such distinctness, simply by the turning of a crank. There is a cylinder to which the crank is attached, also a mouthpiece which can be raised or detached from this cylinder. This mouthpiece contains a piece of ferrotype plate, about 1½ inches in diameter, and is dampened and clamped between two rings. There are pieces of india-rubber pressed in between these two rings so that the ferrotype cannot sound its fundamental notes, but will only respond to what are called forced vibrations. Upon the under surface of this piece there is a little steel point which is attached to the plate by means of a rubber ring intervening between the plate and the steel point. When the lips are placed at the opening in the mouth-piece, the vibrations of sound produced in speaking will be communicated on the plate, thus causing the steel point to be depressed and raised, these motions succeeding each other with a rapidity depending upon the rate of vibrations in a given tone of the voice.

The cylinder is grooved with a spiral thread. The steel point impinges in the depression or grooves of the cylinder upon which a sheet of tinfoil has been attached. As the cylinder is turned, the point traces the spiral on the whole of the surface covered with the foil. You talk against the plate, and by simply reversing the motion of the crank it will repeat what was said.

The experiments were intensely interesting. The operator repeated the familiar poem,

> "Mary had a little lamb,
> Its fleece was white as snow,"

and immediately as he reversed the crank, it was repeated through a tarnished tunnel, obeying all the inflections of his voice. A correct player performed several tunes, placing his cornet over the mouth-piece, and they were all repeated with wonderful accuracy. Some one sang in the mouth-piece and the singing was reproduced. Imitations of crowing, barking, cat calls, whistling and singing, were also repeated, affording much mirth. The possibilities of the invention seem almost infinite, and songs once sung into its mouth-piece, addresses or readings by distinguished persons, messages from loved friends, may be repeated at will years after they have been uttered, as the tin foil containing the impressions can be kept, numbered and reproduced whenever wanted.

—A suffering father wants Edison to invent some kind of a phone or graf that would be acted on by the cry of an infant in the night, so it would instantly grow the cradle and rock like the tender billows on the ocean's breast.

March 24, 1878

"THE TELEPHONE."

He is a Great Man Now.

Mr. Edison, as a yo" " telegraph operator at Memphis, " known for the quaint drawings with which, in odd leisure moments, he illustrated the Southern Press reports. One habit was to convert the tails of his g's and y's into faces, with the most ludicrous expression imaginable.— Another habit was to draw a railroad curve around a ball, with a train of cars at full speed; on the first car was a T, on the second Y, and so on until Tyler, the signature of the report, was spelled out, and the last car, " " " perceptible round the curve, " " on, or think. This continued for some time, until a Memphis editor published a paragraph praising in highest terms the talents of the sketches, but objecting to them on the ground that the printers took up too much time admiring and [illegible] in trying to find correspondence with to-morrow's news. This was the last of the "illustrated press reports," as Edison was called.

Mr. Edison says that, in fact, out two of his most skilful assistants, at work testing his plans in regard to an apparatus for the deaf. The assistants let him forward on the subject of such an apparatus, assuring him that the second ear to be used, [illegible] moans. He feels sure that he can produce a practical [illegible] affirmative.

GLOUCESTER EVENING TELEGRAPH

TUESDAY, MAY 28, 1878

—Before [illegible] sunshine or [illegible] convey ice to other ports of the [illegible]

THE "MODERN MIRACLE".

Arrival of One of Edison's Talking Machines in This City—Description of the Instrument—How it Works—Some of its Utterances, etc., etc.

The phonograph has come. The most bizarre, the most startling, the most perfect. The creation was born, reared up in a day and manifested its unlimited faculties. It does not claim to be dead to all thought of visitors and is apparently perfectly [illegible] ate "for" [illegible] to approval and favor. Insofar, but there is no [illegible] to the fact that it is the most remarkable, curious, At times now Watson's public will soon be accorded the privilege of wondering with open-mouthed amazement.

THE INSTRUMENT,

or instruments—for there are three of them—are in the possession of Mr. George H. Bliss, General Manager of the Western Electric Manufacturing Company, a friend of Edison, the inventor. Was, as previously stated in, The JOURNAL,

has now awarded the privileges of exhibiting the modern miracle in Illinois. They arrived yesterday afternoon, and established themselves in the Methodist Church Block, from which it was deemed probable that they would be unable to effect an escape. They are the very first of their genus that have ever been brought to the part of the country, and, of course, their keeper is especially careful of the "critters."

This morning, when the cover was carefully removed from the box, the reporter drew near and eagerly looked in, but immediately started back, expecting the thing to jump.

"Don't be afraid," said Mr. Bliss; "it won't bite."

Whereupon Mr. Chase, a friend of Mr. Bliss, and the reporter were sufficiently reassured to allow Mr. Bliss to remove the machine from its lair, and place it on the table for the inspection of it, combined with its several motives, as it was observed to be entirely harmless, served to show that it consisted of

AN IRON CYLINDER,

about five inches in diameter and six in length, into which was cast an ordinary record, such as is used in the phonograph. This cylinder was sprung on an axis, projecting at each end about the length of the cylinder, and also elevated by a screw thread corresponding to that on the cylinder. Over the cylinder, and so arranged that a small rod, by the pressure of the cylinder could be revolved, so as to rub rod-fashion on the axis-supports. The mouth-piece is a small round piece of thin tin, having a concave surface on which to catch the sound, supported by a metallic arm, and fixed to the frame-work in close proximity to the cylinder. Fixed to the under side of this mouth-piece, by means of cement, is a minute

EIGHTY-SEVEN NEEDLE

which, when the cylinder is made to revolve under, would impinge into the cover thereof thereon. This was the simple contrivance. Now, in order to

MAKE IT SPEAK,

all that was necessary was to wind the cylinder with a key-crank on the left, to-screw on the ends of the cylinder, and to set the machine in motion, so that the cylinder is revolved to one end of the frame, and the mouth-piece is brought close to the cylinder, the latter being very nicely adjusted against the needle. The machine being in motion into the mouth-piece, the cylinder is slowly revolved; the plate in which the needle is attached vibrates in correspond with the valleys and the hills of the record, and, in turn, nothing such indentations into the cover of the screw, so that it is clear out over the room though very small. The speaking having been concluded, the mouth-piece is swung back, and the cylinder is screwed back to where it was. A large tin funnel is then attached to the mouth-piece, which is swung back to the cylinder. This funnel is designed to gather and send out the sounds as they issue from the instrument; the crank is turned, the needle moves over its former course, the little needle strikes into the indentations, and, rather than vibrating the tin plate of the mouth-piece previously as it was originally found voice. And—to our behalf, the machine spoke! That is all there is to it. It was not a little startling, but a distinct and recognizable friend's eccentricity of speech. The machine sometimes receives a tone or hybrid voice sometimes readily than a bass. Last evening the machine was interviewed numerously, was put into requisition to the gratification of the First Methodist Church.

"Wonderful invention, indeed!" remarked Mr. Bliss, "and I can vouch for the authenticity of that sentiment.

"Several persons who witnessed the exhibition last somebody had imagined as Mr. Bliss' particular exclamation. Others were astounded while getting out the machinery, in such a manner as would not have surprised any one familiar with the machine.

It seemed with the real spirit and tongue such expressions as "Let me alone," "I'll go you my mother knew me by," and numberless other Americanisms, and as to whether the small company had been provoked by him, being had provoked by him, being had provoked by him, emphatically

Ludwigshafener Anzeiger.

Dienstag, den 7. Mai 1878.

Das Bürgermeisteramt. Sg. Kutterer.

Ludwigshafen, 7. Mai. Wir hatten Gelegenheit, den Vortrag des Herrn Sprachlehrers **Sprenger** über Telephon und Phonographh gestern Abend beizuwohnen, und gehen daher ein kurzes Referat über denselben hier wieder. Nachdem der Vortragende die Erfindung des Telephon, wie den Erfinder Bell und die Einführung des Letzteren geschildert, und wie dieser einfache Apparat anfänglich Aufsehen erregte, ging er über auf den Phonographh oder den Sprechwiedersprecher, und gleichte seinen Vortrag in der Biographie des Erfinders zusammen, George H. Edison. Nachdem Redner die verschiedenen Stadien in den Versuchen Edison's charakterisirt, sowohl als späterer Rekorder, Telegraphist, wie privatim, und wie eine wahre Manie in Fleiß und Thätigkeit und eine Erfindungsgabe in ihm zu Tage getreten sei, so daß er nach einander den Automatischen Telegraphen, Quadruplex und Sextuplex T., den Carbon-Telephon, die elektrische Feder, den Mikrophon (Lautsprecher), den Electric-Motographen erfand und auf diese Erfindungen Patente erhielt, ging Redner auf die Beschreibung des Phonographen über, welche und welches zu weit führen würde, hier weiter zu gehen. Genügen wollen wir nur noch, daß selbiger in der Academie der science in Paris, wie in Newyork, als ein Wunder und epochemachendes Werk in unserm achtundzwanzigsten Jahrhundert betrachtet wird und es auch stellt sich die Verwirklichung denselben, ib. — Dem Herrn Sprenger aber legen wir unsern bezüglich Dank für seinen interessanten Vortrag und hätten wir gewünscht, daß er sich eingehender über die einzelnen Manipulationen bei der Vervollständigung der Stimmenmiedergabe auszusprechen hätte, mangelt Augenscheinlichkeit wohl in dem Mangel an praktischen Beispielen seinem Grund haben dürfte.

Mannheim, 6. Mai. Das großherzogliche Regierungsamt erläßt folgender gelegentlich Bekanntmachung, den Verkauf von Blumen, Bouquets u. dgl. durch Kinder an öffentlichen Orten betreffend: Da in hiesiger Stadt unserer bisher immer mehr die Unsitte überhand nimmt, daß schul-

The Sun.

FRIDAY, MAY 31, 1878.

Note Field and Shakespeare.

London, May 22.—A performance was given in aid of the Shakespeare Memorial Theater, Stratford-on-Avon, which has been established at Stratford-on-Avon, at the Opera Comique, this afternoon. The performance was arranged by Mrs. Kate Field, and included the following features: Selections from "Hamlet" and Julius "As You Like It," "Romeo and Juliet," "Much Ado About Nothing," which concluded with Miss Field on the stage, in which she recited "Much Ado About Nothing," which concluded with "Much Ado About Nothing," which concluded with "Much Ado About Nothing," which concluded with

The Philadelphia Times

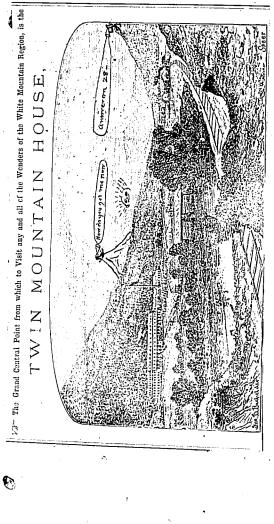
PHILADELPHIA, MAY 27, 1878.

The Daily Circulation of THE TIMES exceeds that of ALL the other Philadelphia Morning Papers COMBINED, except one.

A Great Journalistic Combat.

From the Baltimore Gazette.

One of the most sanguinary struggles that ever occurred in the history of the press the invasion by the British troops, in 1814, took place in the picture gallery of the House on Friday last, Mr. Uriah Hyde Thompson, of the Philadelphia Times, and Mr. Gilbert Hart, of the Philadelphia Record, met on the floor, provided with swords, and selected him if he had written a certain article which had appeared in the paper which he represented. Instead of the paper being represented by the editorial or managing editor, Gilbert Hart, whose courage was admitted in the office of the Baltimore Gazette, acknowledged himself to be the writer. Without saying a word Mr. Painter struck him in the face with the back of his hand, knocking out thirteen teeth and cutting his mouth terribly. Mr. Hart then closed with Mr. Painter with fierce fury, breaking his sword entirely off about at the handle region, and receiving a wound reported at 7 o'clock of the left shoulder. Mr. Painter, seeing that Mr. Hart was disposed promptly to let fast and broke Mr. Painter with the club, breaking his forearm in six pieces and rendering him helpless. Mr. Painter was carried off by the auxiliary reporter and assigned on the floor of the gallery with his body. Then he proceeded to the body of Mr. Hart, who was lying on the floor in a pool of blood, and, placing his knee on his throat, smashed his fingers, and was proceeding to administer on his other hand plaudits when Mr. Gilbert, of the Sun, which, shows for everybody, interfered, and declared that the fight was over, and that it was enough for the bloody work. After the struggle was over, it was found that the southern wall of the gallery was literally covered with blood, and the floor had suffered a distribution of intrenal fats and fibrous lectics.


TWIN MOUNTAIN HOUSE.
The Grand Corral Point from which to Visit any and all of the Wonders of the White Mountain Region, is the
Cheapside, No. 24
Gentlemen's Furnishing Goods

THE DAILY FREDONIAN

JOHN F. HARCOURT, } EDITORS AND
S. L. JOHNSON, } PROPRIETORS.

NEW-BRUNSWICK:
MONDAY, MAY 27, 1878.

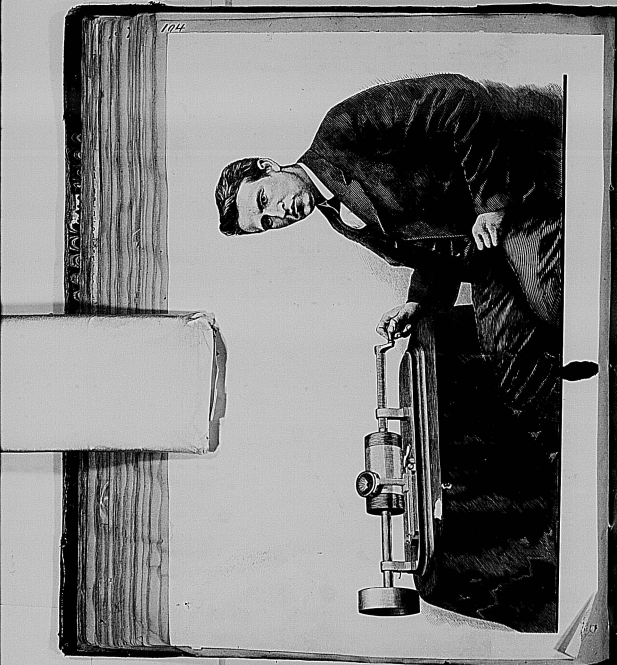
EDISON'S LABORATORY.

To most people the birth of inventions and the steps of inventors have been shrouded in mystery and covered with the hazy glamor of the improbable; and it is with a certain sense of curiosity, not unmixed with awe, that one finds himself for the first time standing on the porch of the weather-stained wooden building at Menlo Park known as "Edison's Laboratory." The whir of wheels and the clank of machinery comes from the inside, while across the grassy field is seen a man slowly approaching who is pointed out as Mr. Edison. Our business once made known to the great inventor, we are treated with the utmost politeness and admitted to the world of wonders within.

The Phonograph is our first objective point. It is the one used by Mr. Edison himself when experimenting with a view to improvements; and as he is an untiring worker the instrument suffers disarrangement and readjustment many times during the twenty-four hours. As we approached, a master hand put it in order. A brass cylinder is grooved with a spiral, and moves along, as well as around its axis, in such a manner that a stationary needle-point follows the depressions accurately from end to end. The needle-point is fixed to a disc of metal which is surrounded by a small wooden frame. The cylinder is now covered smoothly with a sheet of tin-foil and the Phonograph is ready to use. The attendant favors us with a solo, then lifts the needle and places it in its original position. The tinfoil, now covered with marks of the needle, is said by the attendant to contain the necessary elements for the reproduction of the song without the aid of the human voice. In a moment the statement is proved, and as, with distinct tone and modulation, John Brown's soul goes marching along the cylinder we realize that this is an age of inventions and the Phonograph not the least of them. After experimenting with whistling, singing and talking, we are invited to try it. The poets are called upon to contribute, and soon

"It was many and many a year ago
In a kingdom by the sea,"

and "Hickory, dickory, dock, the mouse ran up the clock," resound shrilly through the laboratory. The machine, as the inventor expresses it, "is yet an infant," and its future career implies many things still unheard of. As the inanimate instrument articulates words with the distinctness of a human being, the observer is forcibly reminded of the medieval legend of Albertus Magnus and his "Brazen Head," which chattered so fast that Thomas Aquinas, his pupil, took up a hammer and broke it in pieces. Mr. Edison has fifteen or twenty skilled workmen busy all the time working at his plans and models. His own work is done in the night, the time, in his opinion, best fitted for head work. The appearance of the laboratory alone affords evidence of serious work. The tables are covered with musical instruments, batteries, coils, magnets, crucibles, retorts, and a thousand and one things that an experimenter delights in. The shelves are filled with numberless chemicals, and the apparatus, as well as the application of chemistry to aid electricity, tells the observer that Mr. Edison is an original investigator in that line. The things, however, that show the true character of the place are the undeveloped machines, the brass and iron representations of abandoned projects, the gigantic ideas partially materialized, and the many things in process of construction. They illustrate the enormous fertility, the unceasing toil, and the acute working of the brain that conceived them. They suggest the possibilities of vast future progress. They hint at powers of man as yet unthought of, and lie there, mute emblems of the force of a busy American mind, only wanting the lever of the ancient Greek to raise the world from its foundations.



THE DAILY FREDONIAN.

JOHN T. BABCOCK, } EDITORS AND
C. L. JOHNSON, } PROPRIETORS.

NEW-BRUNSWICK:
TUESDAY, MAY 28, 1878.

SOUND AND ELECTRICITY.

MR. EDISON calls his Phonograph "an infant." Infants are not usually so wonderful in their simplicity or marvelous in their developments; and had Mr. EDISON lived in 1778 instead of 1878, his "infant" would doubtless have cost him his life at the faggot or the rack. It must be evident to every observing mind that we are but upon the threshhold of discoveries in the line of the Phonograph, the Telephone and Electricity. Kindred to those subjects, and forming a part of their philosophic developments, comes the Microphone, by which, according to Professor D. E. Hughes, before the Royal Society of London, sounds are so multiplied and intensified that the footsteps of a house-fly become distinctly audible; and the slightest sound may be intensified, and transmitted to almost any distance by the Telephone. What Faraday's "inductive" electrical current is to the "continuous" current of the galvanic battery, the Microphone is to the Telephone. In both of these cases electricity is the prime factor.

Equally as marvellous are the developments of electricity as applied to the generation of light for illumination. An "electric light," manufactured in Cleveland and constructed for lighting up a large factory in Philadelphia, was exhibited a few days ago before several eminent scientists. Of this "light" and the results of its exhibition, the *Herald* says:

It consists of a brush dynamo-electric machine of 10,000 candle power, arranged to give four separate currents, each running an electric lamp of 2,500 candle power. Two of the lamps were placed on the third and two on the fourth floor of the immense building, and when the engine was started up the machine started at the same time, and, without the slightest manual interference, the lamps flashed out their light in all its magnificence. The effect was most brilliant. The rooms were dazzled with a pure white light like the light of the sun, and it streamed out at all the windows, illuminating houses and streets for a long distance in every direction. The light was very uniform and steady, free from the flickering that used to be an accompaniment of electric light, and, considering the enormous illuminating power, the light was unexpectedly soft and endurable to the eyes. An opportunity was afforded to test the character and whiteness of the light. Books, maps, charts, signals, etc., of brilliant colors were hanging against the wall at one side of the room, and it was decided that the colors were rendered as nearly as by the full light of the sun. Politicians were present to let the amount that the light furnished by the apparatus would cost, if used by the narrow company as it was used last evening, and it was ascertained that the total cost of the whole light from the four lamps, including the items of consumption of carbon in the lamps, interest on the investment, and wear and tear, would not exceed 30 cents per hour. The light produced was photometrically equal to 200 gas burners, burning five feet of gas per hour each. This amount of gas would cost $1 per hour.

From experiments made, and operative results actually gained, in Germany, Prussia, France, England and this country, electricity, as an illuminating agent, is destined, at no distant day, completely to supersede coal gas both in brilliancy and cost. Indeed, experiments already made demonstrate the fact that electricity, as an illuminator, can be introduced into dwellings and factories at a trifling expense, and save to the consumers more than one-half the present cost of gas.

The Evening News
DETROIT, FRIDAY, MAY 24, 1878
$4. TELEPHONES!
For $4.00, I will put Accoustic Telephone in the best in use. I have a wire that I think is longer than any other. Can work with much power as it is insulated all the way. Address, with stamp, for circulars, Chandler, P. O. BOX 1001, A. Magill, Cook, Ohio.

Daily Evening Traveller.

THURSDAY, MAY 23, 1878.

THE PHONOGRAPH, ETC.

MR. EDISON AT HOME AT MENLO PARK

Description of a Visit.

A CURIOSITY SHOP OF WONDERS.

At 6 o'clock on Tuesday evening a merry party of representatives of the press, under the guardianship of Mr. William McMahon, the courteous manager of the Edison Phonograph in Boston, together with Mr. Frank E. Buswell, took the train at the Old Colony depot for Fall River. The press representation was as follows: Mr. Backus of the Advertiser, Mr. Gilbert of the Globe, Mr. Bacon of the Herald, Mr. Webber of the Journal, Mr. Barron of the Transcript, Mr. McNally of the Sunday Times, and a representative of the *Traveller*. The trip as far as Fall River was the same as it would be on any other occasion when a crowd of reporters get together; that is, full of wit and good humor.

The Bristol did not remain long at the wharf after the arrival of the train. Upon arriving in New York, the Boston party was met by Mr. J. H. Johnson, the general manager of the Phonograph Company, who accompanied it to Menlo Park. He was in earnest requisition by the party, and question was plied upon question, which he took with the best of good nature, and answered with the fullest satisfaction. Inasmuch as much matter of news was gleaned which cannot fail to interest and instruct, the larger part of it will be given.

THE PHONOGRAPH COMPANY

has a capital of $600,000, and is made up of the following stockholders: Mr. Gardner G. Hubbard and Mr. G. L. Bradley of Cambridge, Mass., Mr. Charles A. Cheever and Mr. Hilborne L. Roosevelt of New York, Mr. N. H. Painter of Washington, D. C., Mr. Johnson and Mr. Edison. The company after organization paid Mr. Edison a royalty of $10,000 as a guarantee of good faith, and agreed to pay him 20 per cent of the gross receipts from all sources. Almost all the territory in this country has been districted out to sub-agents, together with parts of South America and Australia. The patent right for Great Britain was sold on a royalty basis to the Microscopic Company of London. The royalty was £1500. France is probably to be controlled by Mr. Puskas and Mr. Roosevelt, a brother of Mr. Hilborne L. Roosevelt, of the company. Mr. Edison has determined to sell no more machines out, but to dispose of them on the royalty basis. Mr. Johnson explained the difference between the

EDISON AND BELL TELEPHONE,

and it is very marked and important. When Mr. Bell came before the public with his invention, Mr. Edison was still experimenting with his. While Mr. Bell makes very important use of the magnet, Mr. Edison does not. Mr. Bell's machine may be called the Magneto Induction, and Mr. Edison's the Galvanic Induction. The telephone, like everything else, must have something to supersede as a hint, and the hint in this case was a musical instrument, invented in 1837 by Reis, a prominent scientific German. Mr. Reis published a description of his machine, and Mr. Orton, the late President of the Western Union Telegraph Company, presented Mr. Edison with a manuscript translation of the work. Mr. Edison went to work, developing idea after idea, and conception after conception, until he has completed the telephone. A detailed description of the Edison telephone need not be given; but one thing must be said, and that is in his work he discovered a very wonderful property of carbon, which alone would give him a high place as a scientist. He found that carbon was very susceptible to pressure. So in his machine what may be called benzine-carbon is placed between discs of platinum. A continual current of electricity is passed through the discs, and against the upper disc of platinum the voice is hurled and the carbon is compressed. Then on and on over the primary and secondary circuit the voice hurries and the listener at the other end gets a distinct and accurate reproduction. Mr. Edison has already experimented in a whisper with his telephone from Philadelphia to Pittsburg, a distance of 350 miles. His instrument is 31 times as powerful as Mr. Bell's. Such are the principal points of the conversation with Mr. Johnson between Jersey City and

MENLO PARK.

This is a township 24 miles from New York, and when the traveller alights from the train he can see no more than thirty houses. It was 9.20 o'clock when the party arrived, and they proceeded at once to the laboratory of Mr. Edison, and inasmuch as he was up all night until five o'clock that morning, busily experimenting with his phonograph, Mr. Johnson went to summon him while the visitors took a look around the premises.

The laboratory is a long, white, two-story building, situated on a hill, and gives the idea externally of a country shoe factory. In the rear of the laboratory stands a very old apple tree around whose trunk is clustered old barrels, rickety wheels and heaps of discarded machinery from the laboratory. In the front of the laboratory is a piazza on which was mounted a powerful telescope, through whose clear lenses East River Bridge, 24 miles distant, with its buttresses and cables, could be distinctly seen. It rose to the naked eye like a swarthy giant on the misty horizon, and, in that secluded park, suggested the busy life that was under its very shadow.

Of course there always is some man around a place like this who is rather a queer sort of a fellow, generally liked because he is harmless and as talkative as a trained starling. This time he was an omnipresent, ubiquitous gentleman, who strutted around the laboratory, stroking with the meekest nonchalance his gray Napoleonic goatee. "Expect a party from Boston to-day, I believe," he said. "Yes, sir, and it is here with you now." "Ah! indeed!" he replied, "I am glad to see you, and I know Mr. Edison will be."

The internal arrangements of the laboratory were such as might be seen in any college laboratory. On the right as you enter, however, is a very important part of a great man's possessions, his library.

The main part of Mr. Edison's library is situated in the laboratory, although he has a few books at his house. The principal books on the shelves are Experimental Researches, Chambers's Encyclopædia, Watt's Dictionary of Sciences, American Review, and Dana's Manual of Geology. A man, or rather a student of such standard books must have men of real and sterling worth visit him. Yesterday Prof. Muirhead, Doctor of Sciences in the London University, was there with Mr. Ward, the able superintendent of the direct cable. The professor has succeeded in duplexing the direct cable, which is a scientific conquest in itself.

MR. EDISON.

The late Prof. Henry, of the Smithsonian Institute at Washington, said a short time before he died, that "Edison was the greatest genius not only of this age, but of any age." Mr. Edison shook each one of the visitors by the hand, and expressed much gratification at seeing some Bostonians, and commented pleasantly on Boston and its people, where in 1869 he was a telegraph operator.

He immediately took a seat at the table where the phonograph set, and proceeded to give an exhibition of its powers. The physical appearance is an index of the thought. Mr. Edison wore a light, slouchy Kossuth hat—changed later in the day for a tall hat—which seemed none the better for wear. He had on a dark checkered coat and vest with striped pants, and was totally devoid of anything which would suggest affectation. Not even a stud graced his shirt bosom or a ring his finger. Apparently he is a man not above thirty years of age, has dark brown hair slightly tinctured with gray, and is about 5 feet 9 inches in height. He has large gray eyes, over which the lids close very often. They are manifestly weak, and have pored over many a volume. His face is smooth and sicklied o'er with the pale cast of thought.

If you look at him when his face is devoid of a smile, you fail to discover one wrinkle. If an experiment goes wrong, three very deep vertical lines form just above the nose; or if something pleases him his countenance lights up and the sweetest and most winning smile that ever shone on the face of man plays a witching dance. His mouth is not particularly suggestive. It is small, firm and arched, and is indicative of a nervous perseverance. His head is of an excellent shape, what the Delsartean philosophers would call concave. The forehead is prominent and slopes at a small angle, as does also the back part of the head from the crown to the base of the brain.

Napoleon said, "You may think it strange; but if I wanted a thing done I would select a man with a long nose." Mr. Edison's nose is a very prominent part of his physiognomy and indicates a love of hard work, with little discretion as to its result.

Considerable has been written about

HIS RELIGIOUS VIEWS,

and far from correct. Mr. Edison believes in a God, and one that is all-powerful alike to create and to destroy. He is not a regular attendant of church. He claims kinship with no particular denomination or school of philosophy, but approaches nearer to the Deism of the younger Mill than anything else. But modification would probably have to be made in this to suit his views and beliefs. He is a devout man and full of goodness.

He is courteous, kind, affable and generous. He is just as pleasant to one as to another and does not regard in the least caste or condition. His favorite poets are Poe and Longfellow, and the poem of Longfellow which he most admires is "Evangeline," and Poe's "Annabel Lee" is a constant source of pleasure and delight. He is evidently a most practical and shrewd man, and knows when he is getting the best or worse of a bargain.

He is something of a linguist, and talks fluently the French and German languages. He inveterately uses tobacco, and drinks tea. He enjoys tobacco with as much zest as he does study and experiment. Perhaps a word ought to be said about Mr. Batchelor, his assistant. He has been associated with Mr. Edison ever since he began experimenting. He is an Englishman, was born in London and brought up in Manchester. He came to this country about ten years ago, and is a firm and steadfast friend of Mr. Edison. If a historical parallel will be allowable, Mr. Batchelor is to Mr. Edison what Father Mersenne was to the great Pascal, the celebrated scientist and scholar and inventor of the arithmetical machine.

THE PHONOGRAPH.

Mr. Edison was left sitting at the table when a divergence was made to give a brief personal description. Let us enjoy now some of his talk. The first thing that he threw on to the foil was a stanza from Bingen on the Rhine, commencing "The dying soldier faltered as he took his comrade's hand," and in clear, distinct tones the phonograph gave it back. He then sang the "Wandering Refugee," beginning "In my sunny, sunny home," and with a most charming modulation and intonation, the machine sang it again. The experiments in the main were similar to those in Horticultural Hall; but he told some that he had tried in his laboratory which cannot fail to interest. One was as follows: If words are thrown into the phonograph in a slow and deliberate tone, and if, when they are reproduced, the handle is turned very rapidly the vibrations are crowded one upon the other in such rapid consecution that the sound which issues through the diaphragm becomes mere whistling.

It was said that the rapid turning of the handle of the phonograph made whistled sounds issue forth, although they had been put in the machine as so many words. Now a sentence of prose or a verse of poetry may be transferred from one phonograph to another by simply holding the mouthpieces together. If in this case the experiment be tried and thrown into the second phonograph with a whistling sound, it is given out for the second, not as whistling, but rather as so many distinct, articulated words. For example, if "Now is the winter of our discontent" be put into one phonograph as words and transmitted as whistling into the second, the second repeats it as words. This is a very interesting and important fact in phonographical experimenting.

Another one is as follows: It is well known that Gustave Doré, the celebrated bachelor painter of France, gets models for some of his best heads as follows: He takes a piece of tissue paper, crushes it in his hands and then throws it down carelessly into the sunlight. There is of course a shadow. This shadow generally forms in outline a human face, and if traced around and filled in makes an excellent profile. Something analagous to this is done with the phonograph. Supposing a stanza, say the first in Mrs. Hemans's Fall of D'Assas, be projected into the machine, and in reproduction the cylinder be turned backwards as it were, the words would not be:

> "Alone through gloomy forest shades
> A soldier went by night, etc.,"

but a confusion of sounds, giving, indeed, the letters as follows:

> thgin yb tnew reidlos a
> sedahs tserof ymoolg hguorht enola.

Mr. Batchelor tried this experiment yesterday with "Mary had a little lamb," and it was successful. He also projected several times in succession the words "mad dog, mad dog," and the little machine replied, being turned backwards, with the utmost disregard of the distinguished persons present: "God d—m, God d—m."

Mr. Edison says that of all the languages the best for the phonograph is the Latin, and in illustration of it he gave a few lines of Virgil's *Æneid*. He also tried French and German. He represented two strangers meeting in a beer saloon, and one said to the other: "Sprechen sie Deutsch?" "Ya, meinheer. Ein, zwei drei bier." This afforded considerable amusement.

MUTILATING THE RECORD.

In order to show the permanency of the indentations in the foil and the difficulty with which they can be mutilated Mr. Edison scratched the foil. But still it did not affect the reproduction in only the slightest and most inappreciable way. Even if the breath be blown against the diaphragm the indentation made is indeed small, but still the reproduction can be made almost perfectly, even after attempting to mutilate it.

This method of strengthening the record, or in other words, of passing indentations from tin foil to copper, is very simple and will soon be perfected. There is a vertical lever with the fulcrum near to one end, giving thereby a short and long arm. On the ends of this arm is a sharp needle. Then there is a small and large cylinder, the small cylinder opposite the short arm of the lever.

The small cylinder is covered with foil, and the large one with something else. This foil has the record of some words. Now by mechanism these levers are worked, and the exact indentations are transferred to the other or larger cylinder. One fact should be noticed, that anything could be put on the foil by a certain number of revolutions. There are twenty-two words in "Mary had a little lamb," and Mr. Edison put it on first in 2 revolutions of the cylinders, then on in 1¼ revolutions, and, finally, in less than half of one revolution.

An estimate was made as follows: If there are sixteen threads to the inch and eight inches and forty-five words, there are about five thousand vibrations, or enough to take up three columns of the New York Herald. If there are ten thousand words to the inch—which is possible—and eight inches, then there would be 80,000 words. If a man was sufficiently quick with the tongue to pronounce 100 words to the minute, it would take him nearly 13 hours to give the whole 80,000. These are the main new points in the phonograph brought out by the visit.

This is an ingenious little contrivance and is something new. There is a disc of paper set vertically on a stand. One side of this disc is perfectly smooth and is to receive the voice. On the opposite side is attached first, a cone of cork, then a piece of rubber, to which is attached a steel arm. On the end of the arm is a rough chisel-like needle, which presses or rather falls lightly on a smooth wheel fastened to one end of a horizontal axis.

On the other end of this axis is a larger fly-wheel, probably an inch in diameter. If the voice be projected against the paper disc it vibrates very rapidly and moves the arm backwards and forwards with proportional rapidity. This causes the little needle to bite the small wheel by friction, and so fast does it revolve in response to the vibrations that you cannot see the perimeter of the wheel. This indicates the strength of the human voice and the quality of the tones of the voice, whether harsh or fine.

HARMONIC ENGINE.

The harmonic engine is one of the most wonderful and at the same time most useful machines that was ever invented, and if completed will be welcome in every household. The machine consists of a tuning-fork about four feet and a half long. On each end of the tuning fork is placed a weight of thirty-five pounds. On the outside and a short distance from the ends of this fork are placed two small magnets connected with a powerful battery.

These magnets are very powerful, and theoretically Mr. Edison gets 9-10 of the power of the magnet while others get only 1-10. Besides this, there is considerable loss of magnetism in the heating. An attempt was made by some of the party to pull apart the arms of the tuning fork by sheer muscular force, but they could not move them, while these magnets caused them to vibrate about 35 times in a second.

The utility of the machine lies in the fact that it can be made to do heavy work. The machine which is in Mr. Edison's laboratory is capable of lifting 3 barrels of water in 24 hours up four stories. The cost is merely nominal, it being only about 3 cents a day. A development of this machine will be watched for with interest.

THERMOPILE.

While Mr. Edison was experimenting with his telephone, he discovered that carbon possessed very peculiar properties, and was very susceptible to the influence of heat.

In the hand piece of the telephone, made primarily of rubber, he found that the heat of the hand would materially affect the needle of the galvanometer. He then changed the handle to brass, but still there was an effect that was perceptible, and last he made the handle of cast iron. The cast iron was heated one day with the alcoholic lamp and taken to the telephone by Mr. Batchelor. Mr. Edison, who was upstairs and at the other end of the wire, heard musical sounds and he inquired of Mr. B. what he was doing.

The fact was that as the handle cooled the molecules gave off musical sounds which were transmitted over the wire to Mr. Edison. The old Thermopile has measured the heat of a star of the first magnitude; but Mr. Edison can measure, by means of this, the heat of a star of almost any magnitude. Mr. Edison has in process some experiments with cymogen, which is the most volatile. To obviate the difficulty of the heat of the hand, Mr. Edison proposes to have no handles on the telephone.

TELEPHONOSCOPE.

This little instrument is to the ear what the telescope is to the eye. As the eye receives and transmits the vibrations of the ether, or, in other words, the light, so the ear receives and transmits the vibrations of the air, set in motion by some disturbance. Mr. Edison receives as many as 10 letters a day from all parts of the country, from persons who are deaf. A man does not like to go to a theatre and raise a huge ear-trumpet to his ear; it is too conspicuous. Mr. Edison proposes to invent something which can be concealed and connected with the ear.

In the tube of a telephonoscope a spiral wire was put and it conveyed the sound much better than without. It served the same purpose as the spiral bore in a rifle. Mr. Edison took a common paper funnel, and by its means he heard a cow chew nearly a quarter of a mile off, and heard the shout of men who were as many as two miles off. Mr. Edison's attention will be devoted to a perfection of this as soon as he finishes the improvements on other machines which demand prior attention.

MUSICAL MOTOPHONE.

This machine needs but a brief description, because, except as a toy, Mr. Edison said: "It isn't worth five cents." There is a sounding board before whose face are a number of highly-strung wires. Attached to the board is an arm, and on the end of the arm is a blunt needle.

This needle falls upon a strip of paper, through which an electric current is continually passing. This paper is rough and enables the needle to bite the paper except when the current is passing through it. The arm presses on the paper with a weight of 15 pounds. The paper is chemically prepared, being saturated with chloride of potassium.

Mr. Edison has tried 20,000 different chemical solutions and combinations in order to find that one which

would be his best and surest conductor of electricity, and the next evening he made the lesion from the paper. "Sweet be thy repose" was sung through the microphone with considerable beauty and power, and as other interesting and instructive inventions were made, but there is not room for their description.

IN CONCLUSION.

It was late in the afternoon that the party visited Edison's house, and could be found in as all that was accomplished.

It is situated a few rods from the laboratory and is a large, old-fashioned, gable-roofed structure. It is surrounded by a large yard, which is tastefully laid out with pathways, grass and trees and many artificial curiosities. "Edison's Folly" have made.

The house is not at present occupied as exclusively the dwelling of himself, as one would know, the owner does not put his eyes on both, that they were scarcely ever closed. There is a large family of wife, children, servants, and relatives. A full-blooded Newfoundland puppy and specimen. She is a blonde, and possesses a pair of blue eyes, full of expression and power.

Mrs. Edison, a boy and a girl, runs the house, and their presence, with the noise of children at play, would offer his father, a boy of seven years of age, and Alice by five years of age. They were both presented to the party, and the little girl shook hands with them all.

At three o'clock the party took the train for Jersey City, and at six o'clock last evening were on the Pennsylvania Railroad coming home. Upon the train, a cool and profitable evening was spent in discussing the manners of the visit. It was unanimously the opinion that a more committee, consisting of Mr. Edison, Mr. Vanderwort and his representative of the Daily Graphic, could not have been selected for the purpose, or less likely to make mistakes and to express the hope that he would visit Boston.

THE DAILY GRAPHIC

FRIDAY, MAY 31, 1878.

SCENES AMONG THE NUNS.

The convent was very cold yesterday afternoon when the "Graphic" of the Convent of Mount St. Vincent, on the Hudson, surrounded by people and crowds, to write "eye-witness" of the latest wonder of science, the telephone of Professor A. Edison Hughes. The "Graphic," the church, spiritual, dwelling as many as fourteen and a quarter world, the exhibitor, shrewd, learned, practical, audacious, cutting truthful and not pretending to know or care anything about any world but this. Among the guests were Mr. Edison, Mr. Vanderwort, one of the inventor, F. G. Gilmore, of the "Graphic," Chas. Barnes, Dr. Richardson, of the Associated Press, Mr. Hughes, Professor Hughes, of the Associated Press, and several other well-known journalists. Mr. Edison was very warmly greeted by the Mother Superior, and seemed to feel quite at home. He was much interested in everything in the audience, except himself, and was constantly asking questions of the Sisters that embrace their manifold duties. He was particularly interested in the observatory, Edison's telephones and electric gong, and the kitchen, and the dining-room of the audience.

Having reached at the top, house about the new English invention for the transmission of sound, the party were shown into the large room, the walls of which were covered with pictures of the Mother Superior, the Sisters, and the pupils. Upon the walls were hung the telephones, and the electric gong, and the kitchen, and the dining-room of the audience.

Professor Hughes, the inventor of the type printing apparatus which goes by his name, has added another to the multiplying marvels of contemporary science. To the telephone and the phonograph, he has added the microphone. In some respect it approximates the Tyndallean sound that "carries" to the ear, and causes to sound in the same way that selenium is sensitive to light. That is to say, if we place three bodies in the circuit of a small battery and subject them to sound vibrations of other words, talk at them—the electric current is modified, producing through it will be so continuously modified as the voice that the object may be used instead of a telephone for sending a message.

In the last number of *Nature*, from which the above paragraph is extracted, Professor Hughes's little instrument is described at some length, in connection with experiments given by him before the Royal Society. He used a battery of three simple Bunsen's cells, and a telephone as a phenomenon of the present character. At first he used a stretched wire, but, thought that the vibrations talked at, no effect was marked until a breaking strain was applied; at the moment of breaking a sound was heard. Next the broken ends were pressed together. But in Professor Hughes's own words:

It was soon found that it was not at all necessary to join two wires endways together to reproduce sounds. Two pieces of wire placed vertically one on the other would do as well when their surfaces were in contact, and no matter how considerable a resistance to the current existed at the point where the contact was made, whether one or more portions of the electrical conductor were in the form of loose powder, or of a contact, by a slight pressure between them, sound could be heard. Wire terminals in two communicating circuits, one of platinum and the other of silver by a slight pressure, were exceedingly feeble, and by laying a similar pair between them, sound could be heard. Even when the platinum terminals were left lying on the table by their own weight, that a square coal—flannel on, using two of the latter, and by placing a sound plate on the vibrations were almost produced, the effect increased with the weight. Even when the surface of the wires was wanting, as in the following experiments the Geiger because more and more sensitive, such as water powder—a platinum, and nothing to be detected. Several other metallic powder, such as water powder—a platinum, and nothing to be detected. Several other metallic powders also metallic filings, placed at the points of contact, greatly added to the power of the instrument.

The Professor found that the material with the materials used. "All metals, however," says Professor Hughes, "could be made to possess this property, provided the division of the metal was sufficiently great, and that the material used does not oxidize by contact with the air during the experiments. Thus platinum and mercury are very sensitive and answering in their results, while lead soon becomes of such high resistance as to render communication upon the surface as to be unsatisfactory. A mass of height round about is peculiarly sensitive to sound, while clean, but as the skin soon becomes coated with oxide the sensitiveness ceases. Carbon, made from its surface being entirely free from contraction, is excellent, but the best results I have been able to obtain at present have been from mercury in a finely divided state. I took a comparatively porous conducting body, such as fine willow charcoal used by artists for sketching, heating it gradually on a white heat and then dipping it into mercury while it is incandescent. The mercury in the pores, caused by the sudden cooling, becomes fixed with innumerable minute globules of mercury, thus, as it were, isolating the mercury in a fine state of division. Some of the charcoal carbon treated in a similar manner with and without platinum deposited upon it, and the chloride of platinum, I have also found similar effects from the willow charcoal, heated in an atmosphere of hydrogen, to a white heat and containing a few particles of silver or silver easily reproduced metal. Under certain conditions, the willow carbon will be found to be metallized, having the metal distributed throughout its pores in a fine state of division. Iron also seems to enter the pores if heated to a white heat without being exposed to air, combined with the carbon, as in graphite, and, indeed, some of the best results have been obtained from what I call physical conducting pow ts a fine state of division."

MARVELS OF SCIENCE.

THE MICROPHONE.

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This extension is a question well worth, as we have said, considering at a length, and is called a transmitter. The resistance of the conductors employed is effected by a substance absolutely invisible, and it is this quality which Professor Hughes utilizes in what he calls, par excellence, his microphone. This marvelous instrument, of which we shall here so much in the future, consists of a box-shaped pieces of gas-carbon, one inch long, one-quarter inch wide at the centre, and one-eighth inch thick; the upper pointed and plays free in another carbon block. The two pieces of carbon are connected in metallic, and a battery is used in preference to any other material, since it is more reliable and reliable. Of an instrument this character Professor Hughes, the inventor, says:

The best form of carbon materials for this instrument, however, have not, as yet, been fully experimented on; still, in its present shape, it is very sensitive, and for ordinary purposes is quite in reference. If a microphone is required to be used for a long time, a battery of two cells is sufficient. With this arrangement, I can hear the fly walking quite distinctly. The tick of an ordinary watch can be heard at least a hundred miles distant from the source of sound. In fact, when fairly started on the subject, I find that there is no limit to the sensitiveness required in this result, what has hitherto escaped us with-matter too small for human vision.

When a fly's tread can be heard 300 miles away miracles become possible. Our own day has seen the annihilation of obstacles in the matter of time and astronomical chronology is now a recognized branch of science. But a step we not since day has announced that Mary's-be able to detect the presence of life on another planet by distinguishing phases at least? Our syntactic sense has already done wonders, and we may expect it to do wonders are better up than it has yet done. The microphone was peculiarly fitted for physiological researches. What may we expect in its ab ove unfilled a sphere but the sounds which the functions of living bodies in health and disease give out—even when these sounds are entirely inaudible by ordinary means? The trend of science on the advance, the approach to truths—indeed, of all moving bodies; counting any sounds, may easily and surely be detected by the microphone. Light has long enjoyed a monopoly of scientific attention, but the new scientific inventions were for ordinary light and sight, for making improvements in optical instruments. Now that we have turned our attention to the ear and sound, our marvels have already been startling and wonderful. But new conquests are before them. Touch, taste and smell are yet almost untouched. They have never yet received the attention they deserved. Perhaps when they do, as great results await scientific research as have already rewarded it when devoted to sight and sound.

110

Philadelphia 81

J A Edison

Through the kindness of Messrs Bentley and Hill have arranged the interview for press by Telephone for eight Saturday evening

Will E Chapman

20 paid

Boston

To J A Edison

The press and many public men have seen notice of your appearance in public and insist that you come to Boston I have been over-run with applicants all day Can you Come on some day During the coming week answer at once

Wm McMahon

42 paid

"STAR" SKIRT BRAIDS, "THE BEST."

ACADEMY OF MUSIC.

T. B. PUGH, Manager.

STAR COURSE ENTERTAINMENTS

NINTH SEASON—EIGHTEENTH SERIES.

This Monday Evening, April 15th, 1878,

Professor GEORGE F. BARKER,

(Of the University of Pennsylvania.)

SUBJECT,—"THE TELEPHONE."

SYNOPSIS OF THE LECTURE.

SOUND.

Form of the sound-wave in air; Velocity of transmission of these waves; The pitch is higher as the wave is shorter; Audible sounds usually transmit sound; Lovers' Telegraph; Vibration of membranes by sound-waves; Reproduction of these waves. Phonograph.

ELECTRICITY.

Field of force which surrounds a magnet; Use of magnetic needle to detect currents; Magnetism produced by electricity; Electro-magnet; Electricity produced by magnets; Character of magneto-induction currents; Transmission and reception of electric waves.

APPLICATION.

Telephone, an electric apparatus for producing sound at a distance; First telephones transmitted music, Reis, 1860; Harmonic telephone and telegraph of Gray, 1873; Speaking telephones first constructed in 1875; Reiff's telephone at the Centennial Exhibition; Magneto-telephone of Dolbear, 1876; Various forms of magneto-telephones in use; Edison's carbon telephone of 1877.

DEMONSTRATION.

Reception of articulate speech by telephone; Reception of music from various points by means of musical telephone.

CHAS. J. GRAF, Teacher of Piano, Reference: T. B. Pugh, No. 927 Chestnut Street, Prof. Wm. G. Fischer, No. 1316 Chestnut Street.

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J. E. SOULÉ, Principal.

THE ILLUSTRATED
ADELAIDE NEWS

ADELAIDE: FEBRUARY, 1878.

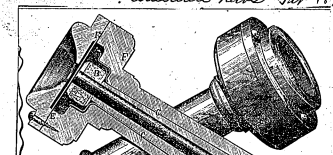
THE TELEPHONE.

This wonderful little instrument (invented by Professor Bell), by which the sound of the human voice is conveyed to a great distance, and which has recently caused so much excitement in Europe and America, was successfully introduced to the Continent of South Australia last November. To the colony of South Australia belongs the honour of bringing it before the public in the Antipodes, and to Mr. A. W. Dobbin is due the credit of being its first manufacturer and introducer. The accompanying engraving, in which both sectional and exterior views of the instrument are given, will give our readers a very correct and intelligent idea of the construction of the telephone as made by Mr. Dobbin. Referring to the sectional view, A is permanent magnet, held in position by the adjusting screw in the rear. Around one end of the magnet is wound a coil (B) of fine insulated copper wire (silk covered), the ends of which are attached to the larger wires (C), which extend to the rear, and terminate in the binding screws (D). In front of the pole and coil (B) is a soft iron disc (E and F). The whole is encased in a wooden casing, having an aperture in front of the disc, and which, besides serving to protect the magnet, &c., acts somewhat as a resonator. The principle of the apparatus may be briefly enumerated as follows:—The influence of the magnet induces all around it a magnetic field, and the iron diaphragm (E) is attracted towards the pole of the magnet. Any alteration in the normal condition of the diaphragm produces an alteration in the magnetic field, by strengthening or weakening it, and any such alteration of the magnetic field causes the induction of a current of electricity in the coil B. The strength of this induced current is dependent on the amplitude and rate of vibration of the disc, and these depend in turn upon the air disturbance made by the voice in speaking, or in any other similar source. Therefore, first, a wave of air throws the diaphragm into a state of vibration; second, each movement produces a change in the magnetic field; and, third, an induced current is generated in the coil wire. Now if to the binding screws wires be attached, connecting in like manner with an apparatus precisely similar to that described, it will be clear that there will be a closed circuit of wire, and the induced current will pass along the wire and through the second telephone and back again to the first one; but in passing through the coil in telephone No. 2 it modifies the magnetization of the magnet and increases or diminishes its power of attraction for the diaphragm. Hence every vibration made by the first disc is repeated by the second one, and whatever sound produces the vibration of one is transmitted and reproduced by the other. If the telephone is being used for long distances one of the wires may be dispensed with by simply connecting one of the screws (D) on each telephone with a wire leading to the ground; by this means an ordinary telegraph line may be at once utilized.

Since Mr. Dobbin first introduced the telephone (last December) he has on several occasions entertained a number of ladies and scientific gentlemen and members of the Press with a series of most interesting telephonic experiments with the most happy results. Having had the pleasure of being present at one of these series we will give a brief outline of the proceedings. The experiments commenced by ladies and gentlemen carrying on conversation through a mass of insulated coiled wire, over a mile in length, one end of the wire being in the drawing-room and the other in the grounds at the bottom of the garden, two, and sometimes three, telephones being attached to each coil of the wire, so that several persons could listen and take part in the conversation at the same time. Every syllable uttered even in a very low tone of voice was heard distinctly at the other end of the wire, and sometimes even casual remarks uttered by other persons in the vicinity of the telephones were heard at the opposite end, which of course intensified the astonishment of those present. A number of songs and Sunday-school pieces were then sung at one end, which came through, if possible, with even greater distinctness than the speaking, the singing having a beautiful mellow tone, similar to that of singing in the water in the open air on a still, calm evening. When duets were sung both voices blended harmoniously together, and yet each voice could be distinctly heard. The telephone was next attached to the piano, and we were surprised at the distinctness with which every note was transmitted along the single wire. A musical box was now attached to the telephone, the effect of which was even more astonishing than that of the piano. A few other experiments were made, but the above is quite sufficient to give our readers a fair idea of the capabilities of the telephone. We noticed also that when Mr. Dobbin doubled the length of the wire that it made no difference whatever in the transmission of the sounds, which only confirms our Professor Bell's statements, that distance up to a certain limit makes no difference.

C. Todd, Esq., C.M.G., Postmaster-General, has also been very successful in conducting a series of experiments with the telephone, having transmitted songs and conversations along the telegraph line between Adelaide and Kapunda, a distance of 43 miles.

By the *Illustrated London News* of December 15, 1877, we notice that conversations have been carried on through resistance coils equivalent to 6,000 miles; but the longest line of actual distance through which conversations have been successfully carried on is between Boston and New York, a distance of 238 miles.



Thomas Edison and the Phonograph.

We take occasion in this week's Paper to inform our readers of the recent advances which have been made in the mechanical transmission and recording of vocal sounds. Upon the following page may be found an account of the development of the telephone. Our task at this moment is to describe a still more startling achievement of genius, and that is a successful record and reproduction of human speech by a simple machine, called the phonograph. We shall speak first of the man who has accomplished the achievement, and second of the machine itself.

In 1847 Thomas Edison was born in Ohio. When he was eight years of age his parents moved to Michigan, and young Edison began life as a newsboy. He was a driving newsboy. At 15 years of age he obtained a contract for the exclusive sale of newspapers on one of the largest Canadian railways, and had a squad of boys working under him. While he was still running on the trains he began chemical studies, fitting up a traveling laboratory to take with him on the cars. Then he became a telegraph operator, and soon afterwards stood at the head of the craft. He celebrated his 20th year by conceiving the idea of sending two messages over the same wire at the same time, thus doubling the capacity of all previous systems of telegraphy. For the last ten years he has pursued his electrical studies and inventions, working with surprising swiftness and exceeding zeal, until to-day he has succeeded in recording and reproducing the human voice and won a world-wide fame.

The phonograph is regarded as the greatest triumph of inventive genius which has been attained even in this inventive age. It is greatest in its achievement and peerless in its simplicity. The engraving on the page shows at a glance the principles upon which it operates. It consists of a hollow cylinder, *A*, mounted on a horizontal screw, the cylinder being rotated and at the same time moved laterally by turning a crank at the end of its shaft. The chief part of the apparatus is the diaphragm, marked *B* in Fig. 1, and shown in detail of its parts in Fig. 2. At *C* is shown the thin plate of metal held by its edges, so that it can vibrate, and at *D* is a fine needle or stylus, which is attached to the

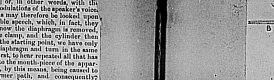


Fig. 1.

Fig. 2.

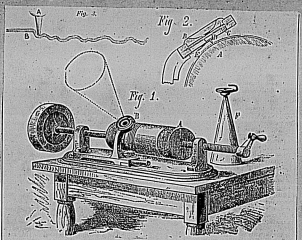
center of the diaphragm. The cylinder is covered with tin-foil, and the diaphragm, *B*, securely fastened in place by clamping its support to the base of the instrument. When this machine is properly adjusted, the stylus, *D*, should lightly press against that part of the foil over the groove. The crank is now turned, while, at the same time, someone speaks into the mouth-piece of the instrument, which will cause the diaphragm to vibrate, and as the vibrations of the latter correspond with the movements of the air undercompression, the soft and yielding foil will become marked, tracing the line of the groove by a series of indentations of different depths (Fig. 3), varying with the amplitude of the vibrations of the diaphragm; or, in other words, with the inflections and modulations of the speaker's voice. These inflections may therefore be looked upon as a sort of visible speech which, in fact, they really are. If now the diaphragm is removed by loosening the clamp, and the cylinder then turned back to the starting point, it is easy to replace the diaphragm and turn it in the same direction as at first, to bear repeated all the words been spoken into the mouth-piece of the apparatus; the stylus, by this means, being caused to traverse the former path, and consequently rising and falling with the depressions in the foil, its motion is communicated to the diaphragm, and thence through the intervening air to the ear, where the sensation of sound is produced.

The method in which the stylus indents the tin-foil is shown in magnified form in Fig. 3, at being the stylus and *B* the cross-section of the tin-foil. In reality the marks left by the stylus are very fine, as the sheet of tin-foil is taken from the cylinder it is grooved with parallel lines about 1-4 to the inch. In each groove there are the indentations of the stylus, quite regular as to size to the naked eye and about 50 of them to the inch.

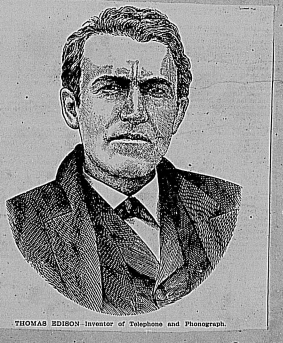
The Phonograph at the Grand Musical Festival.

The phonograph admits of many applications. The tin-foil sheet bearing the recorded speech in one place may be taken from the cylinder and sent thousands of miles, and being placed in another phonograph will reproduce the words and the tones of voice originally imparted to it. This will probably be fully shown at the coming Musical Festival in this city. For some time past Manager Bigelow has been endeavoring to secure a phonograph for the purpose of giving a public exhibition of its wonderful performances at the first day of the Festival. Samuel Hubbard, the agent in this city, has received a dispatch stating that the phonograph will be promptly forwarded—also the tin-foil impressions of warblings by Miss Kellogg, Miss Aus or Rudersdorff and a greeting from Rev. Henry Ward Beecher, for the purpose of reproducing them through the aid of the phonograph at the Festival. Carl Zerrahn, the director, is provided with his tin-foil impression of "Yankee Doodle."

In an article in *North American Review* Mr. Edison indicates what are its probable applications. We may expect before a year is ended to have it rendered commercially serviceable. The principle can be applied to every implement or toy which makes a noise. Think of each new speak the hours, instead of striking them. A child's doll sent Christmas day may repeat the moral precepts which we now put in children's copy-books. The locomotive approaching a crossing may screech out: "Look out for the engine!" or it may cry out the name of the station it is approaching. Mr. Edison believes he can intensify sounds as well as reproduce them as they are committed to the instrument. He says that he can in time make his machine talk so loudly that it can be used on vessels to warn off other ships during fogs. Another last astonishing proposal is that he shall build a huge phonograph to go in the great torch of Liberty which is to be erected in New York harbor, so that the metal giant can make a voice audible over the entire bay. In view of what Mr. Edison has already accomplished, his success in this respect would not surprise us.



THE PHONOGRAPH WITH SECTIONAL VIEW OF DIAPHRAGM.



THOMAS EDISON—Inventor of Telephone and Phonograph.

Concluded on next Page

The Speaking Telephone.

Great progress has been made in the introduction and application of the telephone to the practical uses of intercourse and communication since we gave a description of the Bell instrument seven months ago. The workings of the instruments have been improved, and great advances have been made in methods of making them useful. Other inventors have brought out telephones which are coming into wide popularity because of their excellent qualities.

We show upon this page engravings of two telephones. One is the invention of Thomas Edison, who has achieved widest fame by his phonograph, which we expect soon to illustrate and describe. One of the main features of the Edison telephone is the employment of a carbon disk for the purpose of varying the strength of a battery current in unison with the rise and fall of the vocal utterance. He found that by vibrating a diaphragm with varying degrees of pressure against a disk of carbon, which is made to form a portion of an electric circuit, the resistance of the disk would vary in precise accordance with the degrees of pressure, and consequently a proportionate variation would be occasioned in the strength of the current. The latter would thus possess all the characteristics of sound waves, and by its reaction through the medium of an electric magnet, might then transfer them to a metallic diaphragm, causing the latter to vibrate, and thus produce audible sounds. (Photo-engraving, which is copied from the lately given by *Scribner's Monthly*, shows the arrangement of the parts of the transmitting apparatus of the Edison telephone. The carbon disk, *a*, is inserted by the back portion, *f*, over the diaphragm, *d*, and placed between the two platinum plates, *b* and *c*, which are connected in the battery current as shown by the lines. A small piece of rubber tubing, *h*, is attached to the center of the metallic diaphragm, and presses lightly against an ivory piece, *e*, which is placed directly over one of the platinum plates. Whenever, therefore, any motion is given to the diaphragm it is immediately followed by a corresponding pressure upon the carbon and by a change of resistance in the latter, as described above. It is obvious that any disturbance properly fitted with an iron diaphragm, will answer for a receiving instrument in connection with this apparatus.

Another telephone which is coming into wide use, is that invented by Mr. A. G. Phelps. The peculiar excellence of Mr. Phelps's instrument is said to consist in its distinct articulation, combined with a loudness of utterance that is not to be found in the many other forms which have been thus far brought forward. The instrument designed by Mr. Phelps is shown in our engraving. It consists of a polished case of hard rubber or rosewood with magnet, coils and diaphragm inside. In connection with this telephone there is used a small electro-magnetic machine, contained in an oblong box, which is used as a call bell when the attention of a distant station is required. The currents which are produced by this machine by turning a crank, are discharged by the connecting wire through the bottom of a polished magnet, coiled, and causes a hammer attached to an armature lever to vibrate violently to and fro, thus producing a violent ringing, audible at a distance of fully forward at a considerable distance from the machine. The points of description, which we have taken mainly from *Scribner's*, will be noticed on the subject, are of particular interest, because of the great numbers of this style of telephone which are being introduced in this city.

The use of the telephone in this city has been marked by the character of enterprise which usually attends the introduction of progressive inventions amongour wide-awake people. The American District Telegraph Co. have furnished a large number of the instruments to private parties, and they have given the use of the telephone features which were original with them, but which from their plain advantages are now being introduced in other cities. Notable is the arrangement called the "central system," at their establishment on Newsome street, near California, they have a telephonic office, presided over by the management of Mr. Sabin. In this room each wire from the distributed subscribers centers. If the owner of a telephone wishes to communicate with another owner in any part of the city he signals or calls the central office, and the wire is connected with that of the other party. There are now 100 firms connecting in this office and each one can then, at a moment's notice, put in communication with any one of the 99 others. Thus any firm can communicate with another as easily as it would speak with men, as the messages pass direct without even the intervention of the operator. When a firm is called from the central office they are told the name of the party who addresses them by the central operator, so there would be no chance for the telephonees to impress on one another by calling names. Each firm is furnished with a schedule of all the others which are in communication with the central office. As we have said, the smallest advantage of this centering idea is so great that the great cities at the East are thinking of following the example set them by the enterprising company in San Francisco.

Our coast is kept well abreast of the progress in the adaptation of electro-magnetism to common uses by our skillful friends which makes a specialty of this branch of work. Besides the above, the District Telegraph Company which we have mentioned, there is the California Electric Works which is cognate in its sphere. The gentlemen in charge of this company are second to none in the country in their peculiar profession. In the application of important discoveries abroad and in original discovery and invention they are wide-awake and successful.

EDISON'S TELEPHONE.

PHELP'S TELEPHONE.

Boston Daily Globe.

TUESDAY, MAY 28, 1878.

A VISIT TO EDISON.

How the Great Inventor Lives and Works.

Anecdotes Characteristic of the Man.

Bits of Gossip Gleaned in a Globe Reporter's Visit.

Last Tuesday the representatives of the daily press of Boston and other positions started on a very pleasant excursion to Menlo Park, New Jersey, in which place the home and laboratory of Thomas Alva Edison, the famous inventor, are situated. Menlo Park, or "Pallasville," as it is sometimes called, is twenty-one miles from Jersey City by the Pennsylvania Railroad, and by the courtesy of the Pennsylvania Railroad, each guest was an elevated site commanding a magnificent view of the surrounding country. The party was under the charge of Mr. Edison, who, in his private car, with his turnout while carrying out lunch, which, when partly eaten, was passed around from hand to hand of course. The party left Boston by the Fall River boat on Monday evening, and arrived at Jersey City at 8:30 the following morning. Mr. William Hallidan, the manager of the Boston branch of the American District Telegraph Company, was in charge of the party, and from the very beginning of the trip to the time of the separation at Jersey City, he was the recipient of the thanks of the entire party for his untiring zeal and care. Every one was accommodated, and every minute detail, even, which could add to the pleasure and comfort of the party was punctiliously, politely and pleasantly attended to. The party was met at the depot in New York by Mr. Edison's private car, by Mr. Edward H. Johnson, the General Agent of the Phonograph Company, and by Mr. Norvin Green, the head of the Western Union, and by his secretary, who is also the phonograph business and gentlemanly beating.

Upon the arrival of the party at Menlo Park, the officers of the Edison Ore and Stone and the Fall River boat put forth every possible effort to make the guests of the company feel at home, and the warm commendation of all present for the hospitality shown by the officers of the company was certainly a subject of remark. A few anecdotes characteristic of the eccentric genius are given as follows:

Absent-Minded Edison.

In a conversation with Mr. Thomas Rocks, Manager of the Edison Electric Light Company's office in this city, and Mr. D. J. Hayes, an operator in the Western Union office, who is also a guest of Mr. Edison's, a Globe representative gleaned the following items of interest. Mr. Rocks said: "Edison is one of the most absent-minded men I ever came across. He often calls with a little ruler in his hand, and, holding it in a very peculiar way, and with the middle finger of his right hand, and, in the course of conversation, will suddenly bring the ruler down on a bottom, impressed upon every one present, 'I've got you at last, Tom!' Well, if I should pass but one word to him, he would say, 'Tom, I've got you at last!' Or, if I should say, 'Good morning, Mr. Edison,' he would say, 'Tom, I've got you at last!' Of course, I begged him in the name of all the powers to tell me what he meant by such words. He explained, and, placing it in his pocket, said that he had intended to have it engraved, but that it was a present from a friend of his in New York, and that he always carried it with him. He also said that he had promised to be accepting," said Mr. Rocks, "by the brother operators. He was a first-class operator, and was employed in the Western Union office. He was a poor speller, however, and was always the butt of the fellows' sarcasm." These remarks of Mr. Rocks were fully corroborated by Mr. Hayes, who said Edison was always honest enough to acknowledge that he was a poor speller.

He Was Always Kind.

Generous and open-hearted, never refused to assist an applicant, whether he knew him or not. He (Mr. Hayes) remembers that two of his fellow-men, who were out of employment, came into the office where he was working and stated their cases to him. Edison did everything a man could do for them. He let them room with him, and, I believe, furnished them with food, etc. Several days elapsed, and they still "stuck" to the phonograph. At this point Edison became impatient, and Mr. Rocks took up the thread: "Come on, friends of Edison's," said he, "we're idle. Let us go and get employment." Edison, however, objected, saying his hospitality I last Edison felt my duty morning seeking employment. I remember one time in the convention when he demonstrated of the men. When Edison first came to Boston he was a very complacent and modest man.

He Got 'Struck'

away up near the skies, and came to Boston by a circuitous route, wandered into the Adams House, the corner of Court and Tremont, and purchased a nice tall hat. Of course you can imagine, from the above description, that Edison is a tall man. Of course you can imagine, too, that he looked very much out of place in such a hat, and that when he appeared on the street he was simply sidesplitting

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A Very Reliable Man

in the office, and was never afraid of work. He used to stay over time many a night making experiments. He slept and ate very little, and appeared to be completely engrossed with his experiments." "When we were there," said Mr. Herne, "there used to be a man named Milliken, whom we called 'the hash man,' who used to go around to the newspaper and telegraph offices every night between 11 and 12 o'clock with pies, sandwiches, coffee, etc. In those days the operators were all on the lower floor, and as soon as this 'hash man' came in the front door the boys would all make a grand dive to see who would get the first cup of coffee and the best piece of pie; but Edison would wait until the rush was over, and then deliberately make his selection, which was generally a sandwich and a cup of coffee. These he would demolish in a very short space of time and go right back to his work. He was a very jolly man in the office, when he was not taken up with his experiments; but that was seldom. His disposition was very lively, more so than one would imagine in a man of his nature. At that time he was a most reckless punster, and greatly enjoyed any kind of pun that might be made. Mr. G. F. Milliken, the manager of the Western Union Telegraph office in this city, was next called upon. "While Edison was night operator here," said he, "he was experimenting during his spare time on the automatic telegraph instrument. He had a register arranged to indent the Morse characters with a key into the paper. Then by running the paper through the machinery the lever would make the same movements previously made by the key. It seems to me that that embodied the idea of the phonograph." "Yes," replied the writer, "when a party of us was at Menlo Park a few days ago, Mr. Edison said that he got

The Idea of the Phonograph

from that invention." Mr. J. W. Duxbury, inspector of the city lines, said: "Edison was always very nervous. He would jump up from the instrument right in the middle of a message, not as if at anybody or vexed at anything, but simply from pure nervous force."

Boston Journal.

THURSDAY MORNING, MAY 30, 1878.

THE FATHER OF THE PHONOGRAPH.

THOMAS A. EDISON AT HOME.

WHERE AND HOW HE WORKS.

It is probable that no man is more talked about just now, at least in America, than the inventor of the phonograph, Thomas A. Edison; and while his fame has gone out all over his native land, he has a reputation in Europe also which makes him one of the very foremost men of the age. Men very seldom attain to greatness in so brief a time or at so early an age as in the case of Edison, who must be regarded as being certainly a great man in his way, and who but a few years ago was an unknown though active and thoughtful boy. Not yet thirty-two years of age, he has really given to the whole world a surprise, and in the phonograph, which is but one of his many inventions, has produced an instrument the future development of which, and its uses, cannot at present be foretold. For a little while it will remain a wonder, a curiosity to be exhibited and to astonish the people by the strange anomaly of an inarticulate device reproducing articulate sounds. As an object to be exhibited and studied it will probably pay so well for some seasons to come that the possibilities of its application to practical purposes may be delayed, the work of manufacturing the machines giving Mr. Edison and his assistants all that they will be able to do. It would be unwise, however, to predict any postponement of such application, for the man works with brain and hand almost continually, and in connection with him and his constant experiments there is no more apt thing to say than that "we know not what a day may bring forth." To appreciate him and his work fully one needs to meet him, and to meet him where he is most himself, that is, in his laboratory. To do so is a privilege that has been sought by very many persons, including journalists, who have gone to seek something to interest their readers; scientific men, who have sought him in order to confer with him upon the developments and the future of science; and to some extent that class for which there is no fitting designation, who desire simply to see and speak with a man who has set the world talking of him. There are but few people whom Edison cares to meet, for he does not court notoriety, and does not feel that he can afford the time that the frequent presence of visitors would demand. Still, unless he is very much occupied with his ideas and their elaboration, he is thoroughly courteous to all comers and wonderfully free and lucid in his explanation of matters concerning which information is sought. When his visitors happen to be such as he has expected or desired to receive, he is especially attentive, and is then in his very best mood. It was in such a mood that he was found on Wednesday by a party of Boston newspaper men, who, by the courtesy of Mr. Wm. McMahon, manager of the phonograph exhibition in this city, visited him at his home at Menlo Park, New Jersey.

The party, consisting of six newspaper representatives, were taken under escort on Tuesday evening by Mr. McMahon, assisted by Mr. Buswell of Horticultural Hall, and were provided with a compartment in a drawing-room car attached to the 6 P. M. train on the Old Colony Railroad, from which at Fall River they were transferred to the steamer Bristol, Capt. A. G. Simmons. An elegant dinner was served on board, and the officers of the boat extended to the party all the courtesies that Mr. McMahon, who was rather jealous of his rights as host, would accept in their behalf. Immediately on reaching New York the party were received by Mr. E. H. Johnson of New York, Mr. Edison's friend and manager, and on Wednesday morning proceeded to Jersey City. Taking an early train on the Pennsylvania Railroad, which train, though express, was kindly ordered by the Superintendent to stop at Menlo Park, that point was reached at about half-past nine o'clock in the forenoon.

AT MENLO PARK.

Menlo Park is a little village twenty-four miles from Jersey City, and appears to be indebted to the presence of Mr. Edison's laboratory for the fact of its having come into existence. Viewed from a hight on which the laboratory stands, there are scattered over the field of vision a number of large and handsome houses, indicating that the population includes a fair proportion of wealthy farmers. In the immediate vicinity of the station are several quite elegant dwelling-houses, forming the village proper. One of these is the residence of Mr. Edison. It is two stories in hight, with a pitch roof, and in accordance with what seems to be a prevailing fashion in New Jersey, is painted in two colors, the trimming being of a peculiar reddish brown, which is but a darker shade of the bright soil of the region. The laboratory is within gunshot of this house, and higher up on an eminence at the foot of which is the railroad station. It is a wooden building, about 100 feet long by 40 wide, and two stories high. The entrance is at the end which is finished with verandah and balcony, taking away from the place a little of its appearance of being a workshop. On entering the building we were informed that Mr. Edison, not expecting us until later, and having been at work until 5 A. M., had gone home to obtain a little sleep. Mr. Johnson went to call him, and meanwhile we busied ourselves in an examination of the premises. On the right of the entrance is a private office, containing nothing of particular interest except a blank book lying on the table. The cover of the book, bearing the title: "Laboratory Notes. T. A. Edison. Menlo Park, N. J.," was suggestive of the inventor's character. The next apartment entered occupies about two-thirds of the first floor, and among the contents were cases containing numerous kinds of telegraphic keys, Morse sounders, galvanometers, a thermo-pile, safe-locks, and other articles connected with electrical or mechanical science. Two brick piers afforded bases for work requiring to be done upon a solid bench, and among the more curious articles was a phonograph in process of construction for the Paris Exposition, a weight and clock-work carrying the cylinder around, and a revolving pendulum with universal joint regulating the motion. Beyond this apartment is the shop, where six or eight men are at work under Mr. Edison's direction. A small engine supplies power for the operation of the various machines which are set very closely about the room. These machines are of the very best quality, as are the many tools that are used, and which vary from those which seem almost too delicate to come into contact with the metals which they cut to those which are very evidently designed for rough and hard work. The workmen, who are mostly young, appear to enjoy their labors quite well, and while they seem to have a comparatively easy time are quick to understand and execute Mr. Edison's orders. Returning to the large central apartment, a flight of stairs is found by which the upper of the building is reached. Here there is but one room, occupying the entire floor. It presents a strange appearance at first sight. On shelves arranged against the walls are hundreds of phials containing chemicals, each plainly labeled. In all directions may be seen wires hanging from the ceiling, the click of telegraph instruments sounds from one direction or another, and the eye is arrested at every turn by machines or parts of machines, some familiar and some novel. Only two or three persons were in the room when we entered, and each had some work in hand. Questions asked of any of the men elicit respectful answers, and any remark complimentary to Mr. Edison is sure to meet with a hearty indorsement on their part. In fact, Mr. Edison is very much esteemed by all the residents, so far as we were able to judge by a sojourn of a few hours among them, and it is proposed to change the name of the place from Menlo Park to Edisonville in his honor. In the laboratory the members of our party did not need any injunctions in regard to keeping their hands off the articles on the benches and tables. Looking satisfied them. Even a small pipe organ that stood in one corner with a Moody and Sankey tune book on the key board did not tempt any of the musically inclined ones to indulge in some music. There was no telling what connections might exist that would make touching things an unpleasant operation. So a large induction coil, the telephone, the electric pen, the motorphone or musical telephone, the harmonic engine and the phonograph itself were looked at but not experimented with. The place is quite clean in appearance and admirably lighted, and altogether the laboratory gave a favorable impression of the man before he appeared. After looking the upper room all over the balcony on the front end was visited, and from this point, by the aid of a fine telescope, those who chose to look were able to see the cables on the great bridge now building between New York and Brooklyn.

MR. EDISON.

It was not yet ten o'clock, when, with a quick step, Mr. Edison came up the road with Mr. Johnson, and, entering the building, was received by all of the party with a manifestation of genuine respect. He looked somewhat sleepy, but was in excellent humor, and having greeted each of us in turn proceeded at once to the table on which is placed the phonograph which he uses, and which is run by pulleys connected with the shafting in the room beneath. The movement of a lever to the right or left gives the cylinder of the instrument a forward or backward movement, and the steady motion of the machinery gives smoother effects than the somewhat irregular motion secured by turning a crank by hand. While Mr. Edison is preparing a sheet of tin-foil to place upon the cylinder we will take a look at him. He is a hard man to describe, and no description yet given of him seems exactly correct. He looks young and yet old—worn and yet fresh. His face is boyish and has still a predominance of manly characteristics. A finely shaped head is thatched with a somewhat unruly shock of hair, well sprinkled with gray, which projects over, but does not overhang, a fine shaped forehead, that bears several well defined though not deep lines. His countenance is open, his gray eyes are bright, his nose and mouth are well shaped, and he is in face very far from being a homely man. Clean shaven, his flesh is pale and unhealthy in appearance. When he is experimenting he wears a thoroughly earnest look, and as he speaks his countenance tells quickly whether the thought in his mind is one of weight or of pleasantry. In hight he is about 5 feet 7 inches, and excepting a very slight stoop of the shoulders is of good figure and is firmly built. He is not so deaf as has been described, and it is not a fact that he has never heard the voice of his own invention. He is very hard of hearing, but by placing his ear close to the sounder of the telephone he hears readily, and is very quick to detect false time or false tones. His voice is soft and pleasant, and he is something of a singer. With a very retentive memory and a wide range of reading, he is able to repeat many poems from memory, and in doing so delivers the lines with good taste and expression. He has been described as being careless and slouchy in his dress, but the Boston party found this description scarcely justified. There was a little of carelessness in his get-up, but there was no evidence of slouchiness. With Mr. Edison's previous history the public is already more or less familiar. He was born at Milan, Ohio, Feb. 11, 1847, his ancestors having come to this country in 1730. The Edisons are a long-lived race, the great grandfather having lived to be 102 years old, and his grandfather to be 103. Mr. Edison's father is still living at the age of 74, hale and hearty, and visiting his son the other day outran him in a short footrace. Edison's mother was a Massachusetts lady, cultivated and educated, and was so faithful a mother that although her son never went to school more than two months in his life he is well educated, being master of several languages, and well read in history, general literature and science. His early years were full of change, and as train boy, proprietor of a newspaper stand, engine hand, newspaper publisher, telegraph operator and electrician, he saw many phases of life before he reached his majority. At all times he was given to making experiments, and after becoming a telegraph operator he made a number of ingenious devices, some of which, however, were to enable him to shirk his regular duties, or appear more efficient than he really was. One of the first steps toward his really useful career in experimenting is due to the interest taken in him by G. F. Milliken, Esq., of the Western Union Telegraph office in this city. Mr. Milliken is himself a man of much ingenuity, and is thoroughly versed in the science of electricity. He happened to have Edison under his orders at one time, and seeing what the young man had in him lent him books and encouraged him in various ways. The result was that in a short time Edison began to work for larger results, and among them are the electric pen and the improved telephone, the former of which has been in practical use for about five years.

THE PHONOGRAPH.

We left Mr. Edison some moments ago, preparing the tin-foil to place on the cylinder of his phonograph. It is barely possible that some of our readers may never have seen a description of this instrument. It consists first of a metal cylinder, 8 inches long by 4 in diameter. Around it from end to end is a spiral groove, the threads being very close to each other. This cylinder is mounted on a shaft, which by means of a screw thread corresponding with the spiral groove carries the cylinder back or forth, according as it is turned one way or the other. To the shaft is attached either a crank or a pulley. On the bed upon which this cylinder is mounted, and in front of the cylinder, is an arm which carries the mouthpiece. This arm is movable, so that the mouthpiece can be brought in contact with the cylinder at will. Within the mouthpiece is a disk of thin sheet iron, about two inches in diameter, on the under side of which is fastened a point something coarser than that of a needle. This point, when placed against the revolving cylinder, fits into the groove. When the machine is to be operated a sheet of tin foil is placed on the cylinder, the mouthpiece is placed against it, and as the shaft turns the point on the disk makes grooves in the foil, or if sounds are made into the mouthpiece the vibrations of the disk produce corresponding indentations. When these are brought again under the point they reproduce the vibrations of the disk by which they were caused, and these vibrations in turn reproduce the sounds, articulate or inarticulate, which, having once been a cause, now become an effect. Taking a sheet of the tin-foil Mr. Edison rubbed it smooth, applied a little gum shellac to one of the edges, and drawing the sheet smoothly around the barrel, pressed the shellaced end down close and so secured it. The machine then being put in motion, Edison, placing his mouth to the mouthpiece, recited a verse from "Bingen on the Rhine." This was afterward recited very distinctly by the phonograph, the tone being loud enough to be heard all over the large room. Turning the cylinder back the operator next whistled "Yankee Doodle," the points passing over the same grooves, and therefore imposing the new series of indentations upon those already made. The result was when the machine next recited "Bingen on the Rhine," it whistled "Yankee Doodle" at the same time, something which, as Mr. Edison subsequently remarked, "no man can do, any more than he can smell his own breath." Still another series of indentations was put upon the same piece of foil and the machine next gave us "Bingen" and "Yankee Doodle," with an accompaniment of cackling, crowing and other noises. A fourth series was added, and after giving us, in a breath, so to speak, "Bingen," "Yankee Doodle," the barnyard music and a verse of "Mother Hubbard," the phonograph repeated the matter backward, the sounds being all distinctly heard, though incomprehensible. One or two tunes were given backward with good effect, and a verse of poetry was given in the same way. A very interesting experiment was what Mr. Johnson laughingly called a duet by one man. Singing one verse of a familiar song Mr. Edison, as the phonograph repeated it, sang the same verse in unison with the machine, projecting the sound into the mouthpiece. The result was surprising, the phonograph giving the verse in two distinct voices, each of which, however, was Mr. Edison's own voice. Still more surprising was the result when to the duet Mr. Edison added a whistling accompaniment, which the phonograph reproduced, together with the duet, with great faithfulness. Among other experiments was the singing of a duet by Mr. Edison and his assistant, Mr. Batchelor, both voices coming out very distinctly in the repetition. Some Latin words having been repeated, Mr. Edison remarked that "Latin

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comes out better than any other language." He could not tell why, but thought that it might be because every letter is sounded, and the language does not make frequent use of hissing consonants. The sound of blowing was reproduced strongly, and rolling letters, as in the words "Grand Trunk Railroad" (uttered with a good burr on the letter "r"), were repeated with grand effect. Hissing was but indifferently repeated. Mr. Edison also showed what he called "mutilating the record." After having talked into the machine he scratched the foil quite deeply with his finger nails, and when the words were repeated by the instrument they were accompanied by sounds resembling little grunts. Mr. Edison said that if two inches were taken out of the record, that is, a strip two inches wide, running from end to end of the cylinder, the machine would still repeat the words, but the sound would be like that of a man who is hoarse. An experiment, made to show how exact the reproductions of sounds are, was that of reading a paragraph from a newspaper, hesitating at or stumbling over some of the words. Every hesitancy or inaccuracy of speech was faithfully repeated. It ought to have been stated in the description of the phonograph that when the instrument is to repeat anything that has been recorded the small opening of a large conical tube is placed against the mouthpiece. Sometimes Mr. Edison spoke into this tube, standing about a foot away, and his utterances were actually recorded. He believed that with a paper disk instead of the iron the instrument would record ordinary tones uttered in an ordinary room at a distance of eight or ten feet. The paper disk is the more sensitive, and would be too sensitive to loud tones uttered in close proximity. In the phonograph of the future, which is to be used for purposes of dictation, and will be subjected to ordinary tones only, Mr. Edison will use paper disks. It will give repetitions with more natural tones. In reply to a question, Mr. Edison stated that the singing of bells is very exactly imitated by the phonograph, but as this question was asked as the party were about to take the train he had no opportunity to verify the statement.

THE EDISON PHONOGRAPH COMPANY.

Practical scientists did not sooner learn the value of this remarkable invention as a wonder in science than the speculators upon brain products learned its commercial value. To avoid the mischief which might result from the too free use of Mr. Edison's invention by unscrupulous persons it was thought best to organize a joint stock company which could control and use the phonograph for the benefit of those desirous of scientific knowledge, the general public, which the instrument will instruct, and Mr. Edison, who in his devotion to science sacrifices his monetary interests. Accordingly Mr. E. H. Johnson, a life-long friend of Mr. Edison, and several other gentlemen assembled a few months ago and formed what is now known as the Edison Phonograph Company. The capital stock was placed at $800,000 and has already been paid in. The company consists of the following gentlemen: Gardner G. Hubbard of Cambridge, Mass., G. L. Bradley of Cambridge, Mass., Charles A. Cheever of New York, Hilborn L. Roosevelt of New York, W. H. Painter of Washington, D. C., Thomas A. Edison of Menlo Park, N. J., and E. H. Johnson of New York. All over the world the instrument has awakened a curiosity hardly second to that excited here at home, and the Microscopic Company of London was among the first to make application for the use of the new speaking motor. Negotiations were entered into some time ago, and that company was granted the right to the instrument in England, after paying Mr. Edison £1500 as a guarantee of good faith in advance of a stipulated royalty. In Russia Mr. Edison has preserved his rights by securing a patent for the instrument in the name of a Russian resident. In France also his interests have been protected, and the American talking machine, as it is now being called, will be among the greatest wonders of the Paris Exhibition. Mr. Edison receives a very substantial share of the profits of the company, and in these days of brain piracy it is a cause for congratulation that such is the fact.

Mr. Edison is still at work, as already intimated, endeavoring to perfect his invention. It was suggested to him, by the way, by his experiments on a machine for recording and transmitting the Morse telegraphic alphabet. His work on the latter is suspended for the present. As to the phonograph of the future all that remains to be said of it is that a flat plate with the grooves running in a circle will take the place of the cylinder. Mr. Edison thinks he can make a phonograph which will record and reproduce 80,000 words on one sheet of tin-foil.

With thus much of the phonograph we must conclude this article, but our note-book contains so much of equal interest in regard to Edison and his inventions that another article in regard to him will be given in an early issue.

The World.

NEW YORK, FRIDAY, MAY 31, 1878.

MR. EDISON IN A CONVENT.

SHOWING THE WONDERS OF THE TELEPHONE AND PHONOGRAPH AT MOUNT ST. VINCENT.

HIS NEW INVENTION FOR CONGRESSMEN, WARRANTED "TO TALK A HOLE THROUGH A BOARD."

Early yesterday afternoon a large number of persons who had been invited to witness an exhibition of the phonograph and other inventions of the "wonderful Edison"—the exhibition to be superintended by Mr. Edison himself—passed into the beautiful grounds of the Convent at Mount St. Vincent. Although it rained heavily, the sky was light; the pathways were strewn with blossoms that had blown from the trees and bushes, and the air was rich with the fragrance of flowers. The flowers and the perfume the ladies of the party enjoyed immensely, and they showed no impatience when one of the sisters brought all to a halt, and, pointing to a large building, on the outside of which was a staircase, said: "The door will be opened in a minute." Some of the men immediately climbed the steps, and finding that the door did not open within sixty seconds, and supposing there was only a porter inside, began pounding upon the panels with their sticks. Presently the doors were thrown open, and much to the surprise of the visitors there were discovered a number of the kind sisters bustling about placing chairs for their guests and a hundred sweet girl-undergraduates in Marguerite *coiffures* intently regarding Mr. Bachelor, Professor Edison's accomplished assistant, who was experimenting with a phonograph.

It is a novel thing for Mr. Edison to appear as a public exhibitor. Indeed this was his first appearance, and it may be his last. When he went upon the platform he took a seat and, instantly becoming absorbed with some train of thought, heard little of Mr. Thiebaud's welcome to him, and nothing of his words of praise. The speech being ended, Mr. Edison, brought back from to-morrow, seated himself before his phonograph and produced those strange effects of word and tone reproducing which have long been familiar to the readers of THE WORLD. The phonograph's powers having been shown remarkably well Mr. Edison's telephone was adjusted, and a man being stationed in a room 150 feet distant a conversation was begun, which, though only just audible in the body of the hall, was perfectly distinct on the platform. Just before this a slight rustling noise was heard in the rear of the hall, and then was seen a long procession of the sisters filing into a high gallery. It was then, indeed, a strange picture. The black-robed women sitting against the white wall, isolated entirely from the gayly dressed young girls below, with whom they made a strong contrast, and still further removed from the thoughtful man on the platform, who, not content with the teachings of the fathers, sought out wonders that no man could teach him.

After Mr. Edison's wonders—which included, by the way, the electric pen—had been shown in a general way, Mr. James R. Hecnan, who had proposed the exhibition and prevailed upon Mr. Edison to give it, invited the audience to examine the inventions more closely. Many of the guests, including Mr. F. C. Harriott, Mr. Simonton, of the Associated Press; Mr. Somerville, of the National Press Association, and his wife; Mr. Bertrand Kitell, of the same association, and wife, and Mr. Ludwig, of the Gold and Stock Telegraph, and wife, accepted this invitation. The young ladies of the school, who waited quietly during about an hour while the visitors were examining Mr. Edison's wonders, then ascended the platform. At last, when everything had been explained, one of the pupils treated the visitors to an aria, and it was announced that the exhibition was over.

As the WORLD reporter was going down the drive, Mr. Edison and Mr. Bachelor came running down the hill, racing each other for fun, unmindful of the rain and wet. The reporter seized the wonderful man. "Tell me, Mr. Edison," said he, "how you are getting along with your machine for measuring starlight?"

"I have just completed the first machine," answered Mr. Edison, "and it works perfectly." He then described the instrument very rapidly but completely, and in terms that would be difficult to

repeat. The meter consists of the galvanometer of Mr. Edison's telephone, the principal part being a small disk of carbon. On this disk is placed a straw, upon which the light falls. Connected with the galvanometer is a minute mirror, on which is a hair spring, fastened to a single strand of a spider's web, by which the mirror is suspended. The light falling on the straw causes it to expand, the expanded straw then presses more or less sharply upon the carbon disk and the impulse is transmitted to the delicate mirror which is deflected.

"Now," said Mr. Edison, "I have held a lighted paper against an ordinary thermopile and it had no effect. I held my hand within six inches of my machine and the mirror was deflected. The apparatus is so sensitive that the slightest expansion of the straw causes a marked deflection of the mirror. The shadow of the mirror is thrown upon a gauge and its degree of motion is thus measured."

"I intend," continued Mr. Edison, "to make combinations of different chemicals and make collections of all kinds of wood and stone; and I am going to find out which is the most sensitive body that exists. This heat-measurer will not only be of value in detecting the amount of heat that is evolved from the stars and planets, but it will also be the most sensitive barometer known. It can also be used for rapidly breaking currents of electricity."

"Do you know anything about the microphone, Mr. Edison?" asked the reporter.

"Yes," he answered. "That's one of the biggest 'steals' ever made. It was stolen outright from my telephone, and was gotten up by a man named Hughes."

The microphone, it may be mentioned, is similar to the telephone, including the carbon disk but magnifies sound as well as transmitting it. It has been exhibited before the Royal Society of London by Mr. D. E. Hughes.

Mr. Edison has several new or improved inventions. First is the phonomotor, which, like the cradle-rocking telephone recently described in THE WORLD, owed its origin to banter. Mr. Edison was asked during a visit to Washington about two months ago, if he could invent a machine that would talk a hole through a pine board. He answered that he could, and instantly made a diagram of the machine. The model is now in working order. It consists of the diaphragm or mouthpiece of the phonograph fixed to an upright. Behind the diaphragm is a horizontal bar with a wheel and lever. When this machine is talked to as if it were a phonograph, the vibrations move the lever, and this turns the wheel and the bar. To the end of the bar will be affixed a gimlet. Thus, Mr. Edison will talk a hole through a pine board. *Q. E. D.*

Mr. Edison's phonograph, with a circular plate instead of a cylinder, is rapidly approaching completion. He has recently, however, been giving all his attention to the making of a cylinder instrument for the Paris Exposition. This will be run by clock-work, to insure accuracy of motion. It has an improvement which is not only valuable but curious. The strip of tin foil which receives the sound indentations from the diaphragm is fastened on the cylinder of the original phonograph by gum. On the new instrument the foil is fastened to the cylinder by a bar which presses it into a slot. It was thought that this slot, which is about an eighth of an inch wide would affect the reception of sound; but it was found on experiment that after a strip of tin foil has been indented with sound vibration a piece can be cut out of it without marring the reproduction of the words. Mr. Edison is also constructing an improved ear-trumpet for deaf persons, the value of it depending upon a certain angle of aperture; and he is preparing to utilize the vibrations of an immense bar of iron, bent somewhat in the shape of a horse-shoe magnet.

The Phonograph.

The right to exhibit the phonograph is granted on the following conditions: 1. $100 cash on delivery, before the phonograph is even seen. 2. A bond of $500, with two approved securities, not to run away with the company's money. 3. Twenty-five per cent. of the gros receipts, the exhibitor incurring all expenses, the company none. 4. Daily statements under oath of the receipts of the day previous, and daily remittances, at the exhibitor's expense, of the 25 per cent. due the company. 5. Privilege on the part of the company, through its agent, to examine the books, accounts, &c., of the exhibitor. 6. Right claimed by the company to demand of the exhibitor a system of tickets and doorkeepers which shall be satistory to the company, cost of same to be borne by the exhibitor. 7. Right of the company to annul the lease and take away the phonograph without remuneration to the exhibitor, in case his books, &c., do not satisfy its agent. 8. Right of the company at any time, with or without cause, to annul the lease, leaving, however, the phonograph in the hands of the purchaser, subject to whatever opposition he may encounter from other exhibitors. If these terms are acceded to, the company grants exclusive privilege to exhibit the phonograph within certain limits until October 1, 1878. This privilege for the State of Virginia, exclusive of the county of Norfolk, was offered to Dr. Bagby, but, in view of the restrictions, the offer was respectfully declined.

THE OPERATOR. A JOURNAL OF SCIENTIFIC & PRACTICAL TELEGRAPHY.

June 1st, 1878.

Thomas Alva Edison.

Edison started a shop in Boston, and gave all his spare time to it. His ideas here began to assume practical shape. He invented a dial instrument for private line use, and put several into practical operation. He made a chemical vote-recording apparatus, but failed to get it adopted by a Massachusetts Legislature. He commenced his experiments on vibratory telegraph apparatus, and made trial tests between Boston and Portland. He matured his first private line printer, and put eight into practical operation. From lack of means to pay for quotations, his venture was not successful, and he sold out. This patent subsequently came into possession of the Gold and Stock Telegraph Company, and was considered to have a base or foundation value upon which many subsequent improvements were built.

At one time he was invited to explain the operation of the telegraph to what he supposed was a girl's school. He forgot the appointment, and when found, was putting up a line on a house-top. He went directly from his work, and was much abashed to find himself ushered into the presence of a room full of finely dressed young ladies. He was actually timid in ladies' presence, but his subject was understood, and the occasion passed pleasantly. He was introduced to a number of the young ladies, who always recognized him on the street, much to the astonishment of his fellow-operators not in the secret. Edison is a strong believer in the Boston girl.

His idea of a duplex system constantly burned in his brain, and in 1870 he went to Rochester, N. Y., to try his apparatus between the two cities. Mr. F. L. Pope, the present patent adviser of the Western Union Telegraph Company, assisted in New York. The effort was a failure, although Edison has always claimed it ought to have succeeded. He then went to New York, arriving there dead broke and discouraged. He hung around the office of the Gold Indicator Company for several days. Their apparatus was cumbersome and imperfect, and frequently out of order. At such times the brokers would rush to the office and demand instant repairs. One day when there was an unusual excitement in the gold market, the apparatus failed. The confusion at the Indicator office was great. The Superintendent was out. Edison happened in and stood watching the confusion. He volunteered to fix the machinery. The President looked upon him with amazement, but, being in the mood to catch at straws, gave him permission to try. He speedily found the defect, and the next day was engaged to fill a responsible position with the Company. He immediately began to improve the apparatus, and soon invented a gold printer. The Company was purchased by the Gold and Stock Company, and Edison was thrown out. He then went into company with Pope and Ashley. The Pope and Edison printer was brought out, and a private line system was put in active operation. This was soon sold to the Gold and Stock Company, and Edison has for many years been retained in the service of that Company and the Western Union Telegraph Company at a large salary, they having the first option to purchase his inventions pertaining to telegraphy at prices agreed upon in each case. Edison's inventions pertaining to the gold and stock telegraphy soon replaced the old apparatus, and that system is interwoven with his inventions and improvements. At the formation of his intimate connection with the Gold and Stock Company, he established an immense electrical manufacturing establishment at Newark, which was divided into three large shops and two laboratories for experiment. He employed upwards of 300 men, and was himself the busiest man in America. He gave himself scarcely any time for sleep. An idea of his determination and persistence can be gained from the following incident: He had been given an order for $30,000 worth of improved printers. The sample instrument had worked an experimental circuit, but the first instruments for practical use proved a failure. In vain he sought to remedy the defect, till, finally, taking four or five of his best men, he went to the top floor of his factory, remarking that they would never come down till the printer worked. They labored continuously for sixty hours, and he was so fortunate as to discover the fault, and made the printers operate perfectly at an expense of $5,000. Such severe and protracted labors are common with him. He says after going without sleep more than the ordinary hours he becomes nervous, and the ideas flow in upon him with great rapidity. His sleep after these efforts is correspondingly long, sometimes lasting thirty to thirty-six hours. He knows no such division as day and night in his labors, and, when the inspiration is upon him, pursues the investigation and experiment to the end. As a manufacturer he did not prove a success. The more resources at command, the greater his efforts at invention. At one time he had forty-five distinct inventions and improvements under way. All the large sums received for his patents, and the profits arising from manufacturing to the amount of nearly $400,000, have been expended in inventive efforts. He finally became excessively annoyed at the tax upon his powers arising from regular business, and concluded to remove to some small place inconvenient to reach, where he would be free from curiosity-seekers, and have opportunity to put into practical shape his conceptions. In 1876 he sold his machinery, and moved his family to Menlo Park, N. J., on the Pennsylvania Railroad, twenty-four miles from New York. Here, on the crest of a hill, remote from other buildings, he built a laboratory 28x100 feet, two stories in height. In one room on the ground floor he has a machinery apartment, in which is located a ten-horse-power engine, and a collection of expensive tools, so that any appliance, however intricate, can be made under his own inspection. In another room are ranged on shelves and in cases the models of a large number of his experiments and inventions. Here are also to be found many instruments of precision, which he has purchased at great cost, to assist in his investigations. His library is entirely scientific, and costly, but not large. On his upper floor he has ranged upon shelves thousands of bottles of chemicals, and he makes it a rule to purchase some of every known chemical or mineral, to have at hand in case of need. Here he conducts his experiments under his personal supervision. He has always with him three or four assistants, whom he has selected on account of their skill as draughtsmen or workmen, willingness to comply with his wishes, and their physical endurance, which, with him, is an important consideration. Messrs. Charles Batchelor, Scotch, and James Adams, Irish, and Mr. Kusel, of German descent, are the principal assistants. Sometimes he has fifteen men employed exclusively in developing his inventions, if of importance and near completion. Edison was described by the United States Patent Commissioner as the young man who has kept the path to the Patent Office hot with his footsteps. He has been granted 112 patents in this country, and has some twenty applications pending in the office. His most valuable inventions have been patented in many foreign countries. Of his American patents, thirty-five pertain to automatic and chemical telegraphs, eight to duplex and quadruplex telegraphy, thirty-eight to printing telegraph instruments, fourteen to Morse telegraph apparatus proper, and the remainder relate to fire-alarms, district and domestic telegraphy, electric signals, the electric pen, the speaking phonograph, and a variety of electrical and non-electric apparatus.

The printing telegraph instruments, the automatic or chemical system, by which 1,000 words a minute can be transmitted on a single wire for medium distances; the quadruplex system, by which four messages at a time are sent on the same wire by the Morse method; the electric pen; the carbon telephone, which exceeds all others for its loudness and distinctness; the speaking phonograph, and the aerophone are among his most valuable productions.

He has made many extremely interesting and minor discoveries, such as the lubricating property of electricity, upon which the electro-motorgraph is based, and upon which could be built an entirely new system of telegraphy. His mind is so prolific that he can always afford to accept reasonable compensation for his inventions.

He is sharp at a bargain, and has been styled a Tallyrand in negotiating for the disposition of his inventions. His peculiarities and the great value of his inventions have led to severe struggles for the possession of some of them. His great anxiety seems to be to give an equivalent invention for the price asked, but he professes to be utterly without conscience in case of any attempt to overreach him. In person he is five feet nine and one-half inches

The Edison Quadruplex Suit.

Judge Blatchford, in the equity branch of the United States Circuit Court, heard arguments May 14th on demurrers in two suits involving the right to use the automatic, and duplex and quadruplex systems of telegraphy. The first suit was brought by Thomas A. Edison and George Harrington against the Atlantic and Pacific Telegraph Company and Jay Gould, and involves a claim by the plaintiffs individually and as trustees for about $4,000,000. It appears that in December, 1874, Gould entered into a contract in writing with J. C. Reiff and John McManus, who were interested in the inventions in question, to the effect that the parties thereto would use their best efforts to bring about a sale of the patents to the Atlantic and Pacific Telegraph Company for 40,000 shares of the stock of that company, of the par value of $4,000,000. It was afterward agreed that the shares should be so apportioned that 31,800 shares should be allowed for Edison's inventions, and 8,200 shares for some other telegraphic rights conveyed to Gould. Mr. Harrington, being sick and about to leave for Europe before authority to issue the stock could be obtained, executed a deed of assignment of the patents to Jay Gould, dated April 9, 1875, and placed it in his hands with written instructions not to deliver it to the Atlantic and Pacific Telegraph Company until he (Gould) should receive the 31,800 shares of stock for distribution among the parties entitled thereto. Edison was one of those parties, and was to receive 3,000 shares. At the same time, Harrington sold to Gould the shares that he was to be personally entitled to under that division, and received $25 per share for the same, it being assumed that the optional right of the company to make the purchase would be exercised. The deed of April 9, 1875, was for the nominal consideration of $1. Gould placed it on record in the Patent Office in his own name so as to appear to be the owner of the patents. The bill alleges that the Atlantic and Pacific Company refused to make the proposed purchase on the terms mentioned in the memorandum of December, 1874, and refused to make any other proposition, and yet insisted on claiming the title under the deed of April 9, 1875. On the argument of this demurrer the defendant's counsel insisted that the bill could not be maintained by Harrington and Edison, as holders of the legal title in trust, because Harrington had sold his expectant share of the stock, which would have been issued to him personally if the Atlantic and Pacific Company had exercised the optional right of purchase. To this it was replied that the Atlantic and Pacific could not keep its property on the strength of the abortive propositions for the sale to them; that they were liable as infringers of the patents, and that complainants are entitled to a decree as prayed; that no title passed by the deed to Gould. The court overruled the demurrer.

The case of George Harrington and Thomas A. Edison against the Western Union Telegraph Company and George B. Prescott was next called and argued. This is a bill in equity to establish the title of the complainants to Mr. Edison's inventions in what is called quadruplex telegraphy, which is the subject in controversy in other suits in the Superior Court of New York, in which the Atlantic and Pacific and the Western Union Telegraph Companies are rival claimants for the same inventions. This bill ignores the claims of both companies, and insists that the title, legal and equitable, is in the complainants in this case, and prays for an injunction to restrain the Western Union from infringing a patent granted to Edison and Harrington on April 27, 1875, for the principal invention made by Edison in quadruplex telegraphy. The defendants demurred to the bill on the ground that Prescott should not have been joined with the Western Union, it not being alleged that he infringed the patent in question. To this it was replied that the bill alleges that the company claims title to that patent under a deed made by Edison to Prescott, dated Aug. 19, 1874, and under an alleged sale by them to the Western Union, and that, as the Western Union claims title under Prescott, it was proper to make him a defendant, the object of the bill being to obtain a final decree establishing the title of the plaintiffs as against the title claimed by the Western Union under the deed to Prescott. The court overruled these demurrers also.

Dashes Here and There.

Mr. Edison, the inventor, it it said, begrudges the time he is forced to devote to eating. He should invent a machine to eat for him.

Edison has perfected a fog-horn that can be heard ten miles, but when it comes to an invention for getting his hired girl up in the morning he smiles sadly and falls to musing on the infinite.—*Utica Observer.*

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SALEM, OREGON, MAY 21, 1878.

PUBLIC SPEAKING.

J. J. Whitney, Democratic candidate for District Attorney of the Third Judicial District, will speak on the political issues of the day at the following times and places, to-wit:

Gervais, Tuesday, May 21, at 1 P. M.
Silverton, Wednesday, May 22, at 1 P. M.
Salem, Thursday, May 23, at 7½ P. M.
Stayton, Friday, May 24, at 1 P. M.
Jefferson, Saturday, May 25, at 1 P. M.
Scio, Monday, May 27, at 1 P. M.
Lebanon, Tuesday, May 28, at 1 P. M.
Brownsville, Wednesday, May 29, at 1 P. M.
Harrisburg, Thursday, May 30, at 1 P. M.
Albany, Friday, May 31, at 7½ P. M.

The Telephone in Salem.

Mr. J. E. Strong of this city, ~~agent for the American Telephone Company~~, has obtained some of these wonderful instruments and now has them working at his house. We had the pleasure of trying the practical workings of them and can only say they are all that is claimed for them. One can hardly help feeling the seeming ridiculousness of talking to a little wooden instrument which he holds to his mouth, but when he holds it to his ear and hears the reply as distinctly as though seated by the person who is talking, he can not help acknowledging that the telephone is the greatest discovery since Morse found a method of making the electric fluid a medium of communication, and the useful servant of man. The present telephone is probably only a beginning of the wonders which are to be accomplished by this discovery of the possibility of transmitting sound, and we can as yet scarcely realize the broad field of usefulness to which it is destined. There can hardly be a limit to its application. Mr. Strong and others contemplate the erection of a line of wire from this city to Dallas to be used for conveying messages with the aid of the telephone, and there can be little doubt that it will prove a profitable investment. In a very short time every town and hamlet in the State will probably be connected with the more important places by these telephone wires, and the facilities thus afforded to business can scarcely be estimated. In order that all persons in the city may learn the working and uses of this great invention, Messrs. Strong and Cooper will soon give a public exhibition of it at Reed's Opera House. Connection will be made with the telegraph company's wires, and the audience will have the privilege of conversing with persons at the various points in this State where telephones have been obtained. Mr. Strong will also deliver a lecture on the subject of the telephone and electricity which will no doubt be very interesting, as Mr. S. is one of the best electricians in the State, having made this matter a study for many years.

Boston Courier.

SUNDAY MORNING, JUNE 2, 1878.

—Mr. Thomas A. Edison's inventions are likely to work an important revolution in the business of courtship—especially in the serenading department, as witness:—

THE CURRENT SERENADE.

Wake, dearest, wake and light the gas:
Thou shalt not be alone,
For still for thee, my lovely lass,
I touch my telephone.
Though absent far from thee I am,
Yet softly on thy diaphragm
I give my sweetest tone.
And though away ten thousand miles,
I cannot see thy angel smiles,
Yet I can hear thy laugh:
And oh, unless fond hope beguiles,
Deceiving with mechanic wiles,
I'll trust thy phonograph.
And as I grind thy accents out,
Then fading each fond jealous doubt,
I'll call thee all my own.
And absent yet, on thee I'll bet,
Bone of one bone, by telephone,
My better-half by phonograph,
My own, my own!

NEW YORK, FRIDAY, MAY 31, 1878.

THE HERALD will be sent to the address of

PHONOGRAPH AND TELEPHONE.

PROFESSOR EDISON EXHIBITS HIS INVENTIONS AT MOUNT ST. VINCENT.

A pleasant entertainment, consisting of an exhibition of the phonograph and telephone, was given yesterday afternoon in the recitation hall of the Academy of Mount St. Vincent, on the Hudson. Professor Edison was present in person and illustrated, though he did not explain, his mysterious works. In the audience on one side of the room were the young ladies and little girls, pupils of the academy, to the number of nearly two hundred. The chairs on the other side of the hall were occupied mainly by ladies and gentlemen, the friends of the pupils and their instructors. Some forty or fifty Sisters filled a high, narrow gallery, extending across the rear wall. Notable among the guests were Miss Clara Morris, the actress, and her husband, Mr. Harriott; Mr. Croly and "Jennie June," his wife; Very Rev. Michael Lilly, O. P.; Very Rev. James Dunne, Rev. L. Musart, late chaplain of the academy; Rev. P. Tancry, Edmund S. F. Arnold, of Newport; Thomas D. Cornell, W. F. Thatcher, E. F. Ludwig, William Haddon and Edmund F. Randolph. Quite a large party of ladies and gentlemen of this city were present, the remainder being chiefly from the village itself and the neighbouring town of Yonkers.

The entertainment was opened with a piano solo by one of the professors of the academy. An address was then delivered by Mr. G. J. Thebaud, a lawyer of this city. After explaining briefly the now familiar qualities of the telephone and phonograph Mr. Thebaud presented a humorous view of the uses to which the latter might be put. In the first place, he said there was a certain New York lawyer whose services were greatly desired in an important case to be tried in Chicago. It being impossible to attend in person he prepared the most eloquent speech it was possible for him to make and delivered it with dramatic emphasis into the mouthpiece of a phonograph. The instrument was then forwarded to Chicago, and the Eastern lawyer's eloquence, shot so strangely into the enemy's camp, took the jury completely off their guard and saved the life of a possibly innocent man. The speaker then went on to tell of the convenience of the phonograph to a bashful lover, who could avow his passion in the seclusion of his closet and then stand boldly by the instrument while it ground out the glowing adjectives in his sweetheart's ear. To the Catholic it would be of inestimable advantage, sparing him the painful interviewing of the confessional. Some fifteen or twenty minutes were occupied by the delivery of this address, after which Professor Edison thanked the audience for its presence on such a disagreeable day, and rewarded his hearers for their courage in facing the storm by giving them an entertaining exhibition of his instruments.

THE WONDERS OF THE PHONOGRAPH.

A large table on the platform at the front of the room was arranged for the exhibition of the telephone and phonograph, the latter lying loosely at one corner of the boards, and the former, with its various paraphernalia, occupying the greater part of the space. The wire by which communication was held with operators in a small room 200 feet distant from the hall, ran across a wide yard between the buildings, being nowise affected by the pouring rain. The telephone used was one which Professor Edison had used the previous evening in communicating from his laboratory, in Menlo Park, with the office of Mr. Bentley, in the Western Union Telegraph building, at Philadelphia, a distance of seventy-five miles. The wonders of the phonograph were first displayed, Professor Edison putting his mouth to the instrument and imitating the crowing of a rooster, the barking of a dog, the cry of a peacock, the peculiar enunciation of the darky, the squealing of a pig and a general medley of barnyard sounds. He then recited passages from Shakespeare and from Whittier's poems, every sound which entered the instrument being reproduced with sufficient power to be heard distinctly throughout the spacious hall. This performance by the inventor was highly appreciated and received warm applause from the audience. His chief assistant, Mr. Batchelor, then took his stand at the phonograph and entertained the company with a selection of humorous verses of the more familiar sort, relieving their lightness by forcing the instrument to repeat words of such weighty wisdom as the line, "who steals my purse steals trash," and other choice sayings of Shakespeare.

THE TELEPHONE.

Visitors were then invited to step forward and try the talking-machine, which they did, afterward putting their ears to the ear piece of the telephone and listening to the familiar words and songs which echoed through it from the distant room. A peculiarly effective feature of this part of the performance was the singing of a duet by male voices, which came with weird effect along the electric wire, making the hearer thrill to the strains of "The Sweet Bye-and-Bye." For a change a young lady pupil sang a solo, with piano accompaniment, which lost nothing by coming direct from the lungs and lips without transmission through steel wires or wooden boxes. The excellence of the performance surprised the audience. The girls and young ladies now examined the instruments, and though they would listen attentively and long enough to the mysterious vocalization of the telephone they could not be persuaded to give utterance to their thoughts in the tell-tale phonograph. They hung about it like so many birds around a bunch of grapes, chattering and laughing excitedly, and in loud chorus trying to persuade each other to "speak first." But it was not to be, and though one young lady was emboldened to place her lips to the mouthpiece, her courage forsook her and she rose again without having been able to utter a syllable.

On a smaller table near by one of Professor Edison's four assistants exhibited that inventor's electric pen.

The close of the exhibition was announced at a quarter of four o'clock, and visitors were requested to withdraw to allow the Sisters an opportunity to examine the machines, which was accordingly done, the principles being explained to them at some length. Professor Edison and a number of guests from New York returned on the 4:10 train.

THE HAWKEYE.

Saturday, June 1, 1878.

—Now, if Edison could only invent an almanac that wouldn't lie so like thunder about the weather. But we believe he can't.

—Admitting for the phonograph all that is claimed for it, it cannot be considered perfect yet, because, while it can record what a woman says when she bows her visitor out at the door, and says she is "so glad she came, and that her new hat is perfectly divine, and won't she please come again soon," it can't tell any more than an empty oyster can what she means.

BURDETTE'S CRADLE.

The Greatest Invention of the Age.

Edison and Burdette Join Hands--And Bring Out the Great Patent Telephonic Baby Crib Rocker--Better Than Soothing Syrup and Never Fails.

Recently there appeared in the "Editorial Dots" column of this paper a request by Mr. Burdette that "the wonderful Edison," as the New York *World* calls the famous telephone and phonograph inventor, should arise to the domestic emergency and make his phonograph equal to the occasion. Mr. Edison responds by a sketch which we find in the New York *World* of recent date, and which, through the timely courtesy and skill of Mr. Conrad Lutz, the engraver, of this city, we are enabled to reproduce this morning together with a pleasant description, by the *World*, of the visit by a distinguished party, to Mr. Edison's wonderful electrical laboratory at Menlo Park.

MR. EDISON'S RECEPTION—THE LADIES ASTONISHED AT THE BURDETTE-EDISON DEVICE FOR QUIETING THE BABY.

Mr. Bayard Taylor, now minister to Germany, in his novel of "Hannah Thurston," described his hero as giving an evening party in a large, bare room, lighted by candles, the hero being poverty-stricken. A somewhat similar scene occurred last night at the wonderful Edison's laboratory at Menlo Park, the difference being that Mr. Edison, thanks to his invention, is not poor, and that the candles were replaced by gas of Mr. Edison's own manufacture. Mr. J. M. Tower, at present a resident of Menlo Park, had, with the inventor's permission, arranged for a sort of reception to the phonograph, and last evening the party left New York on a special train. Among the guests were W. W. Evans, the well known civil engineer, J. L. Hicks, Dr. Bailey, Sydney W. Beers, of the New Jersey Midland; J. W. McCulloch, receiver of the New Jersey Central; James N. Beard, of the International Ocean Telegraphic company; Clark Waggoner, collector of internal revenue at Toledo, and his son; C. B. Kid, engineer of docks; Mr. Sarney, James Craig and Winslow Judson, of the Fifth Avenue hotel; Edward Bierstadt, Albert Weber, W. B. Shunk, a prominent engineer, and Mrs. White, of Brooklyn, with several other ladies.

It was strange that a reception should be held in a workshop, but Mr. Edison did not mind this fact, as he was busily engaged with some new ideas when his guests arrived, and the latter made no complaint, as they were only too anxious to hear the phonograph. Mr. Bachelor, Mr. Edison's accomplished assistant, escorted the party to the upper floor, and the ladies and Messrs. Evans and Shunk, who are somewhat deaf, gathered closely about the instrument. All said that they had heard a good deal about it, but that they didn't believe it, and that they intended to write to all the scientific journals and tell their lady friends of it.

Then Mr. Bachelor took his seat before Mr. Edison's baby, as he called it, and talked, whistled and sang at it, amid great applause, beginning with "Mary's little lamb." Then Mr. Edison was called for, and, with a look of surprise at the fact there was an evening party in his place, he went up stairs and began to repeat "Mary's little lamb" to the phonograph. This proceeding called forth a protest from Mr. Weber; and Mr. Edison and Mr. Batchelor then sang duets and talked to the instrument until it suddenly notified them that a can of milk, etc., was on an adjoining table.

"This 'ere punch," Mr. Cornish, of Cornish's tavern, who acted as a head-waiter, "is the same as was given to the 'Tally-Ho,' as told in the *World*, and so drink hearty." Then Mr. Tower produced a testimonial consisting of a handsome scrap-book containing the names of those present, following an expression of the opinion that his title of "the wonderful Edison," conferred upon him by *World* and copied in the Paris *Figaro*,

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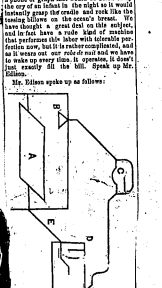
Among the slips in the book prepared by Mr. Tower for the occasion were contributions and his answer. The puzzle was propounded by THE BOOKMAN HAWKERS, and is as follows:

Candid Mr. Edison invent some kind of a phone or graph that would be acted on by the cry of an infant in the night so it would instantly grasp the cradle and rock like the tossing billows on the sea of dreams. We have thought a great deal on this subject, and in fact have made a crude kind of machine that gratifies us the labor with tolerable purity now, but it is rather complicated, and as it wears out *our cradle* will soon have to wake up every time. It operates, it does't just exactly fill the bill. Speak up Mr. Edison.

Mr. Edison spoke up as follows:



A. Cradle.
B. Telephone.
C. Battery.
D. Box containing parrots and cockatoos with liver.
E. Which moves the cradle.

The baby's office was received by the telephone, which, operating through the battery and magnets, set in motion the lever which rocks the cradle. When the baby stops crying the cradle ceases to rock.

After this there was nothing left for the guests to do, and this they did at their leisure. Mr. Edison having disappeared as they entered their way to the railroad station.

N. B., agents wanted. No hucksters need apply.

PROFESSOR HENRY ALBERT AN ACTOR.

THE LATE SECRETARY OF THE SMITHSONIAN INSTITUTION ON THE STAGE.

Thurlow Weed in New York Tribune.

I was alike gratified and relieved by the letter in this morning's Tribune, recently written by Professor Henry to Mr. Patterson. I had fears that Professor Henry, like many eminent scientists, had drifted away from his early religious moorings. The letter reassuring with much clearness of perception, and with such a wealth of illustration, the power, wisdom and goodness of One, by whom all things were created, and by whom preeminence animate and inanimate, nature is harmonized and unified, is, therefore, a gratification and a relief. While Professor Henry's letter is addressed to me, my esteemed friend, Robert C. Winthrop, of Boston, called. He had just read and was much pleased with the letter. Mr. Winthrop had known Professor Henry long and intimately. Being in Washington recently and hearing of his friend's illness, Mr. Winthrop called upon him. The professor explained the nature of his illness, (a partial "paralysis of his right hand and arm), but expressed a confident belief that he would be able to make his annual tour of observation along the coast in a small vessel which the government provided for him. In the course of their conversation the lamentable theory was spoken of.

Mr. Henry remarked that novel and bold theories, even if fallacious, were productive of good, because in the research and discussion which succeeded the facts and arguments adduced to expose error were also to confirm and establish the truth.

In the sketches of the life of Professor Henry an incident is omitted, perhaps, because none but myself are known to relate it. As that incident gave to the professor one of his most distinguished ornaments, it seems worth relating. My acquaintance with Joseph Henry, commenced in Albany, ripened into a warm friendship. He was then an apprentice to John F. Dove, a silversmith in State street, Albany. I was a journeyman in the office of *The Albany Argus*, published by Henry C. Southwick, and edited by Solomon Southwick. During the war with England, which had just closed, the Green street theatre, with a strong company, liberally patronized by the officers of the army stationed in Greenbush, awakened much enthusiasm among the young gentlemen of Albany, several of whom formed themselves into an amateur theatrical company. They fitted up a hall formerly used as a dancing academy, then known as the "Bunghole hotel, on the corner of North Pearl and Hamilton streets. They selected large auditorium. Joseph Henry became a "bright particular star." Miss Young, *Harriet, Duncan* and others, "Cato," were announced equal in conception and execution to the pretensions of experienced and popular actors. His friends, appreciating his talents and genius, urged him to adopt the stage as a profession. His own thoughts and inclination rendered him a willing listener. Soon the manager of the Green street theatre offered him a permanent engagement with a liberal salary. With that the young aspirant for dramatic honors was greatly delighted. But Dr. T. Romeyn Beck, principal of the Albany academy, believed that there was a way opened to the young man promising greater usefulness and more enduring honors than the boards could confer. After consultation with the trustees, Dr. Beck invited young Henry to enter upon and complete a gratuitous academic course. While assiduously cultivating these confiding offers three of his intimate friends, James Dexter, a law student, James Hunter, a printer, and myself, were called into consultation. Hunter and myself sue for our friend in a dramatic career ensured fame and fortune. Dexter, less enthusiastic, preferred to look nearer to those of the "rock" and "bunghole." He urged, and but forcibly, that if the stage was to be ultimately adopted as a profession, an academic education would increase our friend's chances for enduring success, and would be something valuable to him he would have, quite young enough to become an actor. I was sanguine, after a long and anxious mental struggle, proved effectual. The following year Joseph Henry resigned Manager Dorlaska's dramatic offer, and took his seat in the Albany academy. Mr. Dorly, when informed of his apprentice's desire to become a student in the academy, generously surrendered his indenture. There was only a few weeks before the "Albany Routine" became so absorbed, in and delighted with his studies that the theater with all its attractive associations was forgotten. Long years afterward, when we met in Washington or in his office in Albany, while recalling the scenes of our youth, the grave Professor Henry, with a world-wide scientific reputation, reverted with epicurean delight to his life as partaking more of a dream than as a reality.

A STAGE TAVERN ROMANCE.

New York Trade Journal
Office—206 and 208 Broadway.

SATURDAY, MAY 4, 1878.

Electro- and Stereo-typing.

One of the most important industries which have originated during the past quarter of a century is that of electrotyping, when in at the same time the most useful, and now ubiquitous and in production of the most important before. When we consider, in this connective day, of works which pass through inventor's of editions, and the light of magazines, every year, a proportion, is no-ments, etc., which demand extensive reprints, we can form some idea of the value of this process, for at least the economical improvement in the time and labor required. The value lately to be "plated" in any concern, or to prevent disagreement, and the consequent expense. In the multiplication of the impressions of any work once it is stereotyped, as but for electrotype each out would necessarily have to be re-photo engraved, and before soon destroyed by the rollers of the printing press, he requires every again. Being desirous of ascertaining the progress made in this branch of industry, we lately paid a visit to the Electrotype house of this city, Messrs. Keeler, Rice & Co., No. 37 to 47 Vandewater street, where establishment we found to be the most complete and comprehensive in every department of any we have hitherto inspected. This house was established by Lovejoy & Wheeler, in 1870, in a very small way, personally inclined to a new enterprise, in White street. Business gradually increasing, however, a removal was made in 1876 to 19 Vandewater street, where it remained until this spring, when an opportunity offered for the acquirement of even a more peculiarly and admirably suited to the in-town than referred, by any other house in the country; the newly erected five-and stone-front of Mr. George Nugent, which reaches an elevation of over 103 feet above the level of the ground, is directly fronting the East Rivery and the new bridge, and covers, above all other buildings, commands a brilliant and unincumbered view. The establishment, consisting of the entire building, covers an area of 7,500 sq. feet, each department communicating one with the other by means of elevators, and is admirably adapted for the rapid and systematic execution of the business, and for safety and easy communication.

The New Establishment, familiar from the office, is the receiving room, in which respective agreements are made. In this department is also found a machine for applying, automatically, the plumb wash and sand to the back of the moulds, which are composed of wax, by which they become more durable, and from which the wax is poured in copper. Being battery they are then placed in the vats, and the deposit of copper. Being placed in the vats, and the deposit of copper. Being allowed to remain for two upwards, a volume of the liquid is thrown upon them, when set, rejected from these vats, which by the process is not injured, after which a brush, is always the case. We may remark that this is the only house, excepting Harper Bros., now using this machine. This process is termed "wax block-leading." This house was also the first to adopt the magnetic-dynamo machine, imported in the year, one and, from England, which is, how-ever, now replaced by improved machines of our own. In this connection, we may remark that no money or enterprise is spared in effecting every improvement in machinery. In this connection we may state that a machine shop is also on the premises, which is under the supervision of Mr. J. H. Ferguson, one of the firm, who is himself a practical machinist, by use of break-down, require are this readily made, in addition to which nearly all parts of the machinery are manufactured, so that no delay can ensue from breakdown

or other delay, which is a great desideratum of the facilities for a speedy execution of all work. The next department is the finishing room, which is admirably lighted on three sides, including North and East, which latter is of the highest and most peculiar importance. Adjoining this department are engines in use in course of erection, so that in case the one in engine should break down, the establishment can be never as if nothing had occurred. From this we enter the bronzing department, in which the improved machinery for placing and coating is in use. Here we have some 1,500 feet of moving or belt to be kept under thoroughly assessed, owing to the fine and the most powerful bronzed bronze. From this department we entered the electrotyping rooms, and the manipulations already mentioned. Some thirty hands are employed, many of whom have been connected with the house for over ten years, and are thus practically skilled in their var ous departments, and can be relied upon for honesty and faithfulness, a very important point in a business of this kind, and whereby the very finest work is always turned out. The house holds numerous patents for valuable processes, which in many instances save considerable the time of other methods, especially that of depositing copper through the agency of the electric battery. Two finish elevators and one passenger, and by contracting steam and water facility is secured throughout the extensive building. This, house was established in 1870 under the name of Lovejoy & Wheeler. In 1876 Mr. Wheeler retired, and the firm became Lovejoy & Son, Mr. R. W. Lovejoy purchasing Mr. Wheeler's interest. In 1876 Mr. J. H. Ferguson became associated under the present style, and in 1878 Mr. Keeler became a partner in the house. The members of the house are all experienced and practical men, of energetic, enterprising capability, with a letter is recommended from the fact that they are now doing a larger business than in the best times of '73 and '74. They do business for extensive publishers and printers, and to the public in general. Messrs. Keeler, Rice & Co., Vandewater street, whose name is mentioned until this spring, when an opportunity offered for the acquirement of even a more peculiarly and admirably suited to the in-town than referred, by any other house in the country; the newly erected five-and stone-front of Mr. George Nugent, which reaches an elevation of over 103 feet above the level of the ground, is directly fronting the East Rivery and the new bridge, and covers, above all other buildings, commands a brilliant and unincumbered view. The establishment, consisting of the entire building, covers an area of 7,500 sq. feet, each department communicating one with the other by means of elevators, and is admirably adapted for the rapid and systematic execution of the business, and for safety and easy communication.

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THE DAILY GRAPHIC
WEDNESDAY, JUNE 5, 1878.

EARS FOR THE DEAF.

WHAT THE WIZARD OF MENLO PARK WILL DO NEXT—SURPRISING EXPERIMENTS.

It was evening room in the house of Mr. Edison's enthusiastic assistance and friend Clifford around Mount Morris Park, to witness the first trial, in the presence of witnesses, of the new ear trumpet which the inventor had evolved from his busier consciousness.

Mr. Edison revealed to Tim Dunning some two months ago, the fact that he was engaged in the construction of a "kindly susceptible ear trumpet, and our readers will recall the letter in which he invented, without explaining, and without reserve, that he would make an exhibition of the instrument in a few months more. As Mr. Edison is himself so deaf that he hears no more quite sure and with considerable vigilance, his confidence was reposed in his purpose; and his marvellous success in developing the 236 inventions which now stand in his name on the books of the Patent Office presented a wide belief that he could really do what he had set his hand to. This confidence seems now to be justified and realized.

As Mr. Edison's public friends stepped out of the hour laboratory where his spoolers are born to the hour of his residence, a waiting sixth, their hope half a dozen ear trumpets in their hands. These implements looked extremely much like ordinary ear-trumpets, only they were five or six feet long.

"I stood here the other day," said Edison, turning his ear over to the reporter of the Graphic, "and I can one of these to my ear. I heard several things very distinctly. I heard a dog cry; I heard the instrument tick down at the station, 1,000 feet away; and I heard one curious, startling noise sound that I could not literally tell I followed it up and found it to be a locust, one of self-clearing grass, 6,000 feet distance—by-fifths a mile.

There were present on the porch, Edison, Professor Bedloch, Secretary of the Edison and war tattoo, Ulrich Palmer, a noted Washington journalist; Wm. Orton, president, President of the Phonograph Company; Charles Batchelor and several other gentlemen eager to see the experiments. They had waited for a pleasant day.

They carefully arranged a series of stands to express "Lizzie" and "I do not hear" by waving the trumpet over them.

Mr. Batchelor and Ulrich Palmer took one of the ear-trumpets and went fields, across the field, to a spot 400 feet distant.

One of them then said: "Do you hear me now?"

They stated they in the porch, with a touching accompaniment, for the voice was distinctly audible to all with the naked ear.

"Do you hear this?" be repeated, in a lower tone, scarcely audible.

Assent he was answered in the affirmative.

The speakers was repeated over and over till the ear trumpets had to be used. At last came on the words: "I can hear you distinctly now; do you hear me?" But Palmer was 600 feet distant, yet his whispers were perfectly audible. Batchelor walked away from his fifteen feet and repeated that he could not, with the unaided ear, hear the conversation whispers, which were audible to us in the porch. At 600 is to fifteen, so is Edison's ear trumpet to the unaided ear—twenty to one!

But the experiments were scarcely begun.

Batchelor and Palmer walked off across the fields till they were a mile distant. They crossed many undulations—up hill, down dale, now vanishing, now reappearing, till they finally stood forth on a hillock in the twilight, a mile away from the house.

Words were exchanged. All ready.

One at each end put the trumpets to their ear.

"Pretty brilliant" said Bedloch. "He says 'Mary Brown's keep lies meandering in the grass.'"

Then to smile towards the figures on the distant hill, "I heard that distinctly. How loud are you talking?"

"In an ordinary tone of voice," came in response to the man with the trumpet; "accurate louder than would speak in a parlor."

Then the test was resumed. It seemed very strange and necessary to hold a conversation in an ordinary voice with a man a mile off, without a speaking-trumpet and with no wire or electrical assistance whatever.

"This is really telegraphing without a telegraph," exclaimed Bedloch.

As we could plainly see with our opera-glasses that the man on the hill had his trumpet "in position," Mr. Edison stepped to the front of the porch and spoke to them, clearly, but in a voice that could scarcely have been heard 200 feet away: "He a mile better off and get in range."

We noticed and remarked about the phonograph and telephone, and the new sound examiner of Mr Bogbeaten, Boston, which Edison declared "a splendid scare" from the principle of his carbon telephone, which as Mr. Bedloch said, "I hear distinct."

But we could not see them anywhere. They had vanished.

"He says," Mr. Bedloch repeated, "Now is the winner of our disclosure; four \$11 a secret, and I haven't got a cent."

There was a laugh at this, and Edison announced from the other end of the gang that he had found them. They moved nearer 500, and their white flag was just visible through the distant trees.

Salutations were exchanged over the two miles of intervening ground, and an opportunity was furnished to all present to hear the wonderful phenomena.

The ear-trumpet, or "telescraphon," as it is called, is internally a curious combination of funnels centring in a chamber and ending in a wire. Mr. Edison believes Cleopatra's Jayne is complete for the use of partially deaf people a small, inexpensive and compact instrument, which, when concerted with a thin wire to the ear, will enable any one to hear every whisper on the stage of the largest theatre.

Tim Dunning asked permission to describe and sketch the ear-trumpet for Tim Gazette; but was refused permission at present on account of some delay of the patents. But the country and the world will be informed of our new electric toy in any way exhaustive the issue of this latest invention of this marvellous mind—a device which seemingly makes the deaf hear, and which will certainly open new methods of communication to sceptics for telegraph and telephone.

"You are going away for a summer rest, I hear," said Tim Gazette to the gray-eyed inventor.

"If I can get away from this shop," said he. "The inventions of Wizz Mountain inside have accumulated pleased that request at my disposal," he added, laughing. "They are all very well once a locomotive as my successor. If I can get there I shall talk ten minutes one peak to another, with my telephone-phone."

Daily Evening Traveller.
THURSDAY, MAY 30, 1878.

THE PHONOGRAPH, ETC.

MR. EDISON AT HOME AT MENLO PARK

Description of a Visit.

A CURIOSITY SHOP OF WONDERS.

A \$ visited on Tuesday evening a merry party of the inventions of the young man who has electrified all Mr. Wilton Metlabon, the courteous manager of the Edison Phonograph in Boston, together with Mr. Frank B. Darnell, took the train at the old Colony depot for Menlo Park. The party consisted, also, of Mr. Edison's Mr. Beckus of the Advertiser, Mr. Gilbert of the Globe, Mr. Burns of the Herald, Mr. Weiker of the Journal, Mr. Barnes of the Transcript, Mr. McNally of the Sunday Times, and a representative of the Traveller. The trip as far as Fair Haven was the same as usual. In no way other occasion when a crowd of reporters get together that is, full of wit and good humor.

The Inland did not remain long at the wharf after the arrival of the train. Upon arriving at New York, the Boston party was met by Mr. H. J. Gleason, the general manager, of the Phonograph Company, who accompanied it to Menlo Park. He was in earnest negotiations by the party, and question was plied upon question, while he took with the best of good nature, and conversed with the utmost affability.

Inasmuch as much matter of news was gleaned which cannot fail to interest and instruct, the larger part of it will be given.

THE PHONOGRAPH COMPANY

has a capital of $500,000, and is made up of the following stockholders: Mr. Gardner G. Hubbard and Mr. G. L. Bradley of Cambridge, Mass.; Mr. Charles A. Cheever and Mr. Hilborne L. Roosevelt of New York, Mr. A. H. Pelotet of Washington, D. C., Mr. Johnson and Mr. Edison. The company after organization paid Mr. Edison a royalty of $10,000 as a guarantee of good faith, and agreed to pay him 20 per cent. of the gross receipts from all sources. Almost all the territory in this country has been distributed out to sub-agents, together with parties in South America and Australia. The patent right for Great Britain was sold on a royalty basis to the Microscopic Company of London. The royalty was $12500. France is probably to be controlled by Mr. Parkes and Mr. Roosevelt, a brother of Mr. Hilborne L. Roosevelt, of the company. Mr. Edison has determined to sell no more machines out, but to dispose of them on the royalty basis. Mr. Johnson explained the difference between the

EDISON AND BELL TELEPHONE,

and it is very marked and important. When Mr. Bell came before the public with his invention, Mr Edison was still experimenting with his. While Mr. Bell makes very important use of the magnet, Mr. Edison does not. Mr. Bell's machine may be called the Magneto Induction, and Mr. Edison's the Galvanic Induction. The telephone, like everything else, must have something to supercede as a thing, and the latter in this case was a musical instrument, invented in 1837 by Reis, a prominent scientific German. Mr. Reis published a description of his machine, and Mr. Orton, the late President of the Western Union Telegraph Company, presented Mr. Edison with a manuscript translation of his work. Mr. Edison went to work, developing his other ideas, and conceptive after conception, until he has completed the telephone. A detailed description of the Edison telephone need not be given; but one thing must be said, and that is that in his work he discovered a very wonderful property in the carbon button, which is now used by Mr. Bell in a slightly different form from that used by Mr. Edison's machine. He found that carbon was not a conductor to pressure. So in his machine what may be called the diaphragm is a carbon button. Mr. Edison, in answer to a question, said that electricity is passed through the disc, and against the upper disc of platinum. The latter is connected with the battery. The carbon button is placed between the two discs, and secondary circuit the voice carries and the talker as the sheep carries the lamb and assumes responsibility. Mr. Edison has already experimented in a telephone which will carry the human voice from Menlo Park to Philadelphia, 90 miles. He says that it is as powerful as Mr. Bell's. Both use the principle of the electric current with Mr. Johnson's Improved Jersey City suit.

MENLO PARK.

This is twenty-24 miles from New York, and when the traveller alights from the train he can see at once particularly what he has come for. Before him are many buildings. This time he was in a carriage, a Mr. Edison's engineer, who attended around the party. Mr. Edison's laboratory is a long, low building, with a small wing. This may be seen in a carriage, a very old single. One second story windows being the only ones which are visible from the road. In front of the laboratory is a house on which was erected a handsome observatory. This is used by Mr. Edison's son Edward, who is also interested with his father, and, in that scientific path, suggested the idea of the Phonograph to Boston, together with Mr. Frank B. Darnell, took the train at the old Colony depot for Menlo Park. The party consisted, also, as follows: Mr. Beckus of the Advertiser, Mr. Gilbert of the Globe, Mr. Burns of the Herald, Mr. Weiker of the Journal, Mr. Barnes of the Transcript, Mr. McNally of the Sunday Times, and a representative of the Traveller. The trip as far as Fair Haven was the same as usual. In no way other occasion when a crowd of reporters get together that is, full of wit and good humor.

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MR. EDISON.

"The late Prof. Henry, of the Smithsonian Institute at Washington, always said," remarked Mr. Edison, "Edison was the greatest genius out only of the number, but of any age." Mr. Edison struck each one of the visitors by the hand, and expressed much gratification at the visit. He is a man of medium height, with a full face and fair complexion, and has a pleasant and energetic manner.

The party shortly took a seat at the table where the phonograph sat, and proceeded to display exhibition of its powers. The physical appearance of an issue of the machine. Mr. Edison takes a tight, strongly wrought iron—cheaper later in the day for a bit less than a dollar—and on the face of it he has wound on a dark cardstock cone and wax with the utmost tenth, and was utmost deceit of securing the diaphragm. This is a thin sheet of mica, and great pains are also taken in using its finger. Apparently he is a man not above thirty years of age, and he has a pleasant and energetic manner. He says he has not heard quite perfectly in his left ear, but very good eyes, over which the lids close very often. They are unusually large, and have quite a heavy mass of eyebrow. His face is smooth and shaded eye with a heavy mass of eyebrow.

If you look at him when his face is turned at a profile, you fail to discover one wrinkle. If an expression of thought or study ever passes over his face, it just above the temples it is nothing private into his countenance lights up and the sweetest and most pleasant smile imaginable takes its place. His mouth when a wrinkle is in it. His mouth is not an unusually large sequence. It is small, firm and artistic, and the reflection of a nervous possessor of the head is of no common stock, and the hair is brushed back from the forehead in a way that the forehead is generously developed. It is not the size that the back part of the head from the crown to the nape of the neck.

Reporters said, "You may think it strange; but if I wanted a thing done I would select a man with a head like that." Mr. Edison is a man of the highest order of the intellectual type, and a man of tact and work, with little discretion as to its result.

Conversation has been written below.

HIS RELIGIOUS VIEWS,

and far from correct. Mr. Edison believes in a God, but does not believe in the Bible as a revelation from the Creator. He is not a regular attendant of church. He thinks that religion is simply the demonstration or school of philosophy, but approaches nearer to the truth than any other. He is not a believer in a personal God, but thinks that it would be no more difficult for God to be omnipresent than to be omnipresent. He is unable to say that he believes in the existence of a God, but he is not an atheist. He is a believer in a God, but he is not an atheist. He is a believer in a God, but he is not an atheist. He is a believer in

great as before and irresistible as ever. Now the poor old man is dead and buried, and his fame lies in a very interesting and important fact in chronological superficiality.

Mr. Edison tells us as follows: It is well known that distance lends an enchanting, barbaric parure of Finance, gets madeo for some of his best heads as fit-ting as a Bond Street tailor's. Distance lends to the telephone its well-known power to make everybody in the sunlight. There is of course a shadow. This shadow practically forms, in outline a human face, and of round ground and filled in makes an excellent profile. Distance lends to the telephone its well-known enchantment. Supposing a man, say the Jew in Mrs. Hemans's Fall of D'Jasus, be subjected into its crucible, and he comes out a Jew, and a very cultured Israelite withal. Distance is worse than useful as for

"Alone through gloomy forest shades
A soldier will by night, etc.,"

but a confusion of sounds, giving, indeed, the letters as follows:

A
Gigh three rattles a
Ghastly groans and ghostly sounds.

Mr. Bernhardt tried this experiment yesterday with "Mary had a little lamb," and it was successful. He also performed several times in succession the words "one, two, three, and four," and the little machine replied, "one, two, three, and four." Mr. Bernhardt also recited the distinguished persons prosaic: "Give 2—3, thou dog, etc."

Mr. Edison says that of all the languages the best for the phonograph is the Latin, and in illustration of it he gave a few lines of Virgil's Æneid. He also spoke a few words in Greek, but the machine was not strong enough to do it very well. He said and it did it after "Operibus sic flexibili" "Ut, nostrorum, nos, nos" and "Mary" was effected unsatisfactorily.

REVITALIZING THE RECORD.

In order to show the permanency of the telestereotoun in the fut ure the Hitherby with which they are to be connected, Mr. Edison has invented a device by which the records can be made to note the rhythm, and most unspeculiarly way. Even if the breath be taken against the diaphragm the intonation seems to indeed same, but still the reproduction can be made to sound like the original voice. Mr. Edison says of it: "For instead of strengthening the record, or in other words, of paving indentations from the fat to the lean, we simply paint the lean with a coat of grease. There is a nothing here was the fulcrum what to rest on, giving thereby a short and long arm. On the long arm is a fine camel's hair pencil, which rests on the small and large surface, the small effects opposite the short arm of the lever.

The hand is covered with fur, and the pencil is moved by touching the fur. Just as the record passes under the pencil the latter has the contact with the record, and as each indentation are irregularities in the surface, which cause the pencil to rise and fall in accordance. One foot touching the pencil moves it about one-thirty-second of an inch. The record thus receives the impression. There are twenty-five words in "Mary had a little lamb," and the little machine will reproduce them clearly to the listen. One in 10, rendered, and, finally, in ten times half of each revolution.

Mr. Edison says that he believes if there are sixteen threads to the inch, and twenty notes and forty-five words, there are about five thousand words enough to take up three octaves of the New York Herald. If there are ten thousand words to the inch, and if the machine is run at high speed, the whole world in 60,000 words. If a song was sung distinctly quick with the tongue it pronounced 200 words in the minute, and if it was sung slowly it would take 1,000 words. There are the words, "Now is the time for all" through brought out by the vivid.

Mr. Edison continues: little contrivance and a sensitive tongue and a piece of paper are certainly on a stand. One other thing is the fact that the machine is very accurate. On the opposite side is another fine, a coat of cork, then a piece of rubber, and then a piece of metal. The cork and the rubber are in a cage, the little needle, which passes on rather rails rigidly on a smooth wheel instead to one of the ordinary screw.

On the other side of the rail is a larger fur-coat, probably as soft in character. If the voice be one, the needle will not appear that it vibrates very rapidly and causes the diaphragm and forward with great rapidity. The needle is then drawn back over the fur-coat by the small wheel by hand, and as fast does it go its to-and-fro vibrations that you cannot see it. The record is then run back to the starting point through the wheel and the quality of the tones of the voice, whether harsh or soft.

HARMONIC MOTION.

The harmonic engine is one of the most wonderful of Mr. Edison's inventions. It is a machine which will sort thousands of messages and go to the right wire every household. The machine consists of a tuning-fork, which vibrates at the rate of 100 per second, or the tuning fork is set to make 100 vibrations per seconds. On the outside and a small wire, which is connected with an electric battery.

Three magnets are connected and theoretically Mr. Edison says one side of the power of the magnet within others per unit 3-10. Another fits, there is another magnet, and so on. The first magnet in the circuit was made by some of the parts to pull back at the time of the tuning fork by other successive forces. The armature of the magnet is attached to a spring, and the spring is attached to a pencil.

The utility of the machine lies in the fact that it is impossible to get in unless each the machine which is in Mr. Edison's possession consists of fifty-two sets of wires in all hung on a frame. Each set is tuned to a different pitch, and the pitch of each one is different from every other set. The machine will be watched by

THERMOPILE.

While Mr. Edison was experimenting with the telephone he found that the carbon button possessed some peculiar properties, and was very susceptible to the influences of heat.

In the early days of the telephone, made primarily of rubber, he found that the heat of his hand would materially affect the results of the galvanometer. He then enlarged the handle to touch, but still there was an effect that was inexpertive and last he made the handle entirely of wood. This, however, did not do away with the electricity long and taken to the inventors by Mr. Batchelor. Mr. Edison, who was upstairs, was then informed that the heat of the hand could not reach and he said he would not believe it was so doing.

Batchelor was then at the handle and the materials gave off several results which were transmitted over the wire to Mr. Edison. The old Thermopile was produced the desired result and the electricity was then tested on the telephone.

TELEPHONOSCOPE.

This little instrument is on the bar what the telescope is to the eye. As the eye receives and transmits the rays of light to the brain, so other words, the eye, or the ear, receives and transmits the voice. One of the eye is matter by means of the telephone Edison invents as many as it invites a day from all parts of the country, from persons who are deaf. A deaf person can hear by the telephone. Mr. Edison has not "designed to do this" it is the consequence. Mr. Edison proposes to invent something which can be seen by the telephone. It is called

In the table of telephonoscope a device has been put in every of thousand street letter-box within a hundred miles from any one in the world have a telephonoscope in their house. A compact paper tube, set, and by it connected with the telephone, nearly a quarter of a mile off, and hand of hand who wore as many as two miles off. Mr. Edison says that the telephonoscope is the most perfect instrument for facilitating the correspondence between distances which demand prior attention.

MUSICAL REPETITION.

This machine needs but a brief description, be-cause it is simple. Mr. Edison says: "Sing into it words, five times." Then in a second, about 50 whole tens are a number of slightly-varying wires which will be found to be so small as to and so the sing into it once.

This needle plays upon a strip of paper, through which no static electricity is readily possible. This paper is rough and resists the needle to fall into the indentations made by the vibrations of the voice. In the wire drawn on the paper with a speed of 10 inches. The paper is electrically scrapped, being passed between two metallic surfaces.

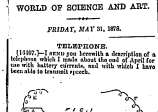
Mr. Edison says that all the languages are best for the phonograph is the Latin, and in illustration of it he gave a few lines of Virgil's Æneid. He also spoke a few words in Greek, but the machine was not strong enough to do it very well. He said and it did it after "Operibus sic flexibili" "Ut, nostrorum, nos, nos" and "Mary" was effected unsatisfactorily.

The English Mechanic
AND
WORLD OF SCIENCE AND ART.

FRIDAY, MAY 31, 1878.

TELEPHONE.

[11402.]—I send you herewith a description of a telephone which I made about the end of April for use with battery current, and with which I have been able to transmit speech.



Since making it I have read with much interest the account of Professor Hughes's investigations. Fig. 1 shows the transmitting instrument, which is made as follows:—a, ordinary telephone cover; b, diaphragm; c, hemispherical piece of boxwood, 1 inch in diameter, and 1 inch thick, hollowed out as to allow it to fit tightly; d, screw, which holding from instrument. To adjust the instrument, screw d (which must fit the case rather tightly) so that it touches c. To ascertain whether it does or not, place an electric bell in the circuit, and if it rings feebly it is all right. All that is then necessary is to fix the cover on the case. Fig. 2, using ordinary Bell telephones and battery.

I would, in conclusion, say that the arrangement above described is only for rural for experimental, and it might be improved upon; but as a proof of the possibility of transmitting speech by the aid of battery currents it is all that is needed.

Nota Bene.

WALKER'S IMPROVED TELEPHONE.

[11403.]—Noticing your editorial note on p. 359 regarding my improvements on Professor Hall's telephone, I think it is right to M. Tressel, as well as to myself, to state that the form of the one I am now using is entirely different from his; it being a pot in ignorance of any details of his method of increasing the sound. I cannot, of course, be sure as to this; but I can be, and am, clear on one point, and that is, that the plan I have adopted, whatever may be its merits, was not suggested to me by any of Mr. Tressel's writings. Further, I may state that I was not in possession of his method, even individually, until after steps had been taken to test my own method. It is difficult to describe the latter without the aid of drawings, but the ideas upon

THE MICROPHONE—CROSS HAIRS.

[11404.]—I may make some twelve dozen of the microphone and can assure you that the following simplified leave nothing to be desired. It is as follows:—A piece of pine about 6in. × 2in. is roughly planed and forms the base of the instrument. Upon this a pad of blotting-paper, same size, and soaked in a weak solution of sulphuric acid, is laid—this above this a plate of carbon, same size. The carbon is prepared by cutting it with a fine saw, carefully, a score, at each end, but touching the size. At one end a piece of wood, 2in. × 2in. × 1in. is screwed or glued, and on the top of this a piece of carbon, 2in. × 1½in. × ¼in. is securely fastened. A thin strip of carbon, like an ordinary French nail, is placed in a depression in bottom carbon plate, and split loosely into a small adhesive, to top plate, a small piece being filed out to a nine cups cubical of carbon. A nail, piece of copper, brass, iron, steel, or platinum wire, or almost any wire may be used, the softest being the best. With such an apparatus as this conversation can be carried on quite well by simply resting over the carbon plate or the nail, or with a round hole break is overwhelming. The point in my modification of the microphone is that of microphone and battery being in one small apparatus, and not two, thanks to "C. E. S." for calling my attention to some of their respecting cross hairs. For this purpose I am sure that fine human hairs would be much the better to use.

W. J. Lancaster.

[11405.]—The Microphone.—Mrs. make a microphone as described by Professor Hughes acts perfectly, the touch of a single hair on a needle point being sufficient to make a needle a much louder transmitter than the ordinary. The battery power necessary for a single instrument is very small, and a single cell charged with zinc water will do well, and, of course, this cell remain in action a long time without attention. The instrument, however, as it stands should be used with the microphone, but for short distances it is neither necessary nor desirable. I use for my telephone a small mahogany box, and placed behind a diaphragm of iron, plane, receiver and another small; most likely because the soft iron is not so liable to be affected by the action of the other magnet. With one cell it is necessary, but necessity for using Bell's patent telephone.—E. P. G.

THE DAILY TELEGRAPH, WEDNESDAY, MAY 22, 1878.

SCIENCE has lately given the world three new separate inventions as marvellous, delicate, and prospectively useful to mankind that it is hard to say which can be called the greatest prize of discovery. Indeed, they belong more or less to each other, and are mutually supplemental, like the famous fairy-gifts in the story of PRINCE RASSIE. That Arab tale relates how three Princes who laid claim to the hand of one and the same Princess were sent abroad by the Sultan her father to settle their rivalry by seeing who could bring back the most wonderful article. Each was favoured by a special protection; and thus one obtained a magic pomegranate which would cure all diseases; another an ivory tube which would enable the most distant objects and scenes to be brought close to sight; and the third an enchanted carpet, by sitting on which you might be transported anywhere at will. The Princes met at a rendezvous far away from their home, and exhibited their treasures with mutual consolation, each declaring his failure of the fair reward, when it occurred to them to test the ivory tube at once, and see by it what the lovely Princess was doing. To the grief of all three suitors, she was plainly observed lying upon a bed of sickness, with the Court in tears and despair around. Thereupon the magic carpet was brought into immediate requisition, and, the lovers having flown through the air upon it, the instant and happy cure of her Royal Highness was effected by means of the enchanted pomegranate. If any one forgets how the knotty question of pre-eminence was finally settled between those three fairy gifts, each of which had proved so useful, we must leave him to turn back to this *Alf Leilah on Leilah*. Just so difficult, however, it would be now to decide whether the palm of merit should be awarded to the Telephone, the Phonograph, or the Microphone, the three latest and most extraordinary gifts of science to our time. All three inventions are closely affiliated in the order and method of their discovery. The telephone, which "wafts a sigh from Indus to the Pole," is by this time sufficiently understood, though by no means yet valued as it will be when the ingenious minds to which we owe it have had time to perfect their apparatus. The phonograph, which actually records speech and sound in a portable and reproducible form—outdoing the chimes of marvels of the Arabian story—was discovered by Mr. EDISON, it is said, while sitting with his pen-point pricked his finger, and, as he drew it away, made an interrupted line of blood upon its surface by the vibration of the point, whereupon he at once placed some MOSAIC paper so that the diaphragm would travel over it, and, speaking through the tube, found small but faultless "dots and dashes" inscribed. Reversing the process, and so managing the impressed paper as to make the diaphragm vibrate, it repeated to him falsetto the "Hallos" which he had shouted at the machine. We might fairly say that was the voice of Science herself rewarding a great inventor with one of the most magical of her hidden secrets, for Mr. EDISON went to work forthwith, and, neither eating, drinking, nor sleeping for two days and nights, toiled until he had produced and brought into working order the first phonograph.

The microphone—the last of these amazing discoveries in that subtle region where electricity, magnetism, motion, and sound execute their invisible interchanges—has sprung forth to startle and benefit the world in much the same capricious way. A paper lately read before the Royal Society announces the invention by Professor HUGHES of this astonishing instrument or apparatus which opens to our ears a universe of sounds hitherto inaudible—just as the microscope revealed a world of minute life and structure unknown before. Like Mr. EDISON, Professor HUGHES was one day employing the telephone for various acoustic experiments. He wished to investigate the effect of numerous vibrations upon the electrical behaviour of conductors, led to this idea by the way in which selenium is known to become electrically affected by light, and also by the researches of Sir WILLIAM THOMSON upon the electrical conduct of strained wires. The Professor had a stretched wire on his telephonic circuit, and, though he talked and plucked at it, no effect followed until it broke. At that moment the telephone uttered a sort of "shh," which was very curious. He placed the broken ends together under a weight, and obtained again faint sounds, which were improved when the wires were connected by iron nails, or a steel watch-chain—the more pieces and more diverse in substance from the conductor seemingly the better. Experimenting still further with his broken circuit, especially in the direction of this whisper from Science about "More pieces," he found metallic powder or fine metal filings wonderfully augment the power of transmitting sounds; while shot in a bright carbon, platinum, carbon, and mercury also gave good results, particularly the last. Following up this clue, Professor HUGHES hit upon a plan of suspending finely divided mercury in a stick of charcoal by hooking the latter and plunging it into quicksilver, whereupon the charcoal became infiltrated with the mercury in minutest but continuous particles. Inserting a "trace mitter" of this sort in his circuit, an absolutely amazing sensitiveness to sound, as well as power of conveying it with the utmost fidelity, was displayed by the apparatus. A touch of the finger on the vibrating plate was conducted to the speaking end in volume of vibration like the rustle of a forest; the stroking of a camel's-hair brush on a card was magnified into the sound of a loud whisper; the beating of a drum, of the most distinctly caught like that of some slegged horse trotting, and it was, moreover, heard to trumpet from its raised proboscis like an elephant in an Indian jungle. Sounds, in fact, totally inaudible before to human ears were arrested and reported by this simple and accidental expedient of interrupting the electrical circuit with a finely-divided conducting material. There is almost no doubt that the perfected Microphone will convey to us that hidden world of life now rising in growing trees and plants which HUMBOLDT and others might be a continuous melody in the auditory organs of earth's smallest creatures. The "music of the spheres"—who could only find a way of localising the vibrations of a star, as we can listen and examine its light with the spectroscope—would possibly become audible to us; and LORENZO, had he known of this magical invention, need not have told JESSICA that we should never catch a note of that cosmic anthem which each golden orb in his motion like an angel sings, still quiring to the young-eyed cherubim." To "hear the grass grow" has become, by this exquisitely delicate discovery, no longer an utterly inconceivable exercise for sharp ears. It may be expected to replace the clumsy methods of the stethoscope and sphygmograph with a most accurate appli-

cation, which will tell the doctor how exactly most the heart and the pulse have to say about his patient's case. Some application of it, by presently employing a little portable battery and circuit, may probably be hit upon, which will greatly alleviate, or even wholly remove, the disabilities of the deaf. But, more than this, while magnifying audible sound, and reporting to us tones which were before inaudible, this new invention is said to solve all difficulties as to articulateness in telephonic transmission. It conveys speech, or music, or the slightest inflections of accent and timbre, with perfect distinctness, and with a power or amplitude that it increases indefinitely that which the telephone has exhibited with a homogeneous conducting wire. In introducing his admirable discovery very modestly to the Royal Society, the inventor remarked, "It is impossible to say what may be the applications or effects of that which I have had the honour of bringing before you;" and to his great honour Professor HUGHES added, "I do not intend to take out a patent, as the facts I have mentioned belong more to the domain of discovery than of invention. No doubt inventors will ere long improve on the form and materials I have employed. I have already my reward in the distinction of submitting my researches to the Royal Society." This is, indeed, a spirit worthy of such great services to human knowledge, and Professor HUGHES has exhumed the fame of his invention by the splendid manner in which he gives the world the full benefit of the discovery.

Although difficult to convey, the explanation of this wonderful power of the "microphone" to magnify sounds does not seem beyond the reach of simple phraseology. "There are two wave-currents running through the telephonic circuit —one of electricity, the other of sound vibrations—and the effect produced by the latter in modifying the resistance and conductivity of a circuit is little or none, so long as the wire remains homogeneous and continuous. If, however, a portion of this be, as in the transmitter, composed of a series of very minute subdivisions, electrical continuity being still preserved, the successive waves are no longer neutralised in their effect upon the electric flow. The molecules of the mercury are thrust together or drawn apart, becoming alternately longer and more resistant, or shorter and more compressible, so that every briefest and smallest sound-distortion and recoil of the air is made to affect perfance note and record itself in the effect produced upon the electrical flow, and the variations of these electric currents reproduce the order, force, and modulation of the sound. With diagrams this theory of the action—which is the one put forward by the accomplished inventor—might have been rendered much more intelligible; but it is said to afford considerable notion of the manner in which the microphone is thought to work. As its name implies, it is the magnifier of sound, and cannot fail to reveals as well as carries sound, and cannot fail to prove an immensely valuable addition to the telephone, while it may be confidently expected that the phonograph will be made available for recording by its help some of the unexpected things to which we shall be enabled to listen through this fairy gift of science. It has been suggested, for example, that molecular motion itself, under certain circumstances, may be conveyed to our ears by this apparatus. We may overhear, for instance, the inner vibrations of a mass of heated metal, or the sound produced by chemical combinations and reactions. Stop by stop man thus explores the

tuitous marvels and resources of that world of Nature which is at once his palace and his prison. Each great secret wrested from the silent but beneficent Spirit of the Universe confers new powers and makes life richer and more commanding. Is it, then, the caprice of that spirit which has imparted these two splendid secrets of the phonograph and the microphone by apparently the most trivial accidents? A pricked finger produces one for us; a broken wire led Professor HUGHES to discover the other. There is no caprice in this mystery. The hour comes, the patient seeker is on the right road, and, at the moment when he least expects it, Nature discloses her hand, and shows another of those far-reaching treasures of knowledge which she keeps for him and his like, the best benefactors of mankind.

ST. JOSEPH DAILY HERALD, THURSDAY, MAY 23, 1878.

THE PHONOGRAPH.

SHAKING HANDS WITH INVENTOR EDISON.

A Walk Through His Laboratory.

How the Great Electrician Looks and Acts.

Correspondence of the St. Joseph HERALD.

NEW YORK, May 17.

In the 5:25 P. M. train on the Pennsylvania Railroad yesterday, was a special car, filled with a select and jolly party of excursionists, who by invitation of J. M. Tower, Esq., of this city, were to pay a visit to the remarkable man, Thomas A. Edison, and examine some of his wonderful inventions.

Among the party of forty, one third of whom were ladies, we noticed James Craig, Col. Osborne, and Winslow Judson, with whom you readers are acquainted. The invitation, written by one of Edison's electric pens, wound up with the remark, "The full of the moon," and as we were not to return to New York until 11 at night, every one had lively anticipations of the novel visit and wonderful sights, the country scene and pure, fresh air of the fields, that we were to enjoy at the "full of the moon."

Menlo Park (Edison's home) is over in Jersey, twenty-four miles from New York. Leaving Jersey City, we crossed the swampy meadows on its borders, sped through Newark and Elizabeth, and within an hour were landed at the little flag station of Menlo Park just as the sun was sinking low.

From the station we ascended directly several flights of stairs, until we stood upon the summit of a bluff—a crowning table land, level and green, overlooking the surrounding country, and receiving the choicest air of heaven. The place is a perfect paradise for a poet or an inventor. Eight houses only show themselves, and they comprise the town. Built on the sides of an immense square, with abundance of room all around each, and unsecured by fences, they make an interesting and imposing appearance. There is no hotel, no saloon; the nearest approach to business is found in the necessary "grocery" on the corner. But Menlo Park, like many western towns, has great expectations. The owners of the soil regard it as a suburb of New York; prices are held up, and the fond image of a teeming city is cherished in their hearts. The future is pregnant with numberless great events, and perhaps includes such a transformation. Judge what a quiet place this is! Why, a man can almost hear himself think, the stillness is so profound.

The chirping crickets rattled their music, as in the mellow twilight, we, two score curious people, wended our way up the hill, and across the race-cut square, by the usual path of travel. Directly in front of, and facing us, 500 yards away, is a two-story frame building 80x100 feet, the front ornamented with a verandah. It looks too large for a house, but too small for a factory.

Time has dulled the white paint, soiled the color, worn the steps, and some panes in the shutterless windows are broken.

Curious eyes look carefully at this building, for we are told it is Edison's workshop, and that information gives a peculiar character to it, common though it actually is. It is no longer a plain wooden-framed and clapboarded house, but as the working home of a genius, it partakes of his fame, and in our eyes, its value is so measured by his achievements, that we approach it almost with reverence. We see continuous jets of steam escaping from its side, and they give plausibility to our excited feelings, regarding the life and work within.

One lady exclaimed, "I approach that building with awe."

Visitors find within its walls the most remarkable collection of machinery, articles, and things imaginable. The back half of the lower floor is used as a machine shop. Here the boiler glows; the engine whirls; the shafting spins, and men with blackened and greasy hands and faces, are attending the lathes, drills, and other machines, which are so thickly placed that a novice or visitor, cannot with safety walk among them. It was evening, but the gas was lit and men were fully at work. No short hours here; but night and day are both employed, Mr. Edison always working far into the night.

We noticed that the workmen who silently attended their job, were foreigners, and we took them to be Germans. The intelligent foreman of the machinery department is also a foreigner. In the front half of this floor are a number of large glass cases, filled to repletion, with scientific apparatus, patterns and models, and spare machinery, unfinished articles, and a thousand of other things, that we don't know any thing about, are scattered around. The party began to crowd in here, but it was stated that Mr. Edison would receive them up stairs, so we all ascended to the second floor; on the way up, peeping through the windows of the chief's private office, we saw the dirty dishes of an unfinished dinner lying among his books and papers. On this floor there is a perfect wilderness of materials. The contents of a drug store are ranged on shelves along the walls; all the liquids and solids known to pharmacists are here, as well as the expensive and rare chemical substances, of value only to a man of science. Near the middle of the room is a frame work, holding a large battery; the open jars are filled with acids and there is a network of wires connecting them all together. In one end of the room a telegraphic instrument is clicking; at the other end is one of Edison's improved telephones connecting with five miles of wire, through which a whisper is transmitted, with perfect distinctness to the listener's ear. Inventive works lie open on the benches, paper funnels of all shapes and sizes, electrical machines, and all sorts of things, useful and strange, are strewn around in admired disorder. Half a dozen phonographs of different sizes are placed at various points. There is a perfect mass of "stuff" strewn over the tables, and floor—the accumulations of years of experiments. The place is so strange that the visitor can single out no one thing, but looks around with bewildering astonishment, treads lightly lest he may disturb something, and is careful not to touch anything, for fear it may explode or cause some horrible mischief. A nervous person would become crazy here in a week or two, but this grand confusion just suits a genius. To him the dirty floors are clean, the confusion order, the rumbling of the machinery a soothing sound. The phonograph, which Mr. Edison worked and explained, is a very simple affair. The wonder is, it was not discovered before. A brass cylinder, a foot in length and four inches in diameter, is connected to a shaft; the shaft rests near each end in bearings; on one end a handle is attached, on the other a circular mass of iron, simply to give weight and steadiness. A thread of the same pattern is cut upon the shaft and brass cylinder. The apparatus close to which you place your lips and talk is concave, and has a diameter of three inches. The sound waves produced by speech, vibrate a metal disk, to which is attached a needle point. A piece of ordinary tinfoil is wound around the cylinder, smoothed down and fastened by gum solution.

Now everything is ready. The needle is moved close to the foil and clamped, the operator commences to turn the crank, and speaks at the same time into the machine

"Mary had a little lamb," &c.

The needle is then drawn away, the crank is reversed and turned backwards until the point where a commencement was made is reached; then the needle is set close to the foil, the handle is turned, and, "*mirabile!*" we hear the same words spoken distinct enough to be heard thirty feet,

"Mary had a little lamb," &c.

This machine does actually talk just as a human being talks; it isn't ventriloquism, and, looking at the instrument, it is puzzling to tell where the talk is, or where it comes from; but when you actually hear it talk, you can't refuse to believe your own senses. But more than this, it will reproduce whistling, singing, laughing, the music of a cornet, or any noise that sound will furnish. A duet, sung into it, is delivered by the machine with both the bass and tenor notes intact. All of these experiments were shown by Mr. Edison to his admiring and applauding audience. Edison is a genius; a born genius; there is no mistake about it.

When I saw him coming up the path, with his hands deep in his pockets, and wearing a worn old hat, it was hard to believe this was the man who has excited the world by his inventions. When we saw him with tumbled hair and dirty hands, sit down before the phonograph and work, we looked in amazement at this man, who is honored by all nations, having a place reserved at the Paris Exhibition to await his pleasure in exhibiting the Phonograph, the most miraculous invention of the age, and which has startled Europe. In appearance he is exactly opposite to the popular idea of a great man. His face is a grand, thoughtful one, and his nose is *the* feature of his face. If a large nose is certain proof of gifts, Edison is a very much gifted man, for he has a regular Wellingtonian nose.

He is beardless, and careless of dress and appearance. His look and his movements betoken deep thought and absorption. He looked as if he worked too hard, and he does, for his life and joy is in his labor, and to him all other things are subordinate. He can hardly tear himself away from the Laboratory for sleep.

When a boy he resided with his parents, at Milan, Ohio, and was employed in a telegraph office. He was called lazy and did not suit his employers. Even then he had an indistict idea of his ability to double the value of electricity. He has pondered all his life, and owes his success most entirely to meditation.

The following stories are related of him: Once when at a dinner party he was deputed to carve the roast. While performing that operation, at the head of the table, he was seen to slowly stop, his countenance and eyes were fixed in an absorbed expression; the knife and fork dropped from his hands; without one word he left the table, hurried to his laboratory, and was seen no more that day.

The day Edison was married, was as much of a work day as any other. Soon after the ceremony, he repaired to his laboratory and quickly lost himself in thought and work. The hours passed swiftly; he was oblivious to all things, and so interested in what he was doing, that the night wore on unknown to him. At one o'clock in the morning a friend sought him out and tapping him on the shoulder, said: "Tom, what's this! why it's one o'clock; why ain't you at home?" and realizing the situation the great scientist made answer: "Is it, and I was married to-day, too; why I quite forgot all about it," and putting on his hat he hurried away. He does not study to be eccentric; far from it, but he is overpowered and overmatched by hard, earnest thought. His life has been a studious one and a more affable and agreeable gentleman one cannot find.

His scientific range is a wide one, for he holds patents on 150 different inventions. He says he discovered the principle of the phonograph in November 1877, and perfected a machine in one month's time. He flies to the accomplishment of an object, like an arrow to its goal. In mechanics and science he is a Napoleon, and still he is but 31 years of age. Already, he has filled a niche in the temple of fame.

He is original in his inventions and ideas as Galileo, Newton or Franklin.

He seems to be unconscious of the position he holds in the eyes of the world, and to desire nothing more than a simple and useful life of work, in his quite country home.

It is said he cares neither for dress, nor money, and that no man is simpler in his tastes and habits. In the early evening the moon rose full and grand, and on it Edison came to the balcony to look at it through the telescope. Pointing to mid-heaven, he said: "When the moon gets up there, it looks to me just like plaster of Paris!"

By the the light of the same full moon, we came back to the city, filled with gratification and delight, at what we had seen and heard.

EDISON'S NEW BABY.

HOPE FOR THE DEAF—THE GENIUS OF MENLO PARK INVENTS A NEW EAR.

The inventive powers of Professor Edison appear to be illimitable. The world is startled by one marvelous invention, and before it has time to take breath another contrivance, either an immense improvement on some former one or something entirely novel, is thrown out.

The latest production of this genius is what is known as the "carbophone," on statement to the correspondent of the Associated Press, between the telephone and phonograph, a very desired patent entirely independent of any previous devices or any existing forms. It consists in charging the focus of the trumpet attached to the phonograph to reproduce the sound registered by the voice.

In the first phonograph the trumpet was a tin or paper funnel; the new attachment is made of carnelians globules and the carbon button which so largely enters into the composition of Edison's telephone and which is sensitive to the point of transmitting the sound of the breath. The new trumpet is modelled after the convolutions of the human ear. The fabricated sound wave is made to recall itself through the medium of the diaphragm upon the receptive piece of tin fail as deeply as the musical tone uttered under ordinary conditions.

This trumpet, as the inventor has had practical experience (being somewhat deaf), is destined to be the greatest boon to persons afflicted with hardness of hearing. Attested to the ear (instead of the phonograph), it will so conduct sound vibrations as to enable a person to hear what is said one mile, slightest sound, even that of the ticking of a pin. In a crowded assembly it will enable a person with the words of a speaker at an almost incredible distance. With this remarkable invention in hand, the world would not be much surprised if there should soon rise from some inventive genius Park or instrument that will enable the deaf to hear and the dumb to speak.

THE NATIONALS.

HARRISBURG, Pa., May 21.—The Executive Committee of the National party met to-day. The declination of ll ujudge R. Bentley, trustees for Supreme Judge, and Christopher Shearer, for Lieutenant Governor, were received. Judge Agnew was then unanimously nominated for Supreme Judge, and Daniel M. Rook for Lieutenant Governor. Judge Agnew is undecided whether he shall accept the nomination for Supreme Judge, tendered him by the National Greenback Labor Committee to-day. The Committee appear to be satisfied that he will stand the nomination, but the Judge informed your correspondent that he should determine his decision, Judge Bentley's letter of declination being received to-day partly with the principles of the National Sentinel

May 22 4th 78

San Francisco Chronicle
TUESDAY.....MAY 28, 1878

EDISON'S PHONOGRAPH.

A LOUD-MOUTHED DELEGATE COMES TO THE BAY FESTIVAL.

He Talks Through the Wood Steam-Exhibits the Phonograph—Says that the Chinese Must Go—Etc.

The exhibition of Sumner W. Burbie, telegraphed in New York a little more than a week ago last Saturday, for an Edison Phonograph, to lend a new and wonderful variety to all the other delights of the monsieous Mer Festival, was wandered for the arrival here on Sunday night of. P. Osbor, in charge of a specimen of the marvel of all the centuries. It was tested by him yesterday afternoon in the presence of a few Studios and a number of reporters, and the performance was a success. The construction of this little instrument of sensitive possibilities is so simple and has so frequently been described that a repetition is hardly necessary. At either end of a plain cast-iron base, about sixteen inches long and six wide, a cast-iron standard six inches high. Through a screwed hole in each of these standards runs a screw an inch in diameter and of a very fine thread. In the center of thisscrew vA cast-iron cylinder four inches in diameter and six long. The surface of its exterior is covered to a fine spiral thread, screwed with that of the screw. Around this surface is rolled a length of

ORDINARY TIN-FOIL.

Four brass rods connect the cylinder's mouthpiece about two inches in diameter with one extreme part of its wonder of the age, and the latter part is also mounted on a brass rod. Osbor explained the principle on which he controlled the artificial diaphragm. This latter is merely a thin disk of mica or heavy mica paper, ten inches in diameter, and in the center of this disk is a small hole, in which is inserted a steel point, resembling the head and half of a fine cambric needle. This is set perpendicularly to the disk, and the point of the latter is adjusted so that the needle's point just touches the tin-foil on the cylinder. The second latter is then put in motion, and the needle point, being attached to the membrane, must trace forever for the amusement or instruction of generations. Mr. Osbor turned the crank and all the screws and rods began to revolve. Then he placed the needle point delicately on the cylinder and said, "Good morning, Mr. Phonograph." He then turned back the cylinder and repeated the salutation. Both times the needle point responded the words, and again commenced to turn the cylinder backward. Then he placed several needle points on the cylinder and requested the machine to speak for the result. "Good morning, Mr. Phonograph" rolled out. Mr. Phonograph itself in a voice even more metallic than that of the inventor. The articulation was never once marred through three days away with a feeling of inexplicable awe. The machine was then turned over to the ladies present for criticism. The first outburst proved it to be too

PROVINCIAL ALTOGETHER.

That it has always universally been alleged that the Chinese must go, and that they are necessary to nobody, was the main point about the tests. The very necessity of the conversation, and of the theory upon which the phonograph reasons, the exact opposite of the Chinese theory, made the machine refuse to speak for the result. Mr. Osbor, however, at last succeeded in getting the machine to say what, as if in mockery appreciated the right of free speech. After the machine had been induced by coaxing to receive sentiment it declared to receive

"Oi, am the monsoonay cussut phonograph, I am! What an think of me?" Despite the not unmistakable burst of heathenism which followed, the machine was in the principle of one, one was a success, being, a Lotus, indeed, that it was found to have been the first Chinese phonograph ever manufactured.

WARMED TOO AGE.

Of a sore into the machinery, Mr. Phonograph filled it back again, but the machine was not to be silenced so easily. The prodigy of the age, however, objected. Mrs. Steiner, not at all disconcerted by the hoax into the monsoonsitive machinery, the phonograph returned in the chorus with

If Uncle owns a body dould dey'd be rich.
If a hair have only seen a hole ery.

This was an immense success. It is true the melody was not enchanting, but for the first attempt at a Chinese song by the American Edison of things, the second the Society wants one to sit on that a Hartford Mr. Osbor, who has been giving the wonderful piece of delight since Thursday, returned to the Studios and a number of reporters and visitors to the exhibition of this little instrument of sensitive possibilities is so simple and has so frequently been described that a repetition is hardly necessary. At either end of a plain cast-iron base, about sixteen inches long and six wide, a cast-iron standard six inches high. Through a screwed hole in each of these standards runs a screw an inch in diameter and of a very fine thread. In the center of thisscrew vA cast-iron cylinder four inches in diameter and six long. The surface of its exterior is covered to a fine spiral thread, screwed with that of the screw. Around this surface is rolled a length of

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Four brass rods connect the cylinder's mouthpiece about two inches in diameter with one extreme part of its wonder of the age, and the latter part is also mounted on a brass rod. Osbor explained the principle on which he controlled the artificial diaphragm. This latter is merely a thin disk of heavy mica paper, ten inches in diameter, and in the center of this disk is a small hole, in which is inserted a steel point, resembling the head and half of a fine cambric needle. This is set perpendicularly to the disk, and the point of the latter is adjusted so that the needle's point just touches the tin-foil on the cylinder. The second latter is then put in motion, and the needle point, being attached to the membrane, must trace forever for the amusement or instruction of generations. Mr. Osbor turned the crank and all the screws and rods began to revolve. Then he placed the needle point delicately on the cylinder and said, "Good morning, Mr. Phonograph." He then turned back the cylinder and repeated the salutation. Both times the needle point responded the words, and again commenced to turn the cylinder backward. Then he placed several needle points on the cylinder and requested the machine to speak for the result. "Good morning, Mr. Phonograph" rolled out. Mr. Phonograph itself in a voice even more metallic than that of the inventor. The articulation was never once marred through three days away with a feeling of inexplicable awe. The machine was then turned over to the ladies present for criticism. The first outburst proved it to be too

PROVINCIAL ALTOGETHER.

That it has always universally been alleged that the Chinese must go, and that they are necessary to nobody, was the main point about the tests. The very necessity of the conversation, and of the theory upon which the phonograph reasons, the exact opposite of the Chinese theory, made the machine refuse to speak for the result. Mr. Osbor, however, at last succeeded in getting the machine to say what, as if in mockery appreciated the right of free speech. After the machine had been induced by coaxing to receive sentiment it declared to receive

BOSTON HERALD.
SATURDAY MORNING, JUNE 1.
HERALD SUPPLEMENT.

AN INVENTOR AT HOME.

A Visit to the Residence of Thomas A. Edison—The Phonograph and Other Inventions at Their Starting Point—The Personal Appearance of the Inventor.

The name of Edison has become very familiar to the scientists of the New and Old worlds during the last few years, and there have been associated with this name many rapid inflations, that have made him a very many fortunes for those who have followed in the footsteps of the master, and as the inventor of the "talking machine" he is known to thousands better than any man of his years in this country. Since his phonograph has been on exhibition in this city the constant inquiry of visitors is: Has Edison died and been "Where is Mr. Edison?" for, after having seen the mysterious result of this rare ingenuity, the first desire is to know something of his personality, his surroundings and the other products of his brain. The message of the exhibition, Mr. William McKinney, has thus far failed in his attempts to get the necessary information, and the public will, for the public might have been spared time, as Mr. McKinney's invitation, a party of Boston newspaper men, Mr. Edison was at his home in Menlo Park, and under the escort of the skillful manager of the Mr. Edison, was subsequently enjoyable one, and will be a source of many pleasant memories, to those of the party who had never before seen the home of this gifted man and the scene of many of his inventions.

THE STUDIOUS AT HOME.

Mr. Edison has taken for his residence one of those plain if unpretentious houses of which Menlo Park is composed. It is situated on the main street of the village, facing the Metropolitan railroad line to Newark, and is a two-story house on an elevation of about twenty feet above the road. It is a light yellow wood colored building, with a flat roof, and has a veranda in front. Just behind the house is a large building, formerly a dance hall, but now used as a machine shop. The entrance to the house is through a side door, which opens into a hall, from which a flight of stairs leads to the second floor. On the right of the hall is the parlor, and on the left the dining room. Both are furnished in a plain but comfortable manner, and the latter is used as a reception room for visitors. The parlor is the inventor's workshop, and here he spends the greater part of his time. Here are his models, his books, his papers, his drawings, his tools, his chemicals, his batteries, his electrical apparatus, his phonograph, his telephone, his electric pen, his electric light, his quadruplex telegraph, his electric railway, his electric motor, his electric meter, his electric engine, his electric railroad, his electric pencil, his electric—but why go on? Here are the models and the drawings of all the inventions that have made Edison famous, and here he has been working for the last two years on the perfection of the phonograph, the telephone, the electric light, the electric railway and the electric motor. Here he has been working, and here he will work, for this is the home of the inventor, and the workshop of the wizard.

THE BUILDING AT WORK.

The building is an ordinary frame structure about 30 feet long by 40 wide and two stories high. The lower story accommodates the machinery, and the upper story is the home of the inventor and his family. When the writer of this article was here Mrs. Edison was busily engaged in preparing the dinner for the party, which consisted of Mr. Edison, Mr. Upton, Mr. Batchelor, Mr. Kruesi, Mr. Osbor, Mr. McKinney and the writer. The dinner was a most delightful one, and was served in the dining room on the first floor. The table was set with all the delicacies and luxuries of the season, and the viands were prepared in the most tempting manner. Mrs. Edison presided at the head of the table, and Mr. Edison sat at the foot. Mrs. Edison is a most charming lady, and her manner at the table was so free from affectation that the guests felt perfectly at home. Mr. Edison, too, was in the best of spirits, and his conversation was full of interesting reminiscences of his early life, and of his experiments in the various departments of electrical science. Mr. Edison is a man of medium height, and weighs about 160 pounds. He has a large head, and a high, broad forehead, which is covered with a luxuriant growth of dark brown hair. His eyes are dark brown, and are full of expression. His face is smooth shaven, and his features are regular and well proportioned. His hands are small and delicate, and his fingers are long and tapering. He is a man of very few words, and is extremely modest in his manner. He is a man of very few words, and is extremely modest in his manner. He is a man of very few words, and is extremely modest in his manner.

used by the inventor in testing its future possibilities. The table upon which it rests is smeared with chemicals, which, however, seem to have counteracted each other and prevented any of their smells from being perceived, and the usual pile of tinfoil is close at hand. At the side of this working phonograph, which is rigged with a power attachment, is a copy of the model sent to the Patent Office, looking more like a toy than anything of use. Scattered around and through the centre of this room are pine tables of all sizes, and alike in nothing except that all are equally chemically prepared by the spilling of surplus materials used in experiments. Upon these tables one sees the same variety of contents, the striking objects being the electrical pen apparatus—a large induction coil, costing the maker $800, and just bought for less than a quarter of that sum by Mr. Edison—the motophone and telephone, and an undeveloped electro-magnetic motor. A pipe organ occupies one corner, a half dozen paper funnels, like those used with the phonograph, but ranging from three to eight feet in length, fill up one end of the room, a telegraphic instrument enters the further end, a showcase, filled with anything from a razor and shaving cup to a badly demoralized watch movement, stands on one side, two powerful stamping presses are firmly fixed to one of the tables, a disorganized type writer is poked away by itself, and overhead of this confusing collection of things scientific and otherwise runs a still more confusing mass of telegraph wires, beginning and ending in all sorts of places, the abrupt terminations being ticketed with letters, numerals or hieroglyphics, whose meaning is probably known only to the chief occupant of this queer place. An inspection of the apartment made the desire to see what manner of man could have brought together such a queer confusion of articles all the more intense, and when

MR. THOMAS A. EDISON

was introduced to the party not one of them could conceal their surprise. Instead of the worn-out man, such as one expects to meet in an inventor, Mr. Edison proved to be nearer like an overgrown schoolboy, with a marvellously well-developed head. He is about five feet nine in height, slight built, and stands erect; of a dark complexion, with light-brown hair and eyes; a clean-shaven face, full forehead, and with a nose and mouth that indicate a positive character. As he had worked until 5 o'clock that morning, it being only five hours later when he made his appearance, he could readily demand to be excused for appearing a trifle sleepy, but a half-hour's talk about his inventions aroused his faculties, and he was after that time as bright and wide awake as any schoolboy. He is but 31 years of age, but has had more experience than many men twice his age, as train boy, newsdealer, engine hand, newspaper publisher, telegraph operator and electrician, all of which avocations he followed before making his mark as an inventor. The peculiarity of his inventions lies in the fact that they are all so thoroughly practical that they command a ready market, and consequently quick cash returns, a very [illegible] difference from the average invention, even of this age. Mr. Edison has reason to hope for a long life of usefulness, as he comes from Ohio stock, and his parents and grandparents have attained a good old age while yet in the use of all their faculties. He is an inveterate smoker and drinker of tea, persistent in all his undertakings, a man of great general information, with a ready command of language, very little of a financier, careful as most men are of his personal appearance, and not so deaf but that he readily hears the sounds of the phonograph, as they reproduce the sounds recorded upon its sheet of tin foil.

THE INVENTIONS,

as seen with the inventor as guide, have a new interest, and it proved especially so in regard to the last and most generally known of these products of his brain, the phonograph. Mr. Edison's voice, like that of all who exhibit this instrument, has become hard and unmusical, but the experiments familiar to all who have visited Horticultural Hall the last ten days were repeated to the evident enjoyment of his visitors. The inventor has had a singular experience in convincing many self-invited visitors that there was no humbug about the machine, notably that with a pious church deacon, who, to test the thing, insisted upon hurling a section of the chapter of Luke giving the genealogy of Jesus upon the tin foil. The reproduction of the long string of almost unpronounceable names after his own manner was sufficient, and this man went away happy. He is still far from satisfied with this machine and the perfected phonograph will probably be constructed so that it shall record upon a flat surface, and possibly put over 500,000 words upon a single sheet of tin foil. Mr. Edison says that the idea of this machine was first suggested by experiments upon a device for recording and transmitting the Morse telegraphic alphabet. It is a satisfaction to know that the inventor of the phonograph is receiving and has received large pecuniary benefits from it, and that his interests in its future developments are fully secured, both in this country and on the continent of Europe. As an improvement to the machine now exhibited, Mr. Edison is perfecting a clock movement for its motive power, and the idea was shown to the party. After the inspection of the phonograph the inventor exhibited his varied achievements, most of which have already been described. The most striking improvement was shown in the telephone, upon which this inventor was at work at the same time that Professor Bell was studying up his invention. The advantages of the Edison telephone will be apparent simply from the statement that its power equals 31 times that of the Bell instrument. It is unnecessary to adjust the mouth or earpiece closely, and the sound of a voice is readily heard when both are held at arm's length. The phono-motor caused no little amusement to the party. It is simply a curious invention, showing that the voice can be used as a motive power, the idea being an adaptation of that of the phonograph, the needle on the back of the disk acting on a ratchet wheel so as to propel it with a rapidity varying with the number of words spoken per minute.

ONE OF THE CURIOUS THINGS

about the visit was the utter lack of any indication that Mr. Edison felt himself to be a great man. He chatted about his inventions with as great a degree of freedom from anything like egotism as it is possible to imagine. Once, and only once, did he trench upon the credulity of the party, and, if he did indulge in a little Munchausenism, he should be pardoned, when his actual accomplishments come so sharply to the bounds of that worthy's stories. One of the party was unfortunately a little deaf, [illegible] service as reporter, and was persistent in his inquiries about that "tin ear" or telephonoscope, to dignify it with its scientific name. Now, this invention is to do for the ear what the telescope does for the eye; that is, provided the machine is pointed right, the ear of the deafest person may be unstopped and made serviceable. It is one of the undeveloped ideas, the principle being established, however. To illustrate the possibilities, Mr. Edison pointed to a tree an eighth of a mile away, and solemnly assured his auditors that his initial instrument had enabled him to hear a cow chew her cud while standing under that tree, and he was a little deaf at that. Mr. Edison looked as if he believed the truth of his statement, and, as it is discourteous to contradict your host, no one disputed it.

AFTER THE EXHIBITION

of the several inventions the machine shop was visited, where from fifteen to twenty men are kept constantly at work developing the theories of this inventor and making experimental machines under his direction. Mr. Charles Batchelder acts as leading assistant for Mr. Edison, and many of the rough drafts of ideas, which are caught up by the active brain of the inventor, are hastily sketched in the "laboratory notes" and worked up under his direction. Having exhausted the ingenious attractions of the laboratory and thoroughly tired out the good-natured master of the place, the party adjourned to a corner grocery, where a lunch was served by the groceryman and his family in a little back room, and where a good deal of food was disposed of, considering the size of the party. The attention of Mr. E. H. Johnson, general manager of the phonograph company in New York, added much to the pleasures of the day, and, among the final courtesies extended, an opportunity for a pleasant call upon Mrs. Edison and the two children of this great inventor should not be forgotten.

THE EVENING STAR.

WEDNESDAY............June 5, 1878.

THE EVENING STAR.

WASHINGTON:

WEDNESDAY............June 5, 1878.

CROSBY S. NOYES....Editor.

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Attempt to Steal Edison's Honors.

It seems that Mr. Edison's invention for measuring infinitesimal degrees of heat, the thermopile, which he has been improving and perfecting for some time past, has been recently re-invented in England, and is announced with a flourish of trumpets as a great achievement of English science. Professor Hughes, who also appropriated for the essential part of his microphone a principle discovered by Edison, is the tardy inventor who brings the thermopile to light long after Mr. Edison discovered the principle on which it is constructed and sent an announcement of the fact, as it appeared in THE STAR, to the chief of the Postal Telegraph Department in London, afterwards keeping him posted in respect to the successive improvements in the invention. But Mr. Edison shall be heard for himself. In yesterday's New York *Herald* he says, explaining the thermopile:

"It consists of a carbon button placed between two metallic plates. A current of electricity is passed through one plate, then through the carbon and through the other plate. A piece of hard rubber or of gelatine is so supported as to press against these plates. The whole is then placed in connection with a galvanometer and an electric battery. Heat causes the strip of hard rubber to expand and press the plates closer together on the carbon, allows more current to pass through and deflects the needle of the galvanometer. Cold decreases the pressure. Moisture near the strip of gelatine can be measured in the same way by increasing or decreasing the pressure and accordingly deflecting the needle. By means of this apparatus or one combined with sensitive electrical galvanometers, it is possible to measure the millionth part of a degree Fahrenheit. Infinitesimal changes in the moisture of the atmosphere can be indicated in the same way—changes which are a hundred thousand times less in quantity than those that can be indicated by the present barometer. It will thus foretell a storm much more readily. The carbon button I have in this instrument is of lamp-black burned from rigolene.

"I discovered about two years ago that carbon of various forms, such as plumbago, graphite, gas retort carbon and lampblack, when molded in buttons, decreased the resistance to the passage of the electrical current by pressure. This is part of the apparatus of the carbon telephone and microphone. The Washington *Star* on April 19th published this discovery, and I sent twenty copies of the paper to foreign countries, one of them to Mr. W. H. Preece, Chief of the Postal Telegraph Department in London. I have corresponded with Mr. Preece and kept him posted. Professor D. E. Hughes, of England, now claims to have invented the telephone, microphone and thermopile. At that time Mr. Preece had in his possession telephones exactly similar to that which Mr. Hughes sets forth as his. Mr. Preece was also present in this country, where I showed him the increase and decrease of pressure by the thermopile. In June, 1877, an account of my discovery appeared in the *Journal of Telegraphy.*"

Mr. Edison is naturally annoyed at this bold attempt to appropriate his brain products, and at the apparent breech of confidence on the part of Mr. Preece, and has sent the following cable dispatches concerning the matter to London:

Preece, London:—I regard Hughes' heat measure and direct impact telephone as an abuse of confidence. I sent you and others papers describing it, also in letters about trouble with expansion telephones. If you do not set it right I shall, with details. EDISON.

Sir William Thompson, Academy of Sciences, London:—Carbon telephone sent Preece two months ago; also publications and letters describing it as heat measure. Great abuse confidence his part in Hughes' matter. Await publications with proofs. EDISON.

In respect to the microphone, "it is announced that Mr. Hughes has discovered that certain bodies are sensitive to sound in the same way that selenium is sensitive to light; and that this discovery, in conjunction with a previous one by Sir William Thompson, to wit: That the resistance offered by wires to electric currents is affected by strains, has produced the microphone. Carbon is the body concerning which Mr. Hughes has discovered this peculiarity, and which he introduces into the current." In the STAR of April 19th, it is remarked of Mr. Edison's carbon telephone:

"The peculiar point about Mr. Edison's invention is a little plate of carbon in the instrument, on which its efficiency depends. Carbon is susceptible to a difference in conductivity by a change in pressure. Mr. Edison has succeeded in discovering a kind so suitable for his purpose, that pressure of the most extreme delicacy, even the slightest breath, may be detected. He is the discoverer of the principle on which his telephone operates, and not simply an inventor."

In the same article from which this quotation is taken, describing the appearance of Mr. Edison with his phonograph and telephone before the National Academy of Sciences, may be found the brief announcement to which Mr. Edison refers, of his discovery of the heat detecting properties of carbon, which led to his invention of the thermopile.

Star.—"Have you made any recent improvements or discovered any new applications of your instruments?"

Edison.—"Well, nothing recently, so far as the phonograph is concerned. Night before last I found out some additional points about the carbon which I use in my carbon telephone. It may be used as a heat measurer. It will detect one fifty-thousandth of a degree Fahrenheit. I don't know but what I can make an arrangement by which the heat of the stars will close the circuit at the proper time automatically and directly. It is a curious idea that the heat of a star millions of miles away should close a circuit on this miserable little earth, isn't it? But I do not think that it is impossible."

Controversies concerning the correct distribution of honors among claimants in the school of invention are notoriously difficult of determination, but Mr. Edison is so well fortified in his position as discoverer of the scientific fact in question and inventor of the instrument by which it is applied to practical use that he can easily hold his own, when the facts are developed against all comers, English or otherwise.

The Philadelphia Inquirer

WEDNESDAY, JUNE 5, 1878.

The Relaying of the Telephone.

Professors Edwin J. Houston and Elihu Thomson have successfully applied the microphone of Professor Hughes to the relaying of the telephone, that is, the automatic transmission of the vibrations of the receiving telephone through a new circuit. For this purpose the diaphragm of the ordinary Bell receiver has attached to it a miniature microphone, consisting essentially of three pieces of carbon placed in the circuit of a battery and receiving telephone.

It is found that the extremely feeble vibrations of the receiving plate of the Bell telephone are quite sufficient to operate the inexpressibly delicate microphone, thus repeating on a new circuit the vibrations imparted by the voice to the original transmitter. This arrangement, therefore, corresponds for telephonic systems to the ordinary relay or repeater used on telegraph lines.

Profs. Houston and Thomson have been at work at the Central High School for several months past, in endeavoring to relay the telephone. Prof. Hughes' wonderful discovery of the microphone has given them the means of at least solving this very important problem. An exhibition was given yesterday, at the Franklin Institute, by Mr. J. B. Knight, secretary, when the instrument operated very satisfactorily.

NEW-YORK DAILY TRIBUNE, WEDNESDAY, JUNE 6, 1878.

TELEPHONE AND MICROPHONE.

A question of priority of invention seems likely to be started between Mr. Thomas A. Edison and Professor D. E. Hughes, concerning the device which the latter has called the "microphone." As nearly as we have been able to ascertain the facts, they may be summed up as follows: Professor Hughes has displayed and described before the Royal Society, London, an instrument magnifying sounds, by which, for instance, the tramp of a fly may be rendered audible and may be heard through a telephone, miles away. The substance used in this instrument for increasing sound, is carbon through which an electric current is passing. Now Mr. Edison invented more than a year ago his "carbon telephone." There is no doubt that he was the first to discover a remarkable property of carbon—that its capacity for conducting electricity may be very largely varied by small differences of pressure applied to the carbon itself. This singular property is made use of in both the Edison telephone and the Hughes microphone. Such small differences of pressure as sound waves can produce, serve the purpose of altering the flow of an electric current in both inventions. So far, Mr. Edison has every advantage of priority.

In two particulars, however, Professor Hughes presses the carbon differently from the earlier device. His best measures were obtained when the substance was "metallized" by plunging it in mercury after being heated to whiteness; but it does not appear that the carbon underwent any such process in some of his experiments; on this point the accounts given are not perfectly definite. Both inventors tried many different substances, and both decidedly preferred carbon. Among the things which Mr. Edison tried were metals finely divided, and also, bits of fiber coated with metal by chemical means; both these methods have some similarity to that which Professor Hughes employed in the subdivision of the material or metal used. But it was in dividing the carbon into two, three or four pieces that the marvellous effects of the microphone were attained, and this "does not appear to be the same thing as, for instance, Mr. Edison's use of powdered gas-coke or carbon. Professor Hughes evidently thinks that the main power of his instrument is obtained by the use of separate pieces of carbon which are lightly pressed together. His theory is that a sound wave causes the molecules of a piece of carbon to vibrate so that they and it take up more room, and hence press against a larger surface in the next piece. The greater the number of molecules thus brought close together in the separate pieces of carbon, the greater will be the joint capacity of the whole to carry the electric current. Professor Hughes illustrates this by placing three or four pieces of carbon in a tube, barely touching each other in the condition they will not convey electricity. But when waves of sound affect them they alternately approach or recede so far closed that the electric current passes through them readily. Thus it may depend upon the mere pressure of the sound waves whether a strong current, a moderate current, or no current at all, shall pass over the wires in a delivering telephone. In this way Prof. Hughes appears to have secured a wide range of power. In most of his instruments he has been solicitous to shape the pieces of carbon or other material, so that they touch each other with rounded or pointed surfaces; thereby getting the largest contacts with the greater pressures, and the smallest with the lesser sound waves.

The most striking difference between the instruments of Mr. Edison and Professor Hughes is that in the latter the carbon is to be talked to direct, without the intervention of a diaphragm or metallic plate. In a recent article on the subject in the London *Mind*, Mr. George H. Prescott says that all modifications of the speaking telephone "employ a diaphragm as the transmitting and, capable of responding to the acoustic vibrations of the air." In one of the more recent improvements of Mr. Edison's carbon telephone, he has substituted a plate for the diaphragm; but the use is the same, to take up the vibrations of sound, and, while vibrating, to press upon the carbon. *The Engineer* (London) says, "Professor Hughes dispenses with the diaphragm. You speak at the French mills or tubes, and the sonorous waves directly effect the required result." Mr. Edison has invented an excellent telephone, but the microphone as it is figured and described seems like a different thing. It transmits sound from a speaker who may be some yards away, and does not require the voice to be projected through a mouth-piece. Its construction is easily more simple than any of the telephones. Two sticks of willow charcoal stuck into a board, and holding a third stick resting between them, thus ⌅, is the whole of the receiving apparatus in one of the best forms. The problem of using the telephone for reproducing public speakers, or sound, at a distance, should be easily solved by the microphone, which it is said, transmits the ordinary tones of the human voice over a short space, with such an increase of force as to be distinctly loud to the listener.

THE DAILY FREDONIAN.

JOHN F. MAHOOKIN, } Editors
S. L. JOHNSON, } and Proprietors.

NEW-BRUNSWICK:
THURSDAY, JUNE 6, 1878.

A VISIT TO EDISON.

On Wednesday, the 5th instant, the officers of the New-Jersey Editorial Association held a business meeting in Railway. Having received an invitation from THOMAS A. EDISON, the inventor of the Phonograph, after the transaction of their business the Editors drove out to Menlo Park in carriages, and availed themselves of the opportunity of inspecting the celebrated inventor and some of his latest inventions. The Laboratory is situated about 1,200 yds. three hundred yards north of the Pennsylvania Railroad station, on high ground, commanding an extensive view of the beautiful surrounding country, and consists of a long two-story wooden building. Telegraph wires extended out from it in every direction, making the circuit of the fields round about, which is two in his experiments. On entering the building one is naturally led to wonder whether it is a chemical or mechanical laboratory. The walls are covered with shelves filled with all manner of chemicals and other substances in bottles and packages; and the floor with tables covered with bottles, magnets, crucibles, retorts, coils of wire, and scores of small instruments which were nameless to us, some apparently complete and others lying around in detached parts, many of which were probably representations of abandoned experiments and others not yet completed. Wheels and pullies were hanging overhead, and the sound of the hammer, the file, the saw and the forge resounded throughout the premises. Some fifteen or twenty men were at work doing things, incomprehensible to us, and which we were informed were making models and mechanically putting into shape the ideas of the inventor. It was a busy scene, and clearly demonstrated that it was a place for earnest and serious work.

On the inventor making his appearance and after introductions, he led the party through his establishment, and directed his assistants to put his Phonograph together, it having been spent when we arrived. He then showed the party his Telephone, and a series of experiments were made by himself and the Editors, in talking, singing, whistling and playing upon musical instruments through five miles of wire. The various sounds were returned in the clearest and most satisfactory manner, showing the immense capability and usefulness of this instrument. Conversations were carried on through the Telephone from Menlo Park to Washington, D. C., a distance of two hundred and thirty-five miles, and it is said to have been done through resisting coils calculated to be over seven hundred miles. This invention alone Edison predicts will soon do away with the ordinary modes of telegraphing, and that the business men in the country will simply sit in their offices and talk direct with men in other cities, instead of writing and sending messages through the operators on the Morse instruments as at present; and we see no good reason why Edison is not a prophet whom every body should believe in this matter.

The Phonograph having been put together, the Editors assembled to his upper room, and there they were introduced to Mr. Edison's chief assistant, CHARLES BATCHELOR, Esq., who assisted in the subsequent exercises. The Phonograph was shown and explained to those present. It needs to be seen to be clearly understood. We found an iron cylinder about three inches in diameter, some eight or ten inches long, on the disk or surface of which were shallow grooves running round it on a spiral, the whole moved on its axis by a crank also on a spiral. On the face of the disk was adjusted a broad strip of tin foil. A mouth-piece was then adjusted over the disk, on the under side of which was a small metallic point which pressed the tin foil over one of the grooves in the disk. The machine was now ready for operations. Mr. Edison first sang a few lines of the old war-song, "John Brown's body lies mouldering in the ground," then reversed the cylinder, when the song was reproduced by the machine in clear and distinct tones, loud enough to be heard all over, the room. Every note and peculiar emphasis or intonation was exactly reproduced, to the astonishment and delight of the visitors, most of whom had never seen anything of the kind before. Experiments were then tried with recitations from "Mary had a Little Lamb," "Bingen on the Rhine," "Hohenlinden," all of which were returned by the machine in the very tones delivered to it. Then experiments were made with musical instruments, singing of various well known tunes, and the sounds and notes were returned in the same key. Duets were sung by Edison and Batchelor, and duets were returned to the listeners by the little revolving machine. Whistling, coughing, laughing, and all manner of sounds that could be thought of by the party, were given to and returned by the machine. Each of the Editors sang, talked, orated and shouted over the little mouthpiece, and the sounds made were hurled back at them with horrible exactness. And what was this more wonderful still, when desired the same piece of tin foil would sweep, sing, whistle, talk and shout all at once and the same time, each sound perfectly distinct from the other and all in the same breath, and made solely by the little metallic point tearing the impressions of the sounds made on the face of the tin foil. The possibilities of the Phonograph were thus demonstrated to be really wonderful, and beyond all conception to the ordinary mind.

The uses of the Phonograph will doubtless be many—the reproduction of public speeches, private conversations, all forms of dictation, music, etc., etc. A merchant in New-York may talk in a Phonograph, enclose the tin foil in an envelope and send it to China, and there the words will be reproduced in the exact tones of the New-Yorker. An 40,000 words can be spoken on a piece of tin foil only ten inches square, the economy of that mode of communication is clearly apparent. As two sheets of tin foil may be written upon at the same time, a duplicate copy may be preserved of the communications. These may be reproduced to-day, to-morrow or ten years hence. Speeches may be delivered, and the reporter take his time in copying the words at any time thereafter,

and at his leisure. The practical uses are therefore multifarious, and only limited by the imagination.

The Phonograph and the Telephone are only a couple out of over a hundred different inventions made by him, and which have made him famous among scientific men. His electric pen and duplex methods of telegraphy are in constant use, and have proved to be of great value. He has also invented a machine for measuring starlight, one to measure the rays of heat from hitherto unknown distances—from the stars, even—which we have no time to mention to-day, notwithstanding he was polite enough to show and explain some of them to his unscientific audience on Wednesday. For nearly two hours Edison kept the Editors busy in witnessing his experiments, and showing them about the premises, all the time filling them with wonder and delight. They finally took their departure, fully convinced that the Phonograph is one of the wonders of this wonderful age, and that the greatest wonder is Edison himself, and that if he had lived a hundred years ago he would have been hung or burnt at the stake on the charge of being a wizard.

Entser, the inventor of the Phonograph, has partially promised to accompany the New-Jersey Editors on their Excursion this year, and take his Phonograph and Telephone along for their instruction and amusement. We expect to receive a positive answer from him in a day or two. His promise among the Pressmen of the State will be hailed with delight from Sussex to Cape May, and he may expect a warm reception. Except needs just the sort of recreation that such an excursion will afford, as we fear he is taxing his strength too much over his inventions.

DÉPART DE SAVANTS FRANÇAIS

Les astronomes français venus en Amérique pour observer le passage de Mercure sur le Soleil le 6 mai, MM. André et Angot, sont repartis mercredi dernier pour la France à bord du steamer *Ville de Paris* de la Compagnie transatlantique. Ils se louent beaucoup de l'accueil qu'ils ont reçu en Amérique, et ils sont surtout enchantés de la petite tournée scientifique qu'ils ont faite depuis leur retour d'Opelon.

A Boston en particulier, d'où ils sont revenus directement à New-York, ils ont pu se croire en pays français. M. Nathan Appleton, dont on trouve le nom mêlé à tout ce qui intéresse la France en Amérique, les attendait à la station du chemin de fer, pour les conduire à la maison de son illustre père, M. Th. Appleton, qui n'a pas voulu, pendant leur séjour à Boston, qu'ils prissent place à une autre table que la sienne. Grâce au concours empressé de ces deux amis de la science, le temps passé à Boston a été merveilleusement utilisé. La première visite de MM. André et Angot a été pour les ateliers où célèbre Alvan Clark, où ils ont été mis au courant des travaux de ce savant industriel, et ont reçu tous les renseignements qui pouvaient les intéresser. Il est probable, ont-ils dit, qu'à leur retour le gouvernement français lui demandera un de ces grands instruments dans la fabrication desquels il excelle.

Les savants français se sont ensuite dirigés, accompagnés du fils de M. Clark et de M. Appleton, vers l'observatoire de l'Université de Cambridge. Le directeur de cet établissement, M. le professeur Pickering, était malheureusement absent; mais M. Clark et M. Trouvelot, astronome français, attaché à l'Observatoire, leur ont montré tous les détails du beau cercle méridien de l'institution et de son grand équatorial.

A deux pas de là, MM. André et Angot ont été reçus par le grand poète américain, Longfellow, qui insista gracieusement pour leur faire accepter une collation. Malheureusement il leur fallut bientôt se soustraire à l'aimable compagnie de ce beau vieillard, qu'on ne peut approcher sans être pénétré d'un profond sentiment de vénération, pour se rendre à l'Université de Cambridge (Harvard College). Le président, M. le professeur Eliot, les attendait, et leur a fait visiter toutes les parties de cet établissement, l'une des gloires de ce pays.

Cette visite était d'autant plus intéressante pour nos compatriotes que la France fait actuellement de grands efforts pour renouveler son enseignement supérieur. Une société particulière, libre de toute attache officielle, y a été tout récemment fondée par des hommes libéraux avides de progrès, et, dans le but d'accélérer ce mouvement de rénovation, les recherches dans chacune des branches les plus éminentes dans le domaine de l'instruction publique. M. le président Eliott a été invité à devenir membre correspondant de la société, et nous sommes heureux d'apprendre qu'il a accepté ce titre.

Le lendemain a été consacré à des visites aux musées de Boston, qu'on appelle justement l'Athènes américaine, et au fameux *Soumerset Club*, le plus beau des Etats-Unis.

Dès leur retour à New-York, MM. André et Angot ont bien fait leur trop court séjour en Amérique; ils ont visité à *Menlo Park*, où ils ont été admis à visiter le laboratoire désormais historique de célèbre Edison. Ils sont revenus émerveillés des prodiges que leur a montrés ce jeune homme de génie, et aussi de la simplicité modeste avec laquelle il expose les plus brillantes et les plus étonnantes découvertes.

New-York Daily Tribune.
FOUNDED BY HORACE GREELEY.
SATURDAY, JUNE 8, 1878.

An interesting letter from Mr. Edison, on another page, sets forth the grounds on which he claims priority in the telephonic inventions which Professor Hughes has recently exhibited in London. It must be granted on all hands that the discoveries of Mr. Edison suggested the line of experiment which led to the invention, and it may prove difficult to draw the exact line at which the English instrument can claim any originality. As a whole, however, it is of simpler construction than previous telephones, and Mr. Jacobs, according to the accounts furnished, to have more remarkable powers. The most striking feature of Mr. Edison's letter is his statement that he has been betrayed as to those inventions by a person who was the agent for his telephone in England. Considering the provocation, Mr. Edison writes with remarkable moderation and dignity. He may be sure that the scientific world will see, to it that he is robbed of some of the laurels he has so honorably and conspicuously won.

TELEPHONE AND MICROPHONE.

LETTER FROM THOMAS A. EDISON.
THE QUESTION OF PRIORITY OF INVENTION.
HOW HIS AND PROFESSOR HUGHES'S DISCOVERIES CONFLICT—EDISON CLAIMS A VIOLATION OF HIS RIGHTS, AND A BREACH OF CONFIDENCE BETWEEN FRIENDS.

To the Editor of The Tribune.

SIR: Allow me to make a few observations upon an editorial article which appeared in yesterday's TRIBUNE upon the recent claims advanced by Professor D. E. Hughes, of London, in his invention of the leading features of my carbon telephone, and of my microtransmitter or instrument for the measurement of minute degrees of heat.

You have attributed to Professor Hughes two improvements upon my method of procuring the electric battery for the telephone namely: In the installation of the carbon by plunging it in mercury, and in the division of the carbon into several pieces. I can appreciate that the latter process is not identical with my use of one short carbon, but perfectly correct, but the substitution of the carbon had been repeatedly tested by me in my experiments on the telephone, especially in a series conducted at the special request of President Orton shortly before his death, at which the illustrative drawings were seen at the time by several persons, and are still in my possession. The substitution of the carbon by plunging it in mercury is also a process perfectly familiar to me, having been employed in many of my telephone experiments of last year, and, though mercury is not specially named, it is clearly included in the expression "finely divided metals" which occurs in the second paragraph of "The Speaking Telephone," as printed in "The Journal of the Telegraph for the 16th of April last. Mr. Hughes seems to have been so impressed with this phrase that he employs it repeatedly, speaking of "mercury in a finely divided state," of "holding the mercury in a fine state of division," of "metal distributed—in a fine state of division," of "iron in a fine state of division," again, of "the minute division of the iron," and lastly of "a platinum surface in a finely divided state."

The change of electrical resistances with enormous rapidity by plunging under pressure was a discovery of my own, distinctly set forth in my application for a patent for an "improvement in speaking telegraphs," dated July 20, 1877, as published at the time in *The Philadelphia Press* and *The Scientific American* (July 28, 1877). This discovery evidently covers the principle claimed as his own by Professor Hughes. He says: "It is quite evident that these effects are due to a difference of pressure at the different points of contact"—which is precisely the principle of my carbon telephone, therein set forth months ago by Mr. Gen. R. Prescott in the above-mentioned column. My statement expressed meaning, however, Mr. Edison at length made the discovery that when properly prepared, carbon possessed the remarkable property of changing its resistance with pressure, and that the ratios of these changes, however, corresponded exactly with the pressure."

You continue as the most striking difference between my telephone and the instrument of Professor Hughes, that in the latter the diaphragm is dispensed with. In his own words, "it will be seen, however, that in the experiments made by myself, the diaphragm has been altogether discarded, resting as it does upon the changes produced by molecular action, and that the variations in the strengths of the currents flowing are produced simply and solely by the direct effect of the sonorous vibrations."

The following extract from Mr. Prescott's book, as given in *The Journal of the Telegraph*, April 16, 1878, will show that the discarding of the diaphragm is my own invention:

In its naked form of transmitter with Mr. Edison has introduced, the vibrating diaphragm is done away with altogether, and the carbon is made to receive the vibrations of the sonorous waves directly, as the vibrations after having been once started. In the new arrangement, now described, the carbon is made to receive the vibrations of the original sound waves directly, by the intervention of neither diaphragm nor membrane. The telephonic plate, of carbon, merely serves, in connection with the battery, to modify the waves in consequence of the molecular motion of the carbon to which it gives rise. The small carbon disc or button, a ninth of an inch in diameter, is made to receive the greater degree of motion for the reason that the whole face of the speaker is thus exposed to the vibrations, and can consequently be affected by the small surface atoms more than could be obtained if only the small surface alone were used.

The claim of Professor Hughes to the discovery that the installation of his microphone can be used as a measure of minute degrees of heat is still more preposterous than the preceding. This is a discovery of mine, which was first announced in *The Washington Star* of the 19th of April last. A copy of that *Star* of the 19th of April last. A copy of that *Star* was sent by me to Mr. W. H. Preece, the correspondent of Professor Hughes in this protected adjuster of Professor Hughes in this protected adjuster of Professor Hughes in this protected "invention," and I have positive evidence that it reached him before the presentation of the so-called "microphone" to the Royal Society. I transmitted as he has made an address from it to the address of May last before the London Society of Arts.

Mr. W. H. Preece, electrician to the London Post Office Department, was in this country in the early part of last year, and visited my laboratory. I freely showed him the experiments I was then making, including the principle of the carbon telephone and the variability of conducting power in many substances under pressure. I made him my agent for the presentation of this telephone, and subsequently of the phonograph, in England, and kept him informed, by copies of publications and by private letters, of my leading experiments, as he always manifested a great desire to be the means of presenting my discoveries to the British public.

I therefore regard the conduct of Mr. Preece in this matter as not merely a violation of my rights as an inventor, but as a gross infringement of the confidence obtained under the guise of friendship.

Yours very truly, THOMAS A. EDISON.

Menlo Park, N. J., June 6, 1878.

The Sun

SATURDAY, JUNE 8, 1878.

EDISON'S "EAR TELESCOPE."

THE RELIEF THAT THE INVENTOR IS PERFECTING FOR THE DEAF.

Conversation Carried on with Ease Between Persons Two Miles Apart—A New Device that will Enable Doctors to Detect Disease.

Upon his latest discovery, which he hopes to utilize principally for the deaf, Edison has not given much thought for a few days. He has had something else in mind. An unusually large number of persons called on him at his laboratory in Menlo Park yesterday, and they found him very busy upon experiments with carbon. His hands were as black as soot and there were smudges of grime all over his face. With an alcohol flame, into which he thrust little tin plates, he converted different substances into carbon, and then tested the resistance and heat, detecting the power of each kind of carbon with the galvonometer.

On one side of him a workman talked nursery rhymes into a phonograph as a matter of business, for the tin-foil record is to be used for a toy phonograph, large quantities of which are wanted for the trade as soon as they can be perfected. These will be sold for two or three dollars each, and will repeat "Mary Had a Little Lamb," "Jack and Jill," "Yankee Doodle" whistled, and a nursery hymn sung.

Edison looked very tired yesterday, and said that he was, but he was feeling very happy at the success of an experiment with the carbon telephone the night before. He had fixed up his line telephone at the end of the laboratory, and Mr. Bachelor, his assistant, held the other end of the wire in his house, a quarter of a mile away, but there was a resistance of a hundred miles in the wire. That is, the effect was the same had Mr. Bachelor been in Baltimore and Edison in Menlo Park.

Without any funnel to concentrate the tone, Edison said:

"Now, Bachelor, I am going to walk to the end of the room and talk to you."

Mr. Bachelor heard him as plainly as did Mr. Griffin, who stood by Edison. He also heard Edison walk across the room. Then Edison in his ordinary tone said something. The telephone caught it up 150 feet away and sent it through 100 miles with perfect distinctness to Bachelor.

"That was the most perfect piece of work ever done with the telephone," said Edison yesterday.

Leaning against the table that supports the telephone were two immense funnel-shaped things that looked like confectioners' cornucopias, big enough to hold a ten-year-old boy.

"These," said Edison, "are what I made my experiments with for the megaphone. I see some of the papers speak of it as a telescopophone. That isn't the name. I guess Redpath, who saw me experimenting with it, called it that by way of a joke. That's a megaphone—great sounder—but it isn't done yet. I've got the principle, though. See here." And Edison lifted one of the great pasteboard funnels so that the large end rested on the table. "Now, put your ear to that," he added, pointing to the little end. "You hear things outside plainer than you did before."

Indeed it was so, and so plainly as to torment the ear.

"But that one is no good," he said, "for this purpose. This is the one, and I have got the principle in it that I was looking for."

He tossed aside the biggest funnel, and took up one somewhat smaller. It was made of thick cardboard, bound with iron hoops like a barrel.

"That's about all there is to it," he said.

"But what is it going to do?" the reporter asked.

"Well, I wanted some simple, convenient thing that deaf people could use in a theatre, church or anywhere. I had an idea that I could, if I could get a just the right means for catching the vibrations of air that produce sound, I could carry them into a little box or chest, that might rest in a man's lap as he sat. From that chest tubes might run concealed in his clothing to his ears. The point was to find out just how to catch the sound vibrations."

Then Edison got on the table, and, swinging his feet, began to tell how he first reasoned out his theory, and then experimented to prove its truth; and Mr. Griffin, his old-time fellow-operator, friend, and recently engaged assistant, says that the narration simply illustrated the mental operations and subsequent investigations that have led to all his inventions.

"You see, sound is produced like light," Edison went on, "by vibrations. Well, what do you do when you want to get light from a distant object, or if your eyesight is bad, to see clearly something near? Why, you make such aids to the eye as will catch and carry to the eye the vibrations of light. When you have done this you see clearly. Well, now it struck me that you'd got to treat the ear in the same way, when anybody's deaf or wants to hear something away off. But the telescope isn't good for much unless the object glass which catches and focuses the light is just at the proper angle. What we want for the ear, then, on the same principle, is an instrument the line of whose angle is exactly right. Then you are going to get your sound vibrations, because they will be caught and focused. The fact is, I'd got to get an ear telescope. Then we made that one," pointing to the big funnel, "but it wasn't right. 'Twouldn't work. Then we made the other one."

"You didn't make it at haphazard, did you?"

"Why, no. I had the general idea of the angle required."

"You mean by the angle, the angle of divergence of the sides of the tel[illegible] tubes from its centre?"

"Yes, that's it. With the proper angle sound vibrations are received, and then conveyed without break or interruption to the ear."

"How did you find that this was r[illegible] at?"

"You see that barn over there?" pointing to a barn a mile or so distant. "Well, I held this tube to my ear, and I heard a [illegible] talking over there perfectly. Just as the telescope catches the rays of light from a star and brings them to a focus, so by pointing this tube directly at the spot that the sound comes from [illegible] catch the vibrations of sound."

"Then this does not magnify [illegible] und?"

"No; only concentrates it. [illegible], this angle is all there is to this. I take a[illegible] cut off a section a finger's length from the end and so I get a short tube with the proper angle, suitable for a comparatively short distance. If I have enough of them they will answer as well as one big tube. Now, perhaps I can carry out my idea and make a little chest, from which these tubes will issue. They will catch the vibrations that are made when a man speaks or preaches, and carry them into the chest, and then they'll pass through the tubes to the ears. I don't want to say that they will do it, because I haven't made the thing yet and tried."

"You think that with such a thing deaf persons will have no more trouble in church or at a theatre?"

"Well, that is what I was thinking about."

For long distance conversation the instrument will have a different shape, as a matter of convenience, and be provided with a speaking tube. There will be two of the ear telescopes, and to the smaller end of each a rubber tube will be joined, for convenient contact with the ear. Between the two telescopes, and connected with them by braces is the speaking tube, which has a very slight angle of divergence. Thus, two civil engineers a mile apart wish to talk. Each of them has a megaphone. Placing the tubes in the ears, one of the engineers can talk through the speaking tube in an ordinary tone of voice, and the other will hear and reply. The instrument is different from the aerophone, which Edison has thought of, the utility of which is for very loud talk at very great distances. Edison proposes to rifle the speaking tube of the megaphone, so that the vibrations may be kept as compact as possible.

Already some extraordinary experiments have been made with the rough cardboard ear telescope, and its utility for the purposes of ordinary conversation for a distance of two miles was shown at Menlo Park a few days ago. It requires no shouting. Even a whisper can be heard 200 yards away.

"But do you mean to say that you require no electricity, no carbon, and no connecting link?" asked a Newark doctor who had stood by as Edison explained the invention to the reporter.

"Oh, no; there is nothing to it but the making of the tube right."

"How does it differ from the aerophone?"

"Why, that opens valves, you know, by compression of air, for the purpose of throwing sound over a great radius. This concentrates vibrations instead."

For field and long distance purposes the megaphone will be mounted on a three-legged table like a surveyor's instrument. For audience rooms it may rest upon the lap, and, of course, has no speaking tube.

Already letters pour in upon Edison from deaf persons who have heard that he is at work at something that will give them ears as spectacles give eyes to others. Sometimes he receives as many as 100 a d[illegible]y, and he has had a batch of circulars printed, for it would take his secretary all day to answer the inquiries. These are mailed to every one who writes.

Edison laughs heartily when he refers to Joseph Medill's letter. The editor of the Chicago *Tribune* said that he would give $10,000 for something that would help his deafness, and he believes that he has got something that will do it. At the same time he is so cautious that he will not predict success for the lap megaphone, simply because he has not made and tested one. The field megaphone he knows is a success.

To-day Edison begins experiments on another invention. He will try to combine the principles of the telephone and microphone so that physicians may have an instrument that they can use instead of the stethoscope.

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SATURDAY AFTERNOON, JUNE 8, 1878

EDISON, the wonderful, has had a fresh wrestle with Nature, and evolved an apparatus by the use of which he makes the deaf to hear. Likewise, he has found out the way to measure the heat of the heavenly bodies. Also, several other things. Go on, Mr. EDISON. Next!

Edison is at work on an ear trumpet which will enable a man seated in his office in Wall street to hear his wife over in Brooklyn call out, "Sam-u-el, you just bring that man over to dinner and you'll find out."

THE DAILY GRAPHIC

SATURDAY, JUNE 8, 1878.

Art correspondence, with sketches of important occurrences and notable scenes, and also photographs of interesting subjects, are solicited from all parts of the world. If used they will be liberally paid for.

The sender's name and address required on every communication, not for publication, but as a private guarantee of good faith.

A BAD EGG.

[From the Burlington Hawkeye.]

An intelligent farmer living in Des Moines County has invented a henophone, modelled on the principle of the telephone, by which one old, reliable hen occupying a central office in the henery, sits on all the nests about the establishment, leaving the other fowls free to lay eggs, scratch and cackle. As fast as a new nest contains the full complement of eggs, it is connected with the central office by a copper wire and the business is settled. The only trouble with the machine is that it sits so hard it hatches out the porcelain nest eggs along with the others, so that one chick in every nest is born with glass eyes and the farmer has to buy and train a dog to lead it around. This makes it expensive.

THE LATEST OFFERINGS OF SCIENCE.

Science has recently brought forth several healthy babies which promise to develop great qualities in their adult stages. All of these—the telephone, phonograph, aerophone, microphone and megaphone—are connected with the expression, reception or repetition of sound. The telephone is based on the principle recently discovered, that atmospheric sound waves can be converted into electrical waves, and reconverted into atmospheric waves. Two years ago the first telephone was a mere toy, incapable of loud expression, and apparently of little use. To-day it has taken its place as one of the powers of the earth, and it is already contesting the field with the telegraph.

The phonograph is at present not of much more practical value than the telephone was two years ago, but it is an embodiment of a discovery that enables a simple machine to repeat all the sounds of which the human voice or any musical instrument is capable, and apparently all it needs is the improvement which new inventions always attain. It speaks imperfectly at present; there are some consonants which it has difficulty in articulating at all; but this is merely a question of mechanical detail, and when we see what ingenuity has evolved from the first watch and the first sewing-machine, there remains little doubt that the phonograph will grow to vast utility and become one of the great labor-saving machines of the world.

The so-called microphone of Hughes, in England, is not a wholly original device. It is based on Edison's discovery of the extreme susceptibilities of carbon, which he applied to develop the extraordinary power of his telephone. But Hughes has evidently made an industrious and skilful application of this discovery, for it is reported that, with the carbon auxiliary, he can magnify the smallest sounds almost indefinitely, and has made a fly's footstep audible! It increases and exaggerates sound to such an extent that it is claimed that "the lightest touches of a feather's edge or of a camel's-hair brush on the sounding-board of the telephone produce a crackling noise of which the intensity was almost painful to the ear." This suggests endless utility; but it has yet to be developed.

The megaphone of Edison is also yet in its infancy. It is a device for magnifying sounds so as to enable the partially deaf to hear, and it is probably based on the great fact of the sensitiveness of carbon discovered at Menlo Park last year.

It may not be true that "Science is the Providence of man" in the sense in which Holyoake affirmed it; but it is certain that science is a providence of man, and that the beneficence of its revelations can hardly be overstated. It has been thought that the rapid progress of physical science during the last half century would scarcely be maintained, but the advent of Edison and the origin of four or five great inventions along a new line in two years again renews the probability that in the arcana of physics man is still to win most notable victories.

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Graphic June 8. 1878

EDISON'S PHONOGRAPH IN PARIS.

WHAT THE SCIENTISTS OF FRANCE SAY OF THE TALKING MACHINE.

THE DAILY SEANCES GIVEN ON THE BOULEVARDS—A FRENCH INVENTOR'S GLADE.

[Correspondence of The Graphic.]

PARIS, May 25.—All about the gayest part of the gay boulevards, amid the throng of strangers of the fabulous at the cafés and the crush of amusement-hungry promenaders who seem to have not an idea beyond what they shall eat and what they shall buy, there may be seen every day and several times a day groups of thoughtful-looking men and women, attending their way to a small hall—in Edison Cancellor's time the back of a convivent of an impending house on the boulevard of that name, where lectures concerning the Electric Telegraph and Illustrations of its working are now being given, for the first time in the French metric, to the public. The greatest sensation in Europe is Mr. Theodore Puskas's, as yesterday I had the pleasure of a personal interview with the gentleman. In the first place, let me say that Mr. Puskas seems to me the man of all others to whom it was wise that this important theme should have been entrusted. "The selection was a happy one in all respects, and Mr. Edison is to be congratulated upon it. Profoundly impressed with the marvellous character of the invention, thoroughly conversant with all its details and those of all instruments in any way similar to it, Mr. Puskas possesses the power of clearly explaining, both in English and French, the workings of the wonderful invention. Yesterday afternoon I was present at a seance at the lecture hall, and after the wonderstricken audience had departed, Mr. Puskas kindly addressed me what the phonograph had been doing in France.

"The truth now of science have been astounded at the latest of the accomplishments of the seven-times marvellous," said Mr. Puskas, "and at first when the powers of the phonograph were announced the universal cry was that there was something which could not be done. But after a time, when the phonograph fulfilled every claim that had been made for it, then a voice arose and said: 'Yes, quite so; I discovered the telephone!'"

"A claim to priority of invention of the phonograph by a Frenchman?"

"The priority of the idea of an instruments which would record the sounds of the human voice, though no such instrument ever was made, and it is highly improbable one ever will be made according to the present conceptions."

"Who is the person who had this idea?"

"Mr. Cros, Ex-President of the Academie des Sciences Occultes. His remarks preceded the first exhibition in the Palace of Electricity, Rue Rivoli. Mr. Cros deposited at the French Academy a sealed paper describing an instrument of which he had an idea, to be called the paleophonograph."

"Did you respect did this idea resemble Edison's?"

"Only to the extent of the notion of a machine repeating the sounds of the human voice. Mr. Cros had no conception whatever of the use of the tinfoil in the instrument. His plan was to make use of Scott's Phonautograph, and upon the cylinder with epinam a hair or a feather or something else that, very delicate and fine. This hair, moved sensitively by the air waves of the voice, would trace on small lines on the lampblack, and these lines Mr. Cros proposed to photograph or by a known process. At the end of a certain length of time and various processes the lines would be found. The idea of instantaneous reproduction was not at all entertained by Mr. Cros."

"Then you do not consider the construction of an instrument in accordance with Mr. Cros's ideas possible?"

"I have the opinion of M. Koenig, the celebrated instrument maker and inventor of the forms of singing flames," replied Mr. Puskas, "that it is thirty thousands Mr. Cros could ever construct an instrument which would work practically. He could not hear it in ten years, and he so master a satisfactory result was to see Edison."

"I understand that you have had an exhibition of the phonograph before that mutual body of learned men, the French Academy of Sciences."

"Yes, and on the occasion there was a great triumph for Mr. Edison, for the members *absolutely refused* to believe the statements of their senses. They thought I was a ventriloquist, and was using that trickery to obtain the results which astonished them. Accordingly, they requested me to leave the room that one of themselves might sing into it. After the conclusion I test the *across* were as crucial in their properties as they had previously been cautious in their suspicions. The warmest admiration was expressed for the great American inventor, and the hearty thanks of the body were sent to Mr Edison."

"I hear the wonder worker is coming to Europe this summer," I said.

"I think he will be here before the Exposition closes," replied Mr. Puskas. "He said he thought he should come to-day. I hope he will for his own sake. As hearty a reception as ever was accorded to a man of science awaits him at the hands of the *savans* of France, and if he comes he will receive a meeting of which any nation on earth would be proud."

In the financial *across* the phonograph is a decided success on the boulevards. Three *seances* a day are held, morning, afternoons and evening, at prices of admission varying from three francs to one, and an average of $200 daily is received at the doors. The hall has been secured for three months, and it is inevitable, with the additional notoriety the phonograph will receive every day receiving, that the vogue of the *seances* should go on increasing, and that crowds greater and greater in number should gratify their curiosity concerning the phonograph. Scarcely a day passes that the inventor is not requested to have a private *seance* of the phonograph given at his or her residence. Yesterday I noticed by M. C. Rosenvi, one of the old and distinguished family, whose name is a synonym for wealth and respectability in New York, Mr. Puskas a short time ago, took the phonograph to the Palace of the Elysee and demonstrated its power in the presence of the Marshal-President and a brilliant assembly. The Marshal was exceedingly interested in the workings of the instrument, and expressed himself astonished at the successful recording, and the *seance* was given at the splendid hotel of the Princess Mathilde, in the Rue Rivoly Cleis, the Cercle Agricole, the Salons of "Encouragement and the Societe de Physique, and in many other establishments, have exhibited the phonograph, and said "it was passing strange."

The phonographs in use on the boulevards were made in France, as the importation of foreign-made instruments is not within the French *invest*. One is Edison's, for cylinders, with cornucopia-like trumpet and a tinning cranks; the other is a later improvement, a, a brass mouthpiece cap and the crank at the end of an elbow. On the boulevards the latter and the first are in use, of course, given in French; and sometimes, when the *auditoire* comes of a class of the businesses there is a smile at the thought of this little iron thing, the phonograph, fiercely using a language with which its maker, Edison, is probably quite unfamiliar. Could you but hear the effect of what superb ease and accuracy of *accent* is pointed out its own praises in the following sentence:

"Le phonographe est un instrument merveilleux! Il reporte tout ce-que-l'on lui dit. Au revoir!"

Students of any foreign language will make use of a phonograph to correct them in pronunciation, and every country required some native to utter a few sentences for it. The irrepressible French *figure* is responsible for the following, given that, a fatuity of distinction, having uttered that, a fatuity of fatuity, turned on their phonograph-cylinder, and, to the astonishment of the great many successful times it stood, threatened to have the instrument taken into the instrument with the remark that it was the most wonderful phonograph has been allotted space in the Exposition.

"Well, but to see you on view there, and it is not likely that you will be allowed to remain there for three or any time. The reason is evident, as soon as the phonograph can accept a paying notice on the door of the hall. In the interest of those who had the right to it in France to show it gratuitously at the Exposition.

Curtis Lenox.

The New York Times.

TRIPLE SHEET.

NEW-YORK, SUNDAY, JUNE 9, 1878.

THE PHONES OF THE FUTURE.

Since the philosophic Franklin first got the lightning "on a string," the ingenuity of man has put the subtle and all-pervading fluid known as electricity to such various uses. In opposition to the ordinary methods of education, he first set it to writing, and having developed its faculty in that direction to the utmost, he has at last taught it to speak with most astonishing organs. It not only reads its own writing, which is more than some lawyers and stenographers can do, but it will gather up the stray *accents* that are floating in the air and give them concentrated utterance. So it is that the era of phones is succeeding the era of graphs through the connecting link of the phonograph. That is as yet scarcely begun, and it is impossible to predict the results of its development. Thus far we have the phonograph, that both reads and writes and harmonizes all the vocal music; the telephone, that transmits sounds over long distances and spectinulates them at the far end of the line; and the microphone, that magnifies them by many diameters. What other phones await us it is early for human genius to tell, but there can scarcely be a doubt that electricity is destined to give us a complete mastery over all the sounds of nature.

Already we have an inkling of what we may expect. The voracious man of science tells us that we may hear the pressing of a fly as a mutable click with all the distinctness of a horse clattering over a bridge in the neutral of Venice's famous line.

Quelquefoste porous audis quasi sapide cerique."

Even the insect's respiration may be clearly heard like the wheezing of an asthmatic elephant. Soon we can bring equidistance to bear to gather up the minutest sounds, magnify them in tremendous volume, and hurl them to any desirable distance. We are assured that we shall be able, not only to listen to the tramp of the distinct insects, but to hear the growing of the grass and the ripple of the sap ascending by earth the tree. We shall be able to catch with the magic alchemy in the laboratory of the leaves; we may increase the greatness of earth and air into forms of beauty, and all the bravery of the Summer's green shall become audible as the elatter of a common workship. Then will the dreaming poet, as he lays him down to the woods or field to feel the thrill at nature's voice, command himself with histories, dales, and wires, and bring to his ears the clash and roll, the boom, the rhythm and the clang of a Titanic orchestra. Nor will it be necessary to go to the fields and subject one's self to the dependence of bees and ants to get all the benefit of the magnified and multitudinous sounds that keep the atmosphere vibrating. They may be gathered from their haunts in field and by brook, and the glees of forests and along the sounding shore, and be brought by wire from every direction to some grand hall in the busiest metropolis, and there let loose for the edification of gathered crowds. Furthermore, instruments may be devised whereby these myriad notes may be commingled and controlled to the utterance of most excellent music. Who knows but even the music of the spheres, the voice of the smallest star that

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"is its motion like an angel sings,
Still spoking to the young-eyed cherubim,"

may be made perceptible to mortal hearing. The voices of earth and heaven may perchance unite in one tremendous symphony through the agency of the symphone. Man is yet to be invented.

But there are other possibilities hardly less interesting. Not every sound, whether of nature or of art, is either soothing or exhilarating. The nerves of man are subject to tortures as well as exultations. It is not given to all persons to be gently

"Stalled with buming night-dies to their slumber,"

and to sense the shrill clarion of the mosquito on his midnight intendilize is anything but soothing. Cats that make night hideous with their private wrangles, and scolding poultry that spoil the morning nap, these utter sounds that no one would wish to have magnified. And though there might be a cacophone devised as an instrument of torture, to be used, perhaps, as a means of punishment for the worst, class of criminals, as something more terror-striking than death itself, yet the virtuoso and humane would be more concerned for some opposites that would utterly destroy and nullify horrid and distracting sounds. For casual humanity to apply itself to conserving some means for eliminating discordant noise from the air and so that the cat on the back fence, with arched back and tail erect, may be "mum and not heard," and the mosquito quench his raging thirst for gore without accompanying the victim with his whining, exhilarating cuticles. And while the combined telephone and microphone might, in the household, enable one to gather up scent interesting whispers and accurately pump the pulsations of two hearts that beat as one, it would be a peculiarly precious boon to be able to sit in one's study all accustomed of noises sounds. The strident and indirect upbraidings of the motherin-law, the peevish cry of other people's children, the heart of buzzpetty passerby, the din of hand-organs in the street or piano in the adjacent boarding-house, and all the distracting noises that make the misery, might be smothered by a faithful anti-phone of some sort, whose function it should be to take the life out of every intruding sound. But no volume of mechanic contrivance would suffice for the setting forth of all the possible results of the invention of phones and their application to the assimilation of sounds. "We can only give the imagination a hint, and let it rove in this new, fascinating field, and speculate on some avail the *slow* processes of invention before a full realization of the benefits of the latest sons of electricity.

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THE WONDER OF THE NINETEENTH CENTURY.
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JAMES BEDPATH, Manager.

THE ENGINEER. MAY 24, 1878.

THE SOCIETY OF TELEGRAPH ENGINEERS.

THE TELEPHONE AND MAGNOPHONE.

On Thursday evening a special meeting of this Society was held to hear a lecture from Mr. W. H. Preece, on the recent discoveries of Prof. D. E. Hughes. As we gave an account of the investigations of Prof. Hughes in our last issue, it is needless for us to recapitulate the experiments. It will suffice therefore to say that the lecturer, who really possesses a talent for description, vividly described to a large audience, the gradual opening out of the discoveries, and the way in which they had been followed up by many beautiful experiments. Prof. Hughes's quiet modesty proved that the sciences (theatrical laughter and electric conducting matter—for aught he finds that in the glass tube transmitter—see cut—it is the glass tube which is really subjected to the vibrations.

At the close of the able lecture's short discussion followed, by the simple expedient of avoiding the inventiveness of heavy W. H. Scott had the opportunity, so far as we can gather at present, obtained results similar to those obtained by Prof. Hughes. In speaking of his experiments, Mr. Scott says:—"Omitting all needless details, it may be briefly stated that my first distinct impressions upon the ordinary magneto-electric telephone were obtained by modifying the diaphragm or vibrating armature of the instrument; thus it was of course quickly found that the smaller the portion, the greater the weight of metal caused to vibrate for a given sound, the greater was the strength of the sound emitted at the "listening end," although frequently at the expense of clearness. Increased definition, however, I may be allowed to impart a convenient optical term—was obtained by the simple expedient of avoiding the inventiveness of heavy and therefore more rigid diaphragms, by employing a number of soft iron in place of one thick plate, and this arrangement is still a practical improvement that instruments provided with five small armatures, of the same four having central eyes—will receive and emit nearly twice a variety of sounds for which in the ordinary "Bell Telephone" there is simply "no thoroughfare."

Even several armature-plates to a considerable number would be required to produce the fine effect produced on each of these coils are farthest from the magnet. Reasons we shall, therefore, think are furnished for using sometimes a vehicle current to further exalt the effect—for multiplying the number of armatures without, at the same time, increasing the weight or inertia of the mass to be moved, and always with advantage until it was found that the most sensitive armature for the receiving instrument that acted in the form of powder or filings. It is not too much to say ten grains of soft iron filings, affixed by suitable means to a paper diaphragm membrane, are capable of producing further results than forty grains in the shape of a "ferrotype disc."

On carefully localising the vibratory sensations of the transmitting telephone, however, and including it in the circuit of a battery and apparatus, which, as at present, is usually pitted to one end, a phenomenon which still obtained when the "iron filings" or previously described was employed. The whole of these experiments were performed with instruments somewhat roughly put together, and consequently pitted to about semi-tone, and it was after carefully discovery step-forward that seemed to have been made when I discovered that by simply substituting the transmitter "string such good results had been obtained, and had slipped about an inch and a half away from the diaphragm, being therefore entirely out of contact with it, from that point of view. The fact that its entire removal did not affect the intensity of the instrument occasioned me, however, but little additional surprise.

It was impossible to avoid believing that here might at last be found the true cause of a variety of phenomena hitherto unrecognised, but which have been observed by numerous experimenters in a more or less freely divided condition were introduced into the circuit in connection with "transmitting telephone," whose conductivity—or "resistance," as ordinary electricians would say—was impossible to the most sensitive wheatstone bridge and "galvanometer," for transcending in delicacy any instrument yet devised.

If other platinum, mercury, or silver—and doubtless other metals in a different degree—were subjected to an extremely fine state of division within the cavities of suitable porous substances, such as pumice-stone, asbestos, &c., similar results to those above mentioned may be formed. Therefore, while carbon appears to act in a favourable degree; by their all the same, a shaker's diamond is "brilliant" well, without any great stretch of imagination, it might be taken for the distant reverberation of a "rustle" in some night's "Scotch mist." Or, "hum" of a mimic

Dr. Nolan, in faithfully transcribing the general appearance, to the eye, of these curves, was of course not able, in the limited time given, to preserve the absolute thicknesses and lengths of the curves, as indicated in the records in the Proceedings of the R. S. So, in the former, the letters A, E, I, O, U, and OU (Webster), I and U are much alike in general form, as also are A and O, the complete of the pairs of the latter being the most striking features; O and A, in the shaders, look about the difference in shape produced by less intensities, the short being drawn out, and more acutely. O I is very interesting. The diphthong consists of O, and the very muscle which characterise the transition from one vowel to the other. It is a very complete character, but its derivation has not yet been made out.

The above presentation of the subject, is necessarily crude and imperfect, but will illustrate the possibilities of an exhaustive investigation. It should be added that Professor Alfred Mayer has published, in the last number of the *Popular Science Monthly*, a representation of the curves made by the clay "bell," and a comparison of them with the curves of the vowel sounds, and with the curves of the Koenig tones, when actuated by the same sound

[Note.—In the woodcut the forms made by the curvatures of the styles for the short letters are wider than they should be.]

* Franklin Institute.

EXAMINATION OF THE PHONOGRAPH RECORD UNDER THE MICROSCOPE.*

By Professor Fleeter, Jr., A.M.

At a meeting of the Philosophical Society, held April 5th, 1878, I described the results of experiments made with the tinfoil which had been indented by the stylus of the phonograph. My object was to ascertain the action of the stylus in cutting the wave forms corresponding to articulate sounds. For this purpose the superintendent of the Philadelphia Local Telegraph Co. kindly placed at my disposal the tinfoil upon which diphthongs were spoken. With the assistance of Wm. Weeks and with small panels in the mouthpiece of the apparatus sounds were repeated thirty-six times, the diagram. These then mounted on glass plates, separated, and the tinfoil cut off at the suggestion of Mr. Knight, the plates were cut out and mounted on another piece of glass vertically, instead of horizontally, in which position the number of the drops produced by any given sound could be seen between at once. I am much indebted to Mr. Holmes for his kindness in adapting the apparatus, which he himself will explain a little later, to the purpose of showing these phonographic records.

Lieutenants Leon Smith, and Greely have provided the means of transferring sounds into form, in various ways, viz.:—By bright lines on the ends of short bars of different thicknesses; by vibrating membranes at the extremity of a "phonautograph," and by the indentations of a revolving mirror. It was natural to conclude that the same vibrations, imparted to a steel point by means of a metal diaphragm, would produce an equally characteristic trace. It was intended to take a number of these depressions in Canada balsam, or some other transparent medium for examination, but this, on the minute eye, the path of the stylus point. There had not been time for this. The same video [illegible] as nearly as possible at the same distance from the mouthpiece, was rolled on the cylinder of the instrument.

The first records, tried to ascertain whether the pronunciation was perfect, were afterwards thrown away, and the best of those were studied were not in any way injured by a second passage of the point of the stylus. By following along the nearly vertical lines, corresponding to which are at the same time in focus, it will be observed that the fine outside of one long followed by two short—or two short followed by one long—the indications being a general resemblance to each other and to reeds. This is a long A, or "Ah." A glance at the diagram will show—still above the same thing, but the overlapped hollows are narrower, and there are no abrupt terminations of the hollows by intersection with the side of the foil which have not been touched by the needle point—or say—on the screen, looked like the magnets of two bells (electric) which have small coils turned towards each other. In the diagram they look like two Indian clubs with the handles together. The same general appearance is observed in the O short, except that, as in a short, the volume is much less, the intensity was less, or—which is the measure of intensity—the path of the needle point was shorter, and it seldom entirely severed the foil; the consequence being a continuous groove of [illegible], but normally irregular, width.

LE MONDE ILLUSTRÉ

JOURNAL HEBDOMADAIRE

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22e Année. N° 1097 — 6 Avril 1878

Directeur, M. PAUL DALLOZ.

Phonographe, Téléphon. Phonostographe, Plume électrique.

Si l'ancienne vieille encore, quel admirable autonome il pourrait construire, grâce aux découvertes de la science moderne! Ce ne serait plus un simple joueur de flûte qu'il offrirait aux regards du public émerveillé, mais un véritable ventriloque, un chanteur automatique. Un Américain, M. Edison, est, en effet, parvenu à faire parler la matière, à lui faire retenir chants et discours.... Dès le début, quand l'inventeur a présenté son phonographe, il a trouvé bien des incrédules, même dans le monde savant; nous pourrions même dire surtout dans le monde savant. La prétendante américaine de la nouvelle découverte était peut-être déjà une raison pour exciter la défiance; — l'Amérique a tant de fois mystifié l'ancien continent! — et l'on était assez porté à croire que toutes les prétendues merveilles des phonographe se réduisaient, en somme, à d'habiles effets de ventriloquie. Il était vraiment permis d'être incrédule, car on avait devant soi un instrument qui venait démontrer une fois de plus que souvent la pratique devance de beaucoup bien souvent la théorie. Voici, d'une façon sommaire, la description de ce curieux appareil :

Le phonographe se compose d'un tympan destiné à transmettre les sons et d'un cylindre dont le rôle est de les inscrire.

Le tympan consiste dans une feuille métallique très-mince tendue à l'extrémité d'une embouchure de bois. Au centre de ce tympan, et perpendiculairement à lui, se trouve fixé un style d'acier très-court supporté par un petit axe en caoutchouc.

Le cylindre récepteur est en cuivre; il porte, gravée à sa surface, une rainure hélicoïdale d'environ un millimètre de largeur et qui va d'une extrémité à l'autre. Il est, de plus, traversé par un axe à vis, le long duquel il se meut et dont le pas est exactement égal au pas de l'hélice. Cet axe est muni d'une manivelle qui permet de le faire tourner. A la surface du cylindre, on applique une feuille d'étain, semblable à celles qui servent à envelopper le chocolat, en ayant soin que cette feuille soit parfaitement lisse et ne présente aucune aspérité.

Lorsqu'on veut se servir du phonographe, on fait tourner le cylindre jusqu'à ce que l'origine de la rainure se trouve en face du style du tympan, de façon que ce style puisse suivre constamment la rainure que creusera la feuille d'étain. On parle alors dans l'embouchure en même temps qu'on tourne la manivelle d'un mouvement régulier. Le style, en vibrant sous l'impulsion du tympan, trace alors à la surface de la feuille d'étain, qu'il enfonce dans la rainure, une série de dentelures représentant non-seulement l'inscription des sons, mais aussi l'articulation de la parole. Voilà donc le discours (ou le chant) inscrit avec son intensité et ses modulations. Pour le faire rendre par l'instrument, on procède de la manière suivante :

On ramène le cylindre à son point de départ exact, de façon que la pointe du style se trouve en contact avec l'origine des dentelures, et on commence à tourner après avoir placé dans l'embouchure un cornet de carton destiné à amplifier les sons et à jouer le rôle de porte-voix. Le style repasse alors par toutes les dentelures qu'il a tracées la première fois et transmet à son tour au tympan les vibrations que celui-ci lui a communiquées d'abord, de sorte que la phrase inscrite se trouve rendue automatiquement.

La semaine dernière, nous avons assisté à une séance de la Société d'encouragement, au cours de laquelle M. le comte du Moncel, membre de l'Institut, a fait sur le phonographe une conférence fort intéressante. Il a rappelé que si le phonographe est d'invention américaine, l'idée première de cet appareil appartient à un Français, M. Léon Scott, qui, en 1857, prenait un brevet d'un tour en tournant qu'il appelait phonautographe. Ce phonautographe se compose d'une caisse de bois en forme de pyramide tronquée, ouverte à sa base et revêtue à l'intérieur d'une épaisse couche de plâtre destinée à empêcher les vibrations de la paroi de la caisse. Le sommet de la pyramide est fermé par un tympan en forme de tambour et dont les membranes sont composées de trois tuniques; deux en caoutchouc et une tunique centrale en baudruche. Les deux membranes sont tendues par un petit appareil en ivoire destiné à jouer le même rôle que la chaîne des osselets dans l'oreille humaine (voir fig. 2 bis) et qui augmente de beaucoup la sensibilité du tympan. Lorsqu'on chante dans le conduit, les vibrations de la voix sont transmises au style qui les écrit en bleue sur un cylindre tournant recouvert d'une feuille de papier sur laquelle on a déposé un petit nuage de noir de fumée

L'appareil a donc enregistré donc déjà les vibrations; le phonographe a fait un pas de plus, puisqu'il inscrit l'articulation des sons; mais un pas dont que celui-ci est le fils de celui-là, ou du moins qu'il existe entre les deux appareils des liens de parenté très-proches.

Reste donc à la séance de la Société d'encouragement. A nous avons vu fonctionner le phonographe Edison. Les résultats de l'expérience ont été très-satisfaisants. Cependant, il y a certains mots que l'instrument rendra plus facilement que d'autres, ceux où il y a des r, par exemple; aussi l'expérimentateur choisit-il de préférence des phrases ainsi construites de mots.

Le phonographe a très-bien redit la phrase suivante : « Le phonographe a un très-bonne mémoire; il ne rappelle tout et il le répète. Hourrah! hourrah! »

Tandis qu'il a articulé d'une façon bien moins distincte les deux phrases anglaises suivantes :

« *How do you do, Sir? How do you like the phonograph?* »

Les quelques imperfections de l'instrument sont disparaître, pourtant, et avant peu, M. Edison doit exhiber un phonographe parfait. Étant donné la véritable génie d'invention de M. Edison, nous ne doutons pas qu'il parvienne aisément à remédier aux légers défauts de son appareil.

Puisque nous nous occupons aujourd'hui d'instruments d'acoustique, parlons aussi du téléphone, que tout le monde connaît déjà de réputation, mais que tout le monde ne comprend pas.

Le téléphone repose sur la propriété que possède un barreau aimanté de produire un courant induit lorsqu'un approche d'un de ses pôles un morceau de fer ou d'acier. L'appareil se compose d'une embouchure E, d'un tympan T, au-dessous duquel se trouve placé, à une petite distance et perpendiculairement à lui, un barreau aimanté A, muni à sa partie supérieure d'une bobine B. Autour de cette bobine est enroulé un fil métallique extrêmement fin entouré d'une enveloppe isolatrice de soie. Les deux extrémités de ce fil sont rattachées à deux conducteurs destinés à mettre en relation deux téléphones. Lorsqu'on parle dans l'embouchure E, le tympan en vibrant se rapproche plus ou moins du barreau aimanté dans lequel il détermine un courant induit plus ou moins énergique, selon que les vibrations sont plus ou moins intenses. Or, comme tout le téléphone récepteur où se produit un mouvement moléculaire spécial appelé mouvement magnétique. Quel, maintenant inappréciable, est suffisant néanmoins pour faire vibrer la couche d'air qui sépare l'aimant du tympan, et, par suite, le tympan. En appliquant l'oreille contre l'embouchure du récepteur, on entend donc distinctement les paroles prononcées à l'autre extrémité du fil.

A raison de la faiblesse du courant induit, la distance à laquelle le téléphone peut transmettre la voix est relativement restreinte; mais on a cependant obtenu des sons perceptibles à une distance de 100 kilomètres, ce qui constitue déjà un joli résultat.

A l'heure qu'il est, un inventeur français croit avoir trouvé le moyen d'écrire les dépêches téléphoniques, et bientôt probablement le téléphone recevra un complément qui lui est nécessaire.

Après avoir décrit le phonographe de M. Edison, M. le comte du Moncel a fait connaître à la Société d'encouragement une autre découverte du fécond inventeur américain, la plume électrique.

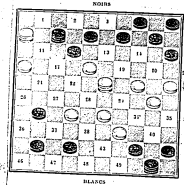
La plume électrique, dont nous donnons le dessin, consiste en un petit appareil électro-magnétique renfermé dans une cage métallique et fixé au sommet d'un tube en plume terminée en pointe à son extrémité inférieure. L'électro-aimant est fixe et, devant ses pôles, tourne une lame de fer doux formant le diamètre d'un cercle d'axe qui joue le rôle de vilebrequin et peut exécuter environ 3,000 révolutions par minute. L'électro-aimant est relié par deux fils conducteurs à un petit élément Bunsen, qui produit le courant dans l'appareil.

Au volant est adapté un excentrique qui imprime un mouvement de va-et-vient à une aiguille renfermée dans le corps de la plume, qu'elle traverse dans toute sa longueur. L'aiguille se trouve donc, par un mouvement très-rapide, successivement ramenée en dedans et projetée en dehors; elle perce ainsi dans la feuille de papier sur laquelle on la promène une série de trous extrêmement fins qui constituent un véritable pointé. Il faut avoir soin de placer le papier sur une surface flexible, un morceau de feutre ou de papier buvard, par exemple, afin que la pointe pénètre le papier et ne s'émousse pas.

Lorsque la feuille est écrite, elle constitue alors un véritable cliché. On la place donc un châssis qui la maintient sur la planche d'une presse destinée à tirer les épreuves. On met alors en dessous une feuille de papier blanc, on rabat le châssis et l'on passe sur le cliché un rouleau de teinte chargé d'encre d'imprimerie à laquelle on ajoute un peu d'huile pour la rendre plus fluide et lui permettre de pénétrer plus aisément dans les trous du cliché. L'écriture ou le dessin

Toujours ces mêmes femmes ! — Ah ! mon ami, si je savais...
Si de la cotte sans..... on avait vu le tort, —
Plus que la coiffeuse, fournissant adultère,
Je transporte les nom par un tout petit côté. —
Et moi, qui sais pour, ne me voit cependant
Par mon faire figurer dans le mot précédent. —
Ah ! si j'avais seulement pu me faire tailler,
Au soleil trop ardent j'aurais pu me voir. —
Enfin, mot, le dernier, et qui n'a pas de rime
Ici je suis dit tout ; consolez-moi bien.

235 — DAMES, par M. Luymd
sans



BLANCS

Les Blancs jouent et s'assurent la victoire en 5 coups.

236 — TROUVER UN PROVERBE BIEN CONNU
DES LECTEURS

Je vendis, en tous sens, de pressure Paris;
Ensuite, mort enfin, je ressuis au logis,
Lorsque l'on me frappe énergiquement sur l'epaule;
Et que vis-je avoidait ? — Un sexe charmant drôle,
Et non d'autrefois, absent depuis dix ans, —
Que sait à parler des choses et des gens
Et qui, toujours nouveau, — Mais non, l'erreur vite,
Je reprends les mots mal à sa bonne heure ancien;
Je parvenais l'ennemi de la vie la plus rapide. —
Il s'appuyait tantôt de mon bras droit ou gauche;
• Pourquoi est-ce aimait-on mon ombre ? —
• Ah bah, mon cher, lui s'y fait : notre vie dûme :
XXXXXX XXXXXX XX XXXXXX XXXXXXXXX
• Et prêtez ses propos et gaîté de manière ! »

P.-L.-B. SABEL.

LA RENAISSANCE DU *PETIT-SAINT-THOMAS*

Tout se fait à la vapeur à notre époque de progrès : le tour du monde en quatre-vingts jours, la mise en vente du *Petit-Saint-Thomas* en deux jours. Voilà qui ne ressemble guère à ces liquidations interminables qui semblent passer à l'état chronique et auxquelles, du reste, nos Parisiennes ne mordent plus.

C'était un véritable enlèvement que cette mise en vente. L'effet moral a été immense ; le résultat des plus rapides. Il n'est telle qu'une confiance séculaire pour entraîner le public. On avait fait dans cette salle devise : « Loyauté fait ma force », que le *Petit-Saint-Thomas* n'a cessé d'appliquer religieusement.

Toutes les marchandises de l'ancienne société, dont la jeune direction avait hâte de se défaire, n'ont fait que paraître et disparaître, comme dans une féerie. Ce mort imposant n'est chiffré par des sommes énormes ; mais on ne compte plus les millions par ce temps de gigantesques roulements de fonds.

Aujourd'hui, tout est fini. Le *Petit-Saint-Thomas* a fait maison neuve. Les quelques marchandises qui restent encore porteront une étiquette orange pour les faire reconnaître. A lundi la réouverture des magasins transformés. C'est aller vite en besogne.

La nouvelle gestion ne pouvait être inaugurée d'une façon plus brillante qu'avec sa magnifique exposition de printemps. Quelle ravissante métamorphose ! Tout semble imprégné de fraîcheur et de jeunesse, dans ces vastes galeries inondées de lumière !

Ces marchandises inédites ont toutes passé par l'examen scrupuleux d'un jury d'admission. Aucun article qui ne soit de premier choix. Les soieries, les lainages, la nouveauté, les lingeries, les batistes sont la propriété exclusive de la maison. Les robes et confections, toutes de grand style, rivalisent d'élégance avec celles des premiers couturiers en renom. Impossible d'imaginer des costumes enfants plus mignons et plus gracieux. Tout cela est riche, mais coquet, distingué.

Les ateliers fonctionnent avec une activité fébrile pour répondre instantanément à tous les caprices de la mode.

Le *Petit Saint-Thomas* met à votre disposition un magnifique album sur papier de luxe contenant 170 modèles nouveaux, dont les dessins originaux sont dus au crayon de nos premiers artistes parisiens.

neuf dixièmes des maladies qui nous affligent se
vées d'anémie, car toutes les fièvres sont anémiques au fond. Les
sont généralement anémiques ou lymphatiques
femmes sont toutes plus ou moins chlorotiques
vieillards, dans le sang est épuisé ou engourdi
aussi tributaires de l'anémie. Il y a encore la
de la goutte chronique, de la grossesse, etc.
Les signes extérieurs de l'anémie sont connus
la pâleur de la face, la décoloration des muqueuses
pavie des forces, l'abattement, la tristesse, l'
sensibilité au froid, une susceptibilité exagérée
nutrition de l'appétit, etc.
Il est grand temps alors d'employer le fer
(fer liquide en gouttes concentrées), car c'est
qui régénère les globules rouges du sang avec
pidité qui n'a jamais été obtenue jusqu'alors
ployant les autres ferrugineux.
On trouve ce précieux liquide dans toutes les
macies et au dépôt général à Paris, 13, rue Le
Envoi gratis d'une curieuse brochure sur l'ané
son traitement.

Nous recommandons particulièrement les
du *Grand-Hôtel*, 4 francs, vin, café et liqueurs
pris ; *Diner de la table d'hôte*, 6 francs, vin
Cette table d'hôte est la mieux servie de Paris.
cuisine qui n'habituent pas le *Grand-Hôtel* sont
ces deux tables.

VIANDE, FER ET QUINA
L'aliment qui aux toniques les plus réparateurs
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FERRUGINEUX AROU
AU QUINA, et aux principes salubres de la VIANDE
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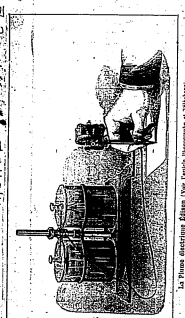
CHATEAU-CHAMPAGNE
MAISON FONDÉE EN 1864.

ez, trouvera ainsi intéressamment exposées et l'on pourra en tirer jusqu'à 40 ou 45,000 exemplaires.

La presse d'imprimerie est, on le sait, une application du vieux principe de la vis. Mais, dans la presse typographique ordinaire, la fonction de la vis est très-limitée. Elle ne sert qu'à produire une pression énergique, mais qui ne peut être que momentanée. Il faut, en effet, que la vis, après avoir produit la pression, puisse être ramenée en arrière, pour que la feuille imprimée puisse être retirée et remplacée par une autre feuille blanche à imprimer.

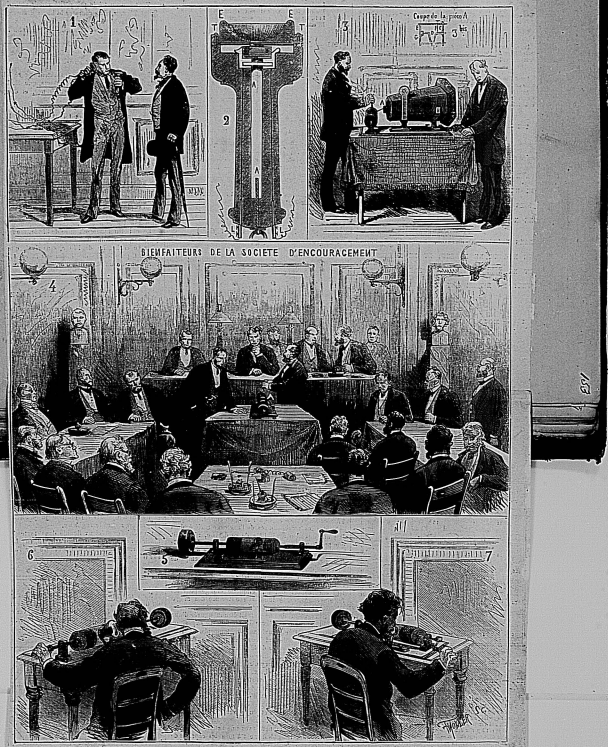
Dans la presse autographique, au contraire, la vis est employée d'une manière continue. Elle ne sert pas à produire la pression, mais à la transmettre, de sorte que la pression est produite par un levier, qui agit sur l'autre de 1,000 francs, il pourrait faire un profit net de plus de 100,000 francs. Grâce à l'emploi de la plume autographique, un dessin, même très-compliqué, ou une écriture semblable à la typographie, peuvent être reproduits en autant d'exemplaires que l'on veut, sans avoir besoin de les copier à la plume. Il suffit, pour cela, de tirer sur papier mince, au-dessus du chiffre écrit à l'encre, la quantité d'épreuves désirée.

Cette application de la plume Edison ne sera pas du moins utile. — A.



La Plume électrique Edison (Vue d'ensemble et détails).

LE MONDE ILLUSTRÉ



1. Représente du Téléphone. — 2. Le Téléphone, inventé en 1877. — 3. Le Phonographe Léon Scott, inventé en 1857. — 4. Le Phonographe à la Société d'Encouragement. 5. Le Phonographe, inventé en 1878. — 6. Emission des sons par le Phonographe. — 7. Inscription des sons dans le Phonographe.

LES MERVEILLES DE L'ACOUSTIQUE. — Phonautographe, Téléphone et Phonographe. — (Dessins de M. Férat, d'après les croquis de M. D.)

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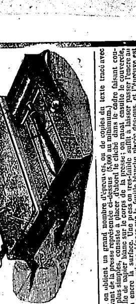

ÉLECTROGRAPHIE
OU LA
PLUME ÉLECTRIQUE
D'ÉDISON

Inventeur du PHONOGRAPHE, du TÉLÉPHONE, QUADRUPLEX, etc.

GEO. L. BEETLE
Intendant général pour l'Europe
9, RUE DE LA BOURSE, PARIS

Prix de l'appareil avec la presse et la pile
200 à 250 fr.
SUIVANT GRANDEUR

La plume électrique d'Edison (l'inventeur du Phonographe, du Téléphone, Quadruplex etc.), est un appareil au moyen duquel on trace sur le papier ordinaire un trait discontinu formé d'un très-grand nombre de petits trous percés dans le papier, à l'aide d'une pointe très-fine sortant et rentrant alternativement dans le tube tenu à la main, et ayant la forme d'un porte-crayon. — Cette pointe est animée d'un mouvement de va-et-vient très-rapide d'environ 180 battements par seconde, transmis par un petit électro-moteur placé en haut du porte-plume, et qui fonctionne aussitôt la mise en action de la pile. — Le papier, ainsi perforé, doit être considéré comme un poncis, grâce auquel on obtient un grand nombre d'épreuves, ou de copies du texte tracé avec la pointe, en se servant de la presse représentée ci-dessus (5,000 au minimum.)

L'opération, des plus simples, consiste à placer d'abord le cliché dans le cadre faisant couvercle, puis une feuille de papier blanc sur le corps de la presse; on rabat ensuite le couvercle, avec un rouleau on encre la surface. Une press on très-faible suffit à laisser passer l'encre au travers de ces petits trous; elle se dépose sur la feuille blanche placée dessous, et l'épreuve est obtenue.

(EXPÉRIENCES TOUS LES JOURS. — 9, rue de la Bourse, Paris.)

Prix du Numéro : 25 centimes — MERCREDI 22 MAI 1878

ABONNEMENTS
DÉPARTEMENTS

ant :
— Bah! laissons-nous séduire, il y a au bout le mariage, ou tout au moins une grosse indemnité.
Croit-on en bonne conscience que la moralité publique gagnerait à encourager de tels calculs?
S'il se trouve dans l'état actuel trois innocentes sur dix qui ont la faiblesse de céder, il s'en trouverait huit demain. De telle sorte que votre projet soi-disant vertueux deviendrait pour les demoiselles un pur et simple encouragement à la bamboche.

S'il allait, lui aussi, se mettre à « faire du boucan » autour de vos machinettes aquatiques et miraculeuses, vous en seriez les mauvais marchands.
C'est qu'il a la patte lourde et l'ongle dur quand on l'agace. Aussi, croyez-nous, ne lui tirez pas les moustaches imprudemment. Pour rien au monde nous ne voudrions vous voir face à face avec lui.
Ses rugissements feraient un accompagnement déplorable à vos cantiques sur le Sacré-Cœur. — C'est qu'on n'entendrait plus que lui!

Pas le moindre espace dans danger un pétard.
Comment donc divertir le
Les pièces d'artifices pour des pièces de vers que MM. raient aux populations.
Mais ces messieurs bouder
M. Laroche-Joubert, depuis le public avec ses projets de
Il veut que tout Français
ans depuis le 31 décembre [illegible]

offre aujourd'hui de gran-
[illegible] de bons de pain et de qui craignent l'augmenta- [illegible] se faire inscrire au bureau

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The North American.

The Oldest Daily Newspaper in America.

PHILADELPHIA:
SATURDAY, JUNE 8, 1878.

THE MICROPHONE.

The Experiments Yesterday of an Assayer at the Mint in this City.

The marvellous, though as yet somewhat vague, accounts which have reached us from England of Professor Hughes' discovery of a new adaptation of the principle involved in Edison's "carbon transmitter" has given a fresh impetus to the experiments of the small army of amateur investigators who follow closely in the wake of the individual pioneers, occasionally opening up new and unexplored paths in the mysterious realms of science. By means of this principle vibrations of the air which are quite inaudible to the human ear may be made to increase the electrical conductivity of a piece of delicately adjusted carbon, so that it will transmit over a wire synchronous electrical pulses, causing a metallic diaphragm in the "receiver" at the distant end to emit a sound so loud as to become almost painful. Yesterday a few of the officers of the United States Mint in this city were quietly invited to walk on tiptoe into the Assayer's private office to witness the trial of a "Microphone," which had been constructed by one of the chemists of the assay laboratory, Mr. Alex. E. Outerbridge. A number of interesting experiments were tried which fully corroborated the astounding statements of Professor Hughes. It was found that when a fine camel's-hair brush was gently drawn across a piece of smooth pine board the noise produced in the receiver resembled that of violently rasping the board with a coarse file.

The Faintest Whisper

was distinctly conveyed over the wire. The tinkle of the new silver dollars, falling like hot cakes from the coining press, was heard at a distance of several hundred feet through the closed doors. The footfalls of a captive house-fly are quite audible in this apparatus. The astonishment of the spectators culminated in silent wonder when the impact of a single hair on the sounding-board of the microphone produced a decided concussion in the receiver. The gentlemen were all convinced that the old saying that "walls have ears" may now be accepted as a literal fact. It may be a surprise to any one but an electrician to be informed that these marvellous effects are transmitted by a wire nearly as fine as a human hair—one-hundredth of an inch in diameter, by actual measurement—and this fine line would doubtless suffice for a great distance. The assayer takes this opportunity of suggesting to Mr. Edison, and the public at large, that the word "phonograph" was long ago appropriated to another science, as the dictionaries prove. "Graphone" would express the right idea, being taken from the two Greek words conveying the same sense; it also eliminates a "ph," one being enough, and it neatly harmonizes with "telephone," "microphone," etc.

THE LAST ONE.

May 25, 1878.] THE SPECTATOR.

THE MICROPHONE.

THE instrument which Professor Hughes has discovered (and which he proposes to call the "Microphone," as the one which enables you to send sound to a great distance is called the "Telephone,") will certainly prove an astonishing step in advance, not only for the science of Sound, but for all the sciences in which sounds are the symptoms of changes hitherto undiscoverable by man. It is, however, hardly right to contrast this instrument with the telephone, as the microscope is contrasted with the telescope. For the microphone apparently will be just as applicable to the hearing of distant sounds as to the hearing of sounds that are near. The telephone brings the sound from a distance, and the microphone magnifies the sound when it is thus brought near. The microphone, in fact, will be just as applicable to the sounds transmitted from Dublin or New York,—if the latter can be transmitted so far,—as to the sounds in a vibrating-plate which is within a few inches of the listener's ear. The telephone brings from a distance without magnifying,—indeed, not without lessening greatly the sound it transmits,—and then the microphone magnifies it, so as to make it even far more audible than it was to the ear of a close listener. The invention depends on so breaking, by the interposition of charcoal permeated by fine atoms of mercury, the currents transmitted by the telephone-wire that the sound is vastly increased by the interruption,—just as heat is known to be vastly increased by a similar interruption of a current, even to the turning of metallic wire to a red or white heat. Thus the microphone will make a minute sound audible, whether it be close or far off. It is said that the march of a fly over the vibrating-plate is rendered as audible by this invention as the tramp of a horse, and that the mere breathing of the fly is heard almost like the trumpeting of an elephant. And this, as we understand, is just as true of a sound transmitted from a distance, as of a sound close at hand. Supposing the fly to walk over the vibrating-plate at one end of the telephone, the microphone will magnify whatever corresponding sound may reach the other end as much as it will magnify the sound at the end at which it occurs. We do not understand that it would be in any way impossible, for instance, to get a physician living in London,—with the help of the microphone and the telephone,—to report on the sounds in the lungs and heart of a patient in Birmingham. The stethescope itself should be superseded by the microphone. But not only should the stethescope be superseded, but the range of the new instrument should be enormously extended by the telephone, the two playing into each other's hands, so that a whisper in Dublin might be heard as a shout in Holyhead. It is this extraordinary power of combining the telephone and microphone together, which opens out such strange prospects as the result of this discovery. Indeed, associated as both may be with the phonograph,—the instrument which records and bottles, as it were, speech, till some convenient future occasion for unbottling it,—it is quite conceivable that the whisper of a dying statesman like Cavour's,—"I will have no state of siege, any one can govern with a state of siege,"—might be repeated after the expiration of a hundred years, in a hundred cities, each of them hundreds of miles away from the place where it was first uttered, in a voice audible to a great assembly, instead of only to the ear of an intently listening friend.

But the most curious results which we can at present anticipate from this marvellous microphone are results due not so much to the transmission of these sounds, either in space or time, as to the discovery through its means of new sounds now inaudible. It has often been observed that other creatures' ears must perceive notes which we do not at present perceive at all; must perceive the vibrations due to waves too short as well as to waves too long to affect the human ear. So far as our inability to see and hear depends on the absolute incapacity of the retina or the ear to be affected by waves of a given length, of course no microphone, any more than any microscope, will render them perceptible. The microscope does not

show us new colours, and the microphone will add show us new sounds. But just as the microscope renders not only visible, but large and conspicuous, what we could not previously discern simply because of its minuteness, so the microphone will render distinct and even loud what we could not previously discern, simply from the want of volume in the sound. The first result should be to provide those who are only deaf,—whose auditory nerve is not destroyed,—with a nearly perfect ear-trumpet,—not, of course, one which will enable them to gather in the general and confused sounds of a room with all the distinctness of good hearing, for the very essence of this instrument is that it can only magnify the isolated vibrations received on the vibrating-plate at the other end of the conducting-wire,—but still complete for the purposes of any isolated sound; that is, sufficient not only to make it audible, but to make it perfectly clear and distinct. But far more curious results should follow. With the help of the microphone, it should be possible to hear the sap rise in the tree; the hum of rushing against small obstacles to its rise, as a brook rushes against the stones in its path; to hear the bee suck its honey from the flower; to hear the rush of the blood through the smallest of the blood-vessels, and the increase of that rush due to the slightest inflammatory action. In fact, the new instrument should add a hundred times as much to the means of investigating the facts of both vegetable and animal physiology, as the stethoscope added to the knowledge of the structure of the heart and lungs; for while the stethoscope only collected the sound, the microphone will magnify it.

That, however, which strikes the imagination most in this wonderful discovery is not so much what it is sure to do, as the wonderful world of possibility it opens. It is almost certain that a ray of light strikes the surface on which it impinges with a definite force, and Mr. Crookes certainly supposed that he had found the means of approximating to a calculation of that force. But if this be so, there must be a definite sound caused by light touching a surface, and the new instrument may enable us not merely to see, but to *hear* light. It is quite conceivable that by the use of the microphone the chemist who is trying to analyse the spectrum of a star may be enabled to hear the first ray of the star strike upon his spectroscope, and to listen to the gentle rain of rays which follows while the spectroscope is exposed to that star, and then to exchange that gentle sound for that of the torrent which would follow when he exposed his instrument to the moon instead of the star. We may find that the rippling of the light from Sirius has a sound quite different in character from the rippling of the light from Arcturus or the Polar Star; and all of these music of starry light, if they can be heard at all, must make a sound as inferior to the cataract which rushes from the Sun, as the dash of a brook ... by temporary suffering still more savagely on the masters, treat them as enemies, and consider that the application of terror to them is, if not justifiable, at least pardonable. They are, moreover, at least as determined as of old. They know very well they cannot win. They see on every side men half-fed, and women asking charity, and children receiving it; they read, at all events, of incidents which seemed to Londoners as if taken from the Book of Chronicles; how the mob "came to Ell Hey worth's mill, but they burned not that mill, forsamuch as Ell had fed the people that day;" and they know their own leaders have no hope, yet believing their solution of the question to be the right one, they will not yield, but suffer everything, or break into sullen fury and destructiveness. Their children, —the big lads of eighteen—are not only not softened by education, but are foremost in the attacks on property and persons; while their women, hardly knowing how to keep their shawls from the pawnbrokers, wrap them round them for the last time to vote down peace. There is character in all this, and strong character, but it is not the temperate strength we all hoped to see produced by modern life. It looks as if education had only deepened the perception of suffering, without developing the readiness to avoid it by compromise, and had increased the perception of harshness, without increasing the perception of the claims of others. The men see less than ever that the master is a buyer of labour and the workman a seller, and that each is free to fix his own terms, subject to the right of his customer or dealer to reject them; while both sides are more ready, instead of less ready, to express irritation by violence. The readiness to resort to the rifle and the torch is most alarming, but not more alarming than the almost total absence, —we may say, after this ballot, the total absence—of any section of operatives who are upon the masters' side. Progress in the North, we fear, is not so rapid as had been hoped, at least if progress is to be defined as we should define it,—as an advance of large communities in sweetness, and light, and righteousness. We do not expect any more violence, because we think the workmen apprehend the terrible new power which the use of weapons of precision has placed in the hands of Governments, as against popular disorder—no mob, however brave or numerous, can stand for ten minutes against the breechloader—but we do apprehend that the division between masters and men, which seemed to be closing, has been reopened, and will be kept open for a generation. There is no Utopia visible in the result of that ballot.

The Sun.

TUESDAY, JUNE 11, 1878.

Mr. Disraeli should make haste to abandon the terrific name he has bestowed upon the latest invention. He calls it a telecosmopolene, and that won't do. A telescope is an instrument for seeing at a distance, and a telecosmopolene would be an instrument for seeing a vote at a distance. But as a vote cannot be seen, the name is inexpressive and absurd. By the way, these combinations of Greek words are perilous, unless the combiner possesses a thorough understanding of the Greek language.

Latest—News has reached us that the real name of the invention that was lately known as the telecosmopolene is the microphone.

THE DAILY EVENING TELEGRAPH—PHILADELPHIA, SATURDAY, JUNE 8, 1878.

THE MICROPHONE.

A WONDERFUL DISCOVERY INDEED.

An Instrument Which Does for the Sense of Hearing What the Microscope Does for the Sense of Sight—Experiments Successfully Made at the Mint Yesterday.

The discovery by Professor D. E. Hughes of Kentucky, better known in England than in America, that "sound can be recorded to the ear" excites considerable interest in the scientific world, and gives to humanity an instrument which does for the sense of hearing what the microscope does for the sense of sight. The first public test of the new discovery was made yesterday afternoon at the Mint, in the Assayer's private office in the Mint. The microphone was constructed of the following materials: A piece of hard wood, a piece of soft wood, a piece of lead, and a piece of the silicon of the Mint. Having delicately collected on the ends, a number of mercurial experiments were made, which, if successful, will, it is said, enable Professor Hughes to transmit the voice over a fine copper hair from any point there across a piece of smooth iron board, the notes produced in the transmission being clear and distinctly ringing the keys with each word that was spoken.

The faintest whisper was distinctly conveyed over the wire.

The tick of the new clever device, calling from the adjoining room, was heard by means of the instrument, through the closed doors, at a distance of several feet.

The microphone is of a duplex fly are quite audible in this apparatus.

The accompaniment of the instrument consists of a battery of two cells, and the weight of a single hair on the conducting wire produces a decided commotion on the receiver.

It is not a surprise to see one but an almost one that these wonderful effects are transmitted by a wire nearly as fine as a human hair, conducting the electricity from one room to another. But the fine wood machine makes the whole a most delicate.

Professor Stuches' Description of the Microphone.

Professor Hughes has published a paper recently on "The Action of Sonorous and Vibratory Varying Contacts of Feeble Electric Currents," which was communicated to the Royal Society of London by Professor Stuches, F.R.S., and read on the 24th of last January. The microphone is fully and clearly described in this paper, which is very interesting and fascinating. Speaking of the discovery, Professor Hughes of his discovery, Professor Hughes of his discovery, says: "The microphone, in connection with the telephone and phonograph, has become world-renowned, in a brief period in mental remembrance, and has been the means of bringing to the notice of the world a number of scientific facts which had made it known inventions and discoveries.

The microphone is the result of a series Professor Hughes has published recently on a feeble electric current, one made with a piece of hard wood, a piece of soft wood, a piece of lead, and a piece of silicon of the Mint. The instrument is so sensitive, he says, that the slightest whisper can be distinctly heard at a distance of several feet

Type A, Slide, as seen on N. O. R. and T. line, is the standard type for this machine. It is of exactly the same character as is employed in the Remington No. 2 and No. 7. The writing was simply done by the same method as was employed to obtain the specimen of writing on the Remington No. 2 and subsequent instruments. If it was a simple slanting or leaning of R, D, D, E, and P, it could produce exactly the same result. The writing is not quite so rapid, but as fast as I can write on the machine, and by the same we should have no effort; for if the effort is to be a question of the movement of R, D, D, E, P, it would seem to be impossible to write with the Remington machine as instantly the slant, shape, and character of A, upon S, side, could ever be, for instance, and no form of movement of the Remington can be as quick as to imitate the slanting character seen in the type there is slanting contact to a considerable degree, which could not be equaled by the Remington, and which could not equalize the influence of a slanting character.

Professor Hughes, in conclusion, says that he does not intend to take out a patent for his instrument, but to leave it to the free hands of discovery that invention. He believes that before long inventors will improve on the form and materials employed.

Possibilities of the Microphone.

Professor Hughes, in commenting upon the telephone, says: "Whether, in connection with the telephone, it can be applied to convey sounds to a distance without wires, I cannot say; but that it can be applied to intensify it, so as to make it even far more sensitive than it is, I have no doubt. I have, in fact, already obtained indications pointing in the same direction of distinct perception by conduction of movements which I could not hear by the ordinary means of hearing. I have not yet been able to carry my researches in this direction—but at least is known to be vastly increased by a similar application of a contact, such as the tapping of metallic wire on a bed or white paper, which I have described. I have, in fact, heard the tick of a watch at the distance of 40 feet. It is said that the march of a fly over the vibrating plate is audible. I have not myself been able to detect the sound, and I think the breathing of the fly is a sound almost like the unwinding of an elephant. *Just think what a sound-magnifying power would be!* I have obtained even a distance as the sound does at ordinary speech.

"It is not understood that it would be in any way impossible, for instance, to get a telephone which would convey articulate speech to a distance of 100 miles, or even more, from one end of the line and the number of a patient in Birmingham. The only difficulty is that the sound would be enormously attenuated, and each word undistinguishable when reproduced, but the range of the new instrument should be enormously extended, and the sound which the ear, or rather the brain, can hear and recognize as the voice of a friend. In London might be heard as a whisper. In the transmitting power of conducting the telephone and interrupting the current, I have found that the human voice can be heard at the distance of 100 miles, and indeed so much may be with the phonograph—the instrument which reproduces sounds. I have found that with the most convenient form of receiver, the whispering can be heard at the distance of 100 miles, and it is possible only to the ear of an electrician trained to hear."

"But the most curious results which we can at present contemplate are those which would accrue if we could find out how to fix the impressions of these sounds, either in specs of lime, as in the phonograph, or in some way in which we could preserve them, so as to be able to call up at our leisure, and the atmosphere will not show us new sounds, but, as it is, we have only to deal with the daily voices, barnyard and menagerie, and the sounds of the streets. Suppose, then, we could preserve the impressions of the voices of *dead and gone friends*, we could not only hear them speak, but we could make them sing. Fancy what a concert we should be able to provide those who are only deaf,—those auditory nerves which are paralyzed, but not destroyed, would respond to those natural sounds which we believe. With the help of the microphone, it should be possible to make the deaf hear, and the blind to read in reading Agassiz should constantly say:

"As to a book reading before the microphone, at least the two ways in which it could be done are obvious. One is the trend through the smallest imaginable wire of the impressions of the voice, as delivered over the phonograph cylinder, and the other is the transmission of the tests of both vowels and mutual physiology as the microscope has revealed it. Whether the microphone will be applied to help us write like stenographers only enhanced the result, the microphone will magnify it.

"But, however, which I have only imagination must fill out with a few words, I will say so much more in this article, as the wonderful world of possibilities is opened. It is not certain that a mere slight sound at the surface on which it impinges may not be magnified to the ear, and that the microphone may not be but little behind the means of communicating to a generation of their sons, that if this be so, there will be no more deafness, and that the blind will read

The Press.

MONDAY, JUNE 5, 1878.

PHONOGRAPHIC PHONETICS.

The phonograph has promised many a revolution in social and commercial affairs. When it is perfected and inwrought into our customs it may make many a change in our consciousness. Our writing it promises, which drivers of the quill will hail with satisfaction; and, perhaps, even the boys and girls at primary schools, and it may be even the whole race of philologists and phonetic savans. It is well known that alphabetic characters, both script and printed, are purely arbitrary. There are certain phonetic characters based on the Roman alphabet, and only less arbitrary in that they aim to represent all possible human articulations, as anatomy shall declare them, with precision and absence of confusion. Now, if the phonograph can produce all articulate sounds in imitations of tinfoil or any kind of medium, it can also transmit them to a recording instrument. It is only necessary to suggest the point. If a needle connected with the receiving disc records in depressions and quavers the sound vibrations of a speaker, it is only necessary to reverse the process in order to have them restored to sound. It can also be reproduced in mechanical signs on paper. Here we come to a true phonic alphabet. Like a the spectrum analysis, it may be only a system of lines within lines. That is of no consequence. It will be as easy to write on relief paper, with vertical and horizontal lines speeding over parallel lines, as by any other system. These varied lines, like those of the spectrum, will become the basis of a scientific alphabet exactly representing the physiological capabilities of the human voice. Here the phonetic problem is solved, and that for all languages on the face of the earth.

To this solution men of the midnight pen will look with immense interest. It is possible to speak a hundred and twenty words in a minute by a clear, rapid speaker. A quick pen will only transcribe about thirty words in the same time. If one could only speak his thoughts into a phonograph, and then by turning a crank grind them out into some kind of intelligible script, this would save three-fourths of the time of ordinary writing, and save a great deal of fatigue. All prof. minual men would be delivered from a tremendous bondage to the flesh if they could save their pens and their hands. To this improvement we look with especial interest, as both hastening the solution of many a philological problem and as lightening the work of the scribe editorial, legal or clerical. Hasten, Edison, in the perfection of thy little electrical magician!

The Sun.

MONDAY, JUNE 10, 1878.

The recent attempt of Prof. Hounzo, in London, to establish his claim as the discoverer of the microphone, has drawn from Mr. Edison the exposure of the Professor's pretensions which appeared in yesterday's Sun. Mr. Edison says that the so-called wonderful microphone, that transmits a sound as faint as the step of a fly, is nothing but a very defiant telephone; that the essential principle of the microphone was patented by him over six months ago in England, as that Prof. Hounzo might have discovered the microphone in the Patent Office! Mr. Edison also shows that Prof. Pierce, to whom Prof. Hounzo expressed his acknowledgments for aid, has long been in possession of a telephone, and in June or July last was shown all the wonders of the Menlo Park laboratory.

The Daily Graphic

TUESDAY, JUNE 11, 1878.

Edison has not invented anything since breakfast. The doctor has been called in.—*Boston Post.*

We shall have the great question regarding the inventor settled in time for dinner; for here we are Mr. Edison!—*Buffalo Express.*

America is still Ahead.

An English scientist has invented a contrivance to detonate that the sound made by a fly's foot in walking over the sounding board can be heard at the other end of the telephone, miles away. The English scientist, who is merely an imitator, will have to take a back seat, however. America's inventor, Mr. Edison, has perfected a machine by which you can hear a fly walk in London, by cable, the other side of the Atlantic, and, by utilizing the thousands of cables over, it will be a simple matter to have a fly walk from England to Australia.—*American Jewell, Paul's Nonsense Potter's Committee* could beat it and give you six.—*Philadelphia Bulletin.*

Edison is going to build little ph onographs for nursery toys.—*Buffalo Express.* This is an error. The speaking toys which will be for sale next fall will not be phonographs, or contain phonographic cylinders, but they will merely contain a little machine on which sound-waves will be transferred by metal on which sound-waves will be transferred by metal on which sound-waves will be transferred by metal

THE DAILY EVENING TELEGRAPH—PHILADELPHIA, SATURDAY, JUNE 8, 1878.

...ment removed at will, and is fitted to a circular, hollowed rubber frame work, which encircles a disk of tinfoil next to the central point in the diaphragm to which is fastened the needle that is the visible agent of recording speech. This needle is suspended from a light strip of steel, and is sensitive to the lightest touch, and the connections between the disk of tinfoil and this needle are made with wax. The tinfoil and needle do not touch the rubber or open space between the rubber mouth-piece and the tinfoil disk are also pieces of small pieces of rubber, which strengthen the vibrations of the needle and so assist in reproducing speech. Tinfoil is placed in the centre of the phonograph, the needle is accurately adjusted in position, so that its point shall traverse the spiral groove of the cylinder, and everything is ready for use. Prof. Dixon places his lips close to the mouth-piece, and says "Good evening Mr. Phonograph, these gentlemen have come to see the greatest wonder of the nineteenth century. Can you talk," turning the cylinder as he talks. Then he returns back the cylinder so that the needle point shall rest at the same place as before, the tinfoil where it did when he commenced, adjusted a long, tin tube, shaped somewhat like the mouth-piece, turned the crank, and his words were repeated distinctly and accurately. Exclamations of wonder, gratitude, surprise, and pleasure followed from those present. Then Prof. Dixon laughed long and heartily, and with marvelous facetiousness and histrionic talent mimicked the mouth-piece, and his words were repeated by the phonograph, exactly reproduced his mannerisms and tones. Then he spoke a couplet of Edison's doggerel, sayings into the mouth-piece, and the phonograph repeated them in tinkling tones, but not less distinct tones. "There was a little girl, she had a little curl, and it hung right over her forehead, and when she was bad, she was very, very bad, and when she was good, she was very good," and Rub-a-dub-dub, three men in a tub, etc. Tom Sawdrom was invited to make a speech and essayed, and the phonograph reproduced Sawdrom's peculiar tone and inflection in the style of—"Why don't you talk? why don't you talk? Give us a touch of Edison's best," dwelling on "best" in familiar and loud sort of way. Then was whistled "Yankee Doodle," but the phonograph whistled it better than Mr. Sawdrom did. Went it said to us personally, we fell in report. The phonograph sang "John Brown's Body," etc., and the phonograph sang it with a certain fervor and patriotic style. But the capacity of the sheet of tinfoil with its surface covered with indentations, was not exhausted yet, and a request was made the speaker, songs and tunes repeated of those who were watching its performance so intently. "Little girl," "Rub-a-dub," "Edison's best," "John Brown's Body," and strains of "Yankee Doodle," followed in sparkling confusion. But the professor's tinfoil gave out and he talked to us, giving the philosophy of the reproduction of the voice, much in the same form as he gave it on Thursday evening and as it was given in an article from the New York Independent, published in these columns a few week's since. And then we went home in the rain.

The phonograph again to-night.

THE MICROPHONE.

A WONDERFUL DISCOVERY INDEED.

An Instrument Which Runs for the Benefit of Hearing What the Microscope Does for the Sense of Sight—Experiments Successfully Made at the Stevens Yesterday.

The discovery by Professor D. E. Hughes of Kentucky, who has resided in Europe, of a new adaptation of the principle involved in Edison's instrument, the microphone, has excited the scientific community of the entire country, which has been constantly on the qui vive, since the first announcement was made, but which does not for the sense of hearing what the microscope does for that of sight. The new instrument is exactly what Professor Hughes claims for it, a microphone in the broadest sense of the word. It is not, as Mr. Edison, the inventor of the phonograph, has styled it, a telephone, but is a microphone in the truest sense of the word. It is simply a device to make audible to the ear the first ripple of the most delicate sound caused by the tread of a fly upon the surface on which it walks, or a particle of dust, a carbon dust, set 100 trembles distinctly enough to be heard by the ear. The instrument is very simple in construction, and can be put together by any one who has a little natural mechanical ingenuity and a few cents to spend for the necessary materials. It is not, however, to be supposed that the instrument is perfect, for it is not. It is quite capable of improvement, and will be improved, as the telephone and phonograph have been improved, by the ingenuity of scientific men, who will make a study of it. It is, however, in its present form a most wonderful instrument, and one which will have a most important effect upon the science of acoustics. It is better that before long it will be improved in the form and materials employed.

Possibilities of the Microphone.

The London correspondent, in commenting upon the performances of the microphone, wrote eloquently of the possibilities of the instrument, and predicted a thousand uses for it. Such is the case here.

The telegraphic letter from a distance without the aid of a telegraph wire, the microphone is capable of transmitting. Even the microphone is capable of transmitting. Even the microphone is capable of transmitting a message from Philadelphia to Washington, or to any other point on a line, by the interposition of a telegraph wire, but the microphone will not convey intelligence over the telegraph wire, but the sound is vastly increased by the interposition of a telegraph wire, and the microphone is useful as a delicate instrument for detecting and magnifying of sounds, as it is not of much use. It should be remembered that the microphone is not a telephone, and will not convey words or sentences as the latter is known, and that the mere breathing of the fly is heard by the microphone, and the sound of the fly's feet and also a conversation carried on in a normal tone is transmitted from a distance of a second close at hand.

We do not understand that it would be in any way impossible, for instance, to put a physician's stethoscope in connection with the microphone, and have the heart sounds of a patient heard audibly in the house and heart of a patient in Miss Nellie Grant's entourage had also been heard audibly in the house as a child in Richmond. With the extraordinary power of combining the telephone and microphone in one instrument, the possibilities are almost beyond conception. The form of the instrument is such that it is not of importance, provided the materials are of sufficient delicacy and sufficient to result in such vibrations as will be made. Carbon is used in preference to any other material, as its surface does not oxidize, and it is therefore more durable, and it is easily moved. The carbon is a conductor of electricity, but more delicate and costly in construction. I have also made very successful use entirely of

The Human Hair.

"The best form and materials for this instrument have not yet been fully settled upon," said Prof. Hughes to-day, "but I have made very successful use of the human hair in the microphone. If a pin, for instance, be laid upon or taken off a table, a sound would be emitted, or if a fly be walking upon a table, the sound of its feet would be heard. With a needle, or piece of wire, I touch the table, and with the tips of a watch, the tramp of a fly, and that to a person at a distance of a second close at hand, and the sound of either is quite distinct. Of course, we may fairly look for it to do far as, with regard to the sense of hearing, what the microscope does with regard to the sense of sight."

How the Results Are Due.

Professor Hughes then stated that an apparatus designed to show that the results are due to the primary principles by molecular action, and explained his time transmitter, which may be used in connection with the microphone or in it. The time transmitter is a clock-work arrangement, which, at 10, 20, 30, ninety seconds in the minute, gives a sound.

Professor Hughes then stated the results of an exterior experiment he has been trying, and the success of it so far as to encourage him to continue it. It was four separate pieces of wire, each one mile in length, and the ends of each were connected, and two terminals of a telephone. Then, and two terminals of a microphone. Then, and

...ment was detected in one case, and mentioned as distinctly with the line and distinctly with the four [illegible].

Then it is made to open on 10, 0, 0, 0, and 0, until the carbon is placed in the electrical current is about one-third that of the original current. The sound is heard by an attendant in a distant room, and is distinctly heard by a person close at hand. If the result was simply to be transmitted to a distance, it would be a very popular contrivance. Without them it would be a most unpleasant instrument. If 10, 0, 0, 0, 0, simply the number of the carbon is used, and not 10, 0, 0, 0, 0, it would be less as a test also if the carbon 10, 0, 0, 0, 0, would be less as a test also if the carbon is placed in the electrical current. It would have an effect, but the effect is not to be a source or entanglement of 10, 0, 0, 0, 0, 0, 0, 0, 0, 0, it would be a source of entanglement. It

A telephoning extract from Mr. Prescott's book appeared in the *Journal of the Telegraph*, April 16, 1877, will show that the diminishing of the distinctness in the new transmitter with Mr. Edison has introduced, the vibrating diaphragm is done away with altogether, it having been found that the carbon button alone is sufficient to vibrate the tongue of the transmitter in its place. With the old vibrating diaphragm the articulation produced in the receiver was found to be due to the sound waves impinged with the vibrating disk sometimes in advance of the voice, which probably results from the latter overpowering in the receiver the sound waves set in motion by the transmitter. In the new instrument, now here exhibited, the sound is more clear and unmistakably heard that a whisper can be distinctly heard in unconnected and unformed. The inductive plate, which consists of a thin piece of mica covered with a conducting lamp black, and connects a considerable portion of the sources waves upon the small carbon button or button, and thus produces a greater effect in an electric current. The part of the receiver is to apply sufficient heat on the disk then could be obtained to heat on the disk then could be obtained if only the small resistance of the battery.

The chemistry of the carbon telephone can be used as a measure of minute degrees of heat; it will move proportionate than the preceding. This is a fact of which I am sure. Mr. Edison has informed me in Washington. Mr. of the law of April last. A copy of that paper was sent by me to Mr. Preece, the consulting and electrician to the British Post Office, and I have positive evidence that he received this before the presentation of the so-called "microphone" to the Royal Society, and before the address of that man as an invention of Mr. Edison.

Mr. D. E. Hughes, electrician to the London Post Office Department, was in this country a few years ago, and I have been informed by a secretary, I feel assured that the statement was true, making, including the principle of the carbon telephone and the microphone, that Mr. Hughes was in this country between under pretense, I may say, to be making the presentation of this telephone, and subsequently of the microphone, but that he was in fact here to steal, by sketches, publications and by pictures in general, my electric appurtenant, as he always manifested a great desire to be aware of promotion my discoveries to the British people.

I am informed by the solicitor of Mr. Preece in this matter as to merely a violation of my rights as an inventor, but as a gross infringement of the copyright of my book, entitled "Electricity Simplified," New York, very truly,

Menlo Park, N. J., June 6, 1878. THOMAS A. EDISON.

"ZANOBIA."

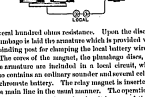
Improvement in Dynamo-Electric Machines.

It is stated by the *Bldg. Pol. Jour.* that the firm of Schuckert, in Nurnberg, have lately been devoting attention to the improvement of dynamo-electric machines, for galvano-plastic purposes and the electric light. Their machines are like the Gramme, but the following points may be noted. The rotating iron ring, wound with copper wire, is a flat disc; thus the wires of the two long sides of the cross section come under the action of the flat-shaped magnetic poles, and the induced currents of the two sides combine having the same direction. The whole wire length is thus utilized. Centrifugal force at high velocity does no injury. Again, the iron ring is not in one massive piece, but in several ring discs, separated from each other by ecanite, pasteboard, or the like, the whole ring being held together by brass rivets. The object here is to hasten the disappearance of remanent magnetism, in rapid change of the poles, and to obtain the maximum of magnetization. This construction allows of the firing of the ring or metal without disturbing inductive action, since only very small part of the wire is in contact with it, and the evil effects of a possible heating are obviated.

Original Articles.

EDISON'S PRINCIPLE DELAY.

Mr. Edison has recently invented an ingenious and novel relay instrument, based upon an entirely new principle. He takes advantage of the property which a plumbago possess of decreasing its resistance enormously under slight pressure. Thin discs of that material are placed upon the crapped poles of an electro-magnet, (see diagram), the coils of which have



several hundred ohms resistance. Upon the discs of plumbago is laid the armature which is provided with a binding post for clamping the local battery wire.

The coves of the magnet, the plumbago discs, and the armature are included in a local circuit, which also contains an ordinary sounder and several cells of bichromate battery. The relay magnet is inserted in the main line in the usual manner. The operation is as follows: When the main circuit is opened the attraction for the armature ceases, and the only pressure upon the plumbago discs is due to the weight of the armature itself. With this pressure only the resistance of the plumbago to the passage of the local current amounts to several hundred ohms; with this resistance in the local circuit the sounder remains open. If now the main circuit be closed, a powerful attraction is set up between the poles of the relay magnet and its armature, causing a great increase in the pressure upon the plumbago discs, and reducing its resistance from several hundred to several ohms, consequently the sounder closes. So far the result differs but little from the ordinary relay and sounder. But the great difference between this relay and those in common use, and its value, rests upon the fact that it repeats or translates from one circuit into another, the relative strengths on the first circuit. For instance, if a weak current circulates upon the line in which the relay magnet is inserted, the attraction for its armature will be small, the pressure upon the plumbago discs will be light, consequently a weak current will circulate within the second circuit; and on the contrary, if the current in the first circuit be strong, the pressure upon the plumbago discs will be increased, and in proportion will the current in the second circuit be increased. No adjustment is ever required. It is probably the only device yet invented which will allow of the translation of signals of *variable strengths*, from one circuit into another, by the use of batteries in the ordinary manner. This apparatus was designed by Mr. Edison for repeating acoustical vibrations of variable strength in his speaking telegraph, a description of which we shall shortly publish.

Telegraphy and Mr. Prescott's Book About It.

The wonder of the telephone, which at present engages the popular mind, will serve also to direct attention to the vast progress of the import- 4 science of which it is but a new and problematical development. Practically electricity itself, the mysterious foundation of modern telegraphy, has hardly owned the first conditions of a science until within the last years, and electric telegraphy, as every one knows, has existed but a little more than a generation, and its great applications and triumphs have been made and won within the memory of every person of middle age.

What the steps of this progress have been, and their order, would take a volume to indicate; but when we consider that the first business line was put in operation in 1838, in Bavaria, and the first in this country six years later, we realize the rapid advance and immense extent of the system of communication which now covers the whole globe. It would be hardly instructive to print here the number of miles of wire in use, or the force of men employed in their constructing or working; nor is it needed to enlarge the myriad indispensable services the telegraph is constantly performing for the business, the information and interest, and the comfort and affection of mankind, for these are familiar to all. And if one would gain an adequate conception of the scale and continual activity of mind employed in the utilization and improvement of the great invention, we should refer the inquirer to Prescott's "History and the Electric Telegraph," the latest work of Mr. George B. Prescott, and the most thorough treatise on the subject, whether considered practically or theoretically, that has been issued in this country at least.

Mr. Prescott, who was one of our near neighbors a few days ago, is well-known as the accomplished electrician of the Western Union Telegraph Company, and, probably, the American most fit to do this particular work. And yet he has hardly made just what the public want; for while, in every detail, the book is enormous itself, there is no continuous and comprehensive grasp of the subject into one narrative, such as might have been given separately without injuring the value of the treatise as a manual for electricians and for those studying the advance made in telegraphy both as a science and as an art. In this matter he has it in his power to supply what some of the explanative offer—a lucid history of the telegraph all over the world.

Our present electric telegraph would be more properly described as electro-magnetic, for it depends upon the magnet—whose kindred to electricity, though so certain, is not at all understood—as much as upon the electric battery; chemical action and magnetic induction being the two component forces of telegraphy. Mr. Prescott's careful and perspicuous descriptions of the batteries, machines and the multitudinous combinations and suggestions of inventors, for the first time afford the American reader a complete acquaintance with what European scientists have been doing in this field. Of a great number of these we presume we may say few telegraphers know anything.

* * *

In short, if Mr. Prescott's book possessed the addition we have suggested, of a chapter of continuous summary and broad account of all the reach of telegraphy and the various modes and incidents of its working, it would be as entirely satisfactory to us, the laity, as it now to the narrower circle of students and scientists who are specially concerned with its subject.—*Springfield Republican.*

The Telegraph.

Exhibition of Bell's Telephone.

Prof. A. G. Bell gave three lectures and exhibitions of the operation of his Telephone or speaking telegraph, at Chickering Hall, in this city, on the 17th, 18th and 19th May. Owing to the high prices charged for admission and defective business management, the attendance was small. The exhibitions of the operations of the Telephone were moderately successful, though not so much so as has been reported at previous exhibitions in Boston and Providence.

Telegraphic Phenomena.

LAFAYETTE, INDIANA, May 16.

To the Editor of the Journal of the Telegraph.

Some time ago I constructed a telephone after a new pattern of my own invention, and connected it to the main line, and sang different tunes here. They were distinctly heard at Otis 82 miles north of this city. Others along the line heard the tunes the same as if it came from an organ. I then tried words, they went all right but could not be understood. Has any telephone ever been made that by *the use of a battery* words could be understood at the distant end of the line? When the test was made in Canada on the new "Dominion" lines, and words were spoken, was the main battery disconnected? I do not believe the human voice has ever been sent over a line where a make and break circuit vibrator was used. Will you please enlighten me as well as others of this "mystery?"

GEO. B. HAYES.

Prof. Bell's speaking telegraph or telephone is worked either with a battery current or a permanent magnet. It is understood that for vocal purposes the permanent magnet is preferable, but it is practicable to use the battery current, and it has been done very frequently. We are not informed as to the conditions under which the test was made on the Dominion lines in Canada.

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Responsible and Energetic Agents wanted to introduce the Apparatus.

NEW TELEPHONIC INVENTIONS.—Mr. Joseph P. Noyes, of Binghamton, N. Y., writes to the *Tribune*, describing a new device for increasing telephonic sounds. He introduces into the electric current a V-shaped apparatus, consisting of two strips of somewhat flexible material, joined or in electrical connection at their lower ends and slightly parted at the upper. The material is a conductor of very high resistance. To each upper end a wire of the circuit is attached. It will be seen that, if the V is gradually closed, the current will pass over less and less of the poor conductor. This is facilitated by rounding the inside edges of the strips along the line where the contact is to take place. Mr. Noyes then applies a diaphragm so that its movements of vibration (by sound waves) shall open and close the V. By this device, it is stated, far louder sounds are obtained than with the ordinary telephone. At Philadelphia, Professors Edwin J. Houston and Elihu Thomson, of the Central High School, have for some months past been endeavouring to effect a relay of telephonic messages from one circuit to another. Professor Hughes's construction of the microphone has now enabled them to solve this problem, as that contrivance can be made to repeat on a new circuit the most delicate vibrations that have started from a Bell telephone. The new relaying apparatus has been shown at the Franklin Institute, and was executed there satisfactorily.

THE MICROPHONE IN THE PULPIT.—The *Halifax Guardian* says that a young gentleman, well known in connection with a firm of telegraph engineers in the town, has contrived to have his sermons at home. He placed a microphone in the pulpit of a chapel in this town, and connected it, by means of a private telegraph line, with a house over a mile distant. Every part of the service was distinctly heard by the owner of the house, with the exception of a few words rendered indistinct by the preacher becoming a little excited, and shaking the microphone, the presence of which he never dreamt of, or he might have been somewhat nervous at the idea that his sermon was being conveyed away he knew not whither. So faithfully did the microphone do its work that the chapel-keeper was heard to close the doors after service, walk up the aisle, and up the pulpit steps, in conversation with some one. During the week experiments have been made in the schoolroom of another chapel, and the singing of the scholars was transmitted and retransmitted over a number of telegraph lines with remarkable clearness. The idea is about to be put to practical use, the gentleman already referred to having given instructions that his house should be connected with that of a gentlemen near, in order that an invalid may hear the service from one of the churches in the town.

DISPUTED INVENTION OF THE MICROPHONE.

We are glad to have the opportunity of printing the following communication :—

TO THE EDITOR OF THE ELECTRICIAN.

SIR : With reference to your article headed "Disputed Invention of the Microphone," I enclose you two messages sent to New York, which I hope you will publish.—YOURS, &c.,

June 25, 1878. W. H. PREECE.

To NORTH GREEN, NEW YORK.

Please give following message to Associated Presses and to Ashley :—

"Pray give the most absolute and unqualified denial to the statements made by Edison respecting me. Hughes has not brought out any thermopile. His microphone is quite a different instrument to Edison's telephone. It was worked at first without any communication with me, or information imparted by me, in any way whatever. I knew nothing of it until it was shown to me, together with Professor Hughes and Mr. Norman Lockyer. I am in no way whatever a coadjutor of Hughes. "W. H. PREECE."

"I emphatically endorse every word of the above message "D. E. HUGHES."

CORRESPONDENCE.

THE MICROPHONE AND THE TELEPHONE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Allow me to make a few observations on the Microphone and Telephone, and the remarks thereon in the articles by Messrs. W. Smith and Sankrock in numbers two and three of your journal.

From a rough description of the Microphone, in a late number of the *Débats*, I constructed one, adapting an ordinary cigar box and the carbon from a used Leclanché. The vertical rod was a piece of ordinary hard lead-pencil. All the phenomena described in *The Electrician* could be easily obtainable on a hundred miles wire in length between my cabin house and the town, and on which all my previous telephonic experiments had been made.

The battery power used varied from one to twenty Meneitti's, which rendered indistinct by the preacher becoming a little excited, and shaking the microphone, the presence of which he never dreamt of, or he might have been somewhat nervous at the idea that his sermon was being conveyed away he knew not whither. So faithfully did the microphone do its work that the chapel-keeper was heard to close the doors after service, walk up the aisle, and up the pulpit steps, in conversation with some one. During the week experiments have been made in the schoolroom of another chapel, and the singing of the scholars was transmitted and retransmitted over a number of telegraph lines with remarkable clearness. The idea is about to be put to practical use, the gentleman already referred to having given instructions that his house should be connected with that of a gentlemen near, in order that an invalid may hear the service from one of the churches in the town.

The battery power used varied from one to twenty Meneitti's, with high internal resistance, and one to ten Leclanchés, with very low resistance. I find the lower the battery power the better are the results, and with one Leclanché everything goes most successfully over the distance mentioned. The insertion of extra resistance in the circuit makes but a comparatively trifling difference in the results ; my watch was clearly heard on the circuit with an interpolar resistance of 15,000 ohms, using four Leclanchés.

In the last paragraph of Mr. W. Smith's article I observe that he anticipates being able to converse through our longest cables ; whilst I find that resistance enters little or nothing into the question, a stumbling-block has yet to be overcome in the cable's electrostatic induction. Together with my colleague at Otranto, Mr. Eggington, we have had repeated trials both ways on this cable, 187 knots in length. No variation whatever in the battery power enables us to hear even mechanical sounds, the rapid current-waves from the microphone's vibrations being unable to sufficiently quickly discharge themselves through the telephone ; in fact, the line remains attracted the whole time the microphone is in circuit, and, by making and breaking "earth" contact at the receiving end, the sound appears the same, but stronger, than that from a Morse armature on short circuit*.

Our latest trials were with a positive current on the microphone, and a weaker negative one at the receiving end, but still without success, and certainly, unless we can devise a double-current microphone, cables are cut off from its field of operations. With Corfu, 150 miles, no better results are obtainable, and, for the present, all further trials have been suspended.

Mr. Sankrock very justly takes exception to the term "microphone." It does not do for sound what the microscope does for sight. To my idea it should be termed a "sound finder," seeing that sounds absolutely inaudible to the sharpest human ear become with it quite distinct ; for instance, a hair drawn across the surface of the microphone can never be heard by the naked ear, yet through the microphone the noise of its passage is unmistakeable. Audible sounds are not magnified ; a pistol fired over a microphone does not cause you to hear a salvo of artillery, nor does the ticking of a watch increase to the noise of a steam-engine.—Yours truly,

W. G. FORSTER.

Zante (Greece), June 10th, 1878.

* The telephone coil has not more than 25 ohms' resistance. Bearing in mind this principle, nearly any single goodly sounder can respond to the slightest electro-magnetic instrument's coils.

A MOST DELICATE THERMOSCOPE.

Thomas A. Edison, of New York, is inclined to dispute certain discoveries recently made in England. We were among the first to publish an account of the delicate "thermopile" (a better term, which we here adopt, is the electrical thermoscope"), which forms part of the discoveries of Professor D. E. Hughes. Professor Hughes's discovery was in this case the result of an accident. He had been making certain experiments with glass tubes, and for the moment, not having a glass tube at hand, he took up a quill, and fashioned it for his purpose. The result he expected to see was not obtained ; in fact, the experiment failed, but the failure drew attention to some other important facts. The quill contained carbon, and under the action of heat the quill expanded more than the carbon. The differential action resulted in the increase of the ohmic resistance, and so influenced the current as to set in motion the galvanometer. We are now informed that Mr. Edison long since constructed an instrument for measuring to a astonishing exactness the smallest variations of temperature. In his experimental researches he discovered that, under certain electrical conditions, carbon was exceedingly sensitive. The slightest change of temperature affects the expansive and contractile properties of certain bodies, we might almost say all bodies, but some to a greater degree than others, and by resting on the carbon such a better or a worse contact to be made in the electric circuit, according as the temperature is raised or lowered. Not only is Edison's instrument sensitive to changes of temperature, but it also indicates the increase or decrease of moisture in the atmosphere. Mr. Edison, indeed, goes so far as to say that "spitting on the face will be indicated by a movement of the galvanometer needle." Surely, the drawing rooms of our transatlantic friends ought to be furnished with one of these instruments in a new case, with a recording apparatus, so that the number of expectorations in the room might be daily registered. We do not like the record of our sins to glare upon us too strongly, and are apt to say "out of sight out of mind ;" but a gentle reminder of this sort might prove effective in reducing expectoration to a minimum.

This wonderful instrument, however, is a very simple affair, after all. Everybody can make one. The most important parts of the apparatus are the battery and the galvanometer. In the electrical circuit we connect the galvanometer and some carbon buttons. The carbon is in contact with the wire-conductor of the circuit, or between the metal plates. The current passes through one plate, then through the carbon, and through the other plate to the opposite pole of the battery. Mr. Edison connects the plates by a piece of hard-rubber or gelatine, but it will at once be seen that the best material to connect the plates is a non-conductor which is exceedingly sensitive to heat or moisture. The instrument proper then requires carbon contacts, such that the expansion or contraction of a second substance under the influence of heat or moisture alters the contact to make it more or worse contact, and thus provides for or increased current by or worse resistance at the points of contact, or, on the contrary, decreased resistance and decreases the current. Mr. Edison's instrument is given as follows by the *New York Herald*:—" Mr. discovery is given as follows by the *New York Herald*:—" Mr. discovery is given as follows by the *New York Herald*:—" Mr. Edison next exhibited his new discovery, the thermopile, to measure infinitesimal degrees of heat. Mr. Edison explained the instrument to the *Herald* reporter in the following words :—" It consists of a carbon button placed between two metallic plates. A current of electricity is passed through one plate, then through the carbon and through the other plate. A piece of hard-rubber or of gelatine is so supported as to press against these plates. The whole is then placed in connection with a galvanometer and an electric battery. Heat causes the strip of hard-rubber to expand and press the plates closer together on the carbon, allows more current to pass through, and deflects the needle of the gal-

accordance with the vibrations of the disc, producing thereby a corresponding variation in the electrical resistance of the carbon cake, which is placed in circuit with a battery and receiver and which are connected respectively with the two plates of platinum.

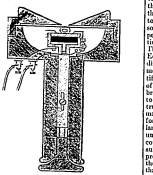


FIG. 1.

The essential principle of Mr. Edison's transmitter consists in causing a diaphragm, vibrating under the influence of sonorous vibrations, to vary the pressure upon and therefore the resistance of a piece of carbon which is placed in the circuit of a voltaic current, to which is impressed, by the variations of its resistance, no undulatory motors which is capable of reproducing in a telephone at a distant station sonorous vibrations corresponding to those at the transmitting end of the line.

Mr. Edison's instrument is acoustically similar to Professor Bell's telephone, and bears a resemblance electrically to a special form of the microphone of Professor Hughes, but it is just the similarity to the one which constitutes its difference from the other. It resembles the Bell telephone in taking up sonorous vibrations by means of a diaphragm placed in front of a resultajcon, and it differs from it in the method by which it converts the vibrations of the diaphragm into waves of electrical force. It resembles Professor Hughes's microphone in the employment of a battery current in the circuit of which is interposed a resistance which is variable, but it differs from the microphone in the means by which that variation of resistance is brought about by the sonorous vibrations imparted to the instrument. It may be said to occupy a place between the two, and it would be difficult to say which it most resembles, or from which it differs most widely.

It has for many years been well known to electricians that the resistance of all conducting bodies, and we may assume of all substances, varies under variations of pressure, and this fact has been noted in the construction of relays and certain other telegraphic instruments where good contacts are required, it being the aim of the manufacturer in such cases to insure as small a resistance as possible at the contact points by the employment, wherever practicable, of strong springs for increasing the pressure between them.

Some imperfect conductors exhibit this property in a more marked degree than others, and the fact that the resistance of powdered carbon varies in a remarkable degree under variations of pressure, was taken advantage of by M. Clerac, of the Administration des Télégraphes in Paris, as far back as the year 1865, who constructed at that time resistance tubes containing powdered carbon, the resistance of which could be regulated by increasing or diminishing the pressure upon the contents of the tubes by means of an adjusting screw. This property of carbon has also been made use of by Mr. Edison in his carbon telephone, and in the year 1873 he constructed tubes similar to those of M. Clerac as rheostats for artificial cables, but we understand that Mr. Edison discovered the property independently of M. Clerac, and without a knowledge of what had previously been done by that electrician. A new and important application, however, which has been described, Mr. Edison substituted a carbon cake for the section of India-rubber tube between two of its material, could not be relied upon for keeping the instrument in adjustment; and, in order to get rid of an unpleasant metallic ringing tone emitted by the spring, shorter and stronger springs were tried, and Mr. Edison was led by the greatly improved result to do away with the spring altogether, to insert a solid substance between the carbon and the diaphragm, and to make the diaphragm as thick that its vibration under the influence of the loudest tones became inappreciable. With an instrument so constructed, Mr. Edison states that he obtained perfect articulation, and that whispered conversation was clearly transmitted to a distant station. There can be no doubt that at this point Mr. Edison was sailing round and very near to the discovery of Professor Hughes, and it furnishes one more instance in the history of scientific research of an experimenter being on the verge of making a great discovery, but missing it by broaching off in another direction, or by failing to see in the phenomena under observation their true explanation. Thus the independent discovery made by Mr. Edison was that carbon in various forms, and more especially in the form of compressed lampblack or soot, is variable in electrical resistance under variations of mechanical pressure. The discovery of Professor Hughes is, that all conducting substances may be employed with equal success, provided that their surfaces are not unalterable under the influence of an electric current, or if unalterable that their oxides are dispersed as rapidly as they are formed. The experiments of Professor Hughes demonstrate very clearly that sonorous vibrations throw into molecular activity or tremor all substances within their range of influence, and that if words or notes be sounded in the neighbourhood of a bundle of wires, it will take up the vibrations constituting the sounds, and if on its surface be placed a steel point, or there be two or more electrically connecting surfaces in contact with one another, the slightest molecular agitation of the resistance board is communicated to the conducting material, and no undulatory character is imparted to, or otherwise unvarying current passing through it, corresponding in its undulations to those of the sonorous vibrations by which the original tremor was produced. It will thus be seen that Mr. Edison's discovery is but a special case of the larger and more comprehensive discovery of Professor Hughes and just as the theoretical discoveries of the two inventors differ, so do the constructions of their respective instruments, and the reasons given for those differences differ also. Mr. Edison uses carbon because he finds that it makes a poor electrical contact under feeble pressure, which contact increases as that pressure is increased, while Professor Hughes employs carbon in certain forms of his microphone on account of its property of making the best electrical contact with very slight pressure indeed. For the same reasons Mr. Edison finds it necessary to insert a diaphragm in all forms of his apparatus, that being the mechanical contrivance employed by which sonorous vibrations are converted into vicissitudes of mechanical pressure, and by which variations in the conductivity of the carbon or other material is insured. It is true he has made his diaphragms in some cases as much as $\frac{1}{2}$, in. in thickness so as to reduce to a minimum their amplitude of vibration, but the experiments of Professor Bell, as well as the researches of Lord Rayleigh, have shown that metallic diaphragms are capable of vibrating under the influence of sound through amplitudes so minute as to be inappreciable and under sonorous vibrations so small as to be altogether unsuspected before. On the other hand, Professor Hughes employs no diaphragm at all, the sonorous vibrations in his apparatus acting directly upon the conducting material or through whatever solid substance to which they may be attached.

In considering Mr. Edison's most interesting instrument it is important to point out the very essential differences which exist between it and the microphone of Professor Hughes, because the name *carbon* telephone might otherwise lead to the idea that on account of carbon being employed in some forms of the latter instrument there is greater similarity between them than really exists.

For long circuits the arrangement adopted by Mr. Edison is shown in the diagram, Fig. 2, in which A is an induction coil in which the secondary wire s is within and enclosed by the primary wire p; the former has a resistance of from 150 to 200 ohms. The coil c is to the length of or resistance of the line. The receiving telephone R is very similar in principle to Professor Bell's instrument, but differs from it in the fact that the thin iron diaphragm is polarised by being attached at a point on its edge to one pole of the magnet which is bent twice at right angles to suit the construction; the other pole carries a coil of wire, the resistance of which is about 75 ohms, which is placed below and concentric with the diaphragm as in Professor Bell's instrument. P K is a polarised relay which closes a circuit, in which is a local battery E and call bell B, when a signal

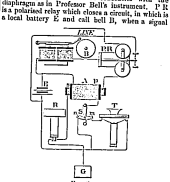


FIG. 2.

from the distant station is sent through the line. At S is a switch, the lever of which either (1) by being placed at a disconnects the transmitting telephone T and battery E from the induction coil A; (2) by being placed at b cuts out the battery E to the line through the induction coil; or (3) by being placed at c throws the transmitting telephone T with the induction coil and line. By the first the apparatus is ready to receive a call signal from the distant station, by the second it is connected for transmitting a signal, and by the third the telephonic circuit between the two stations is closed and articulate communications may be sent.

For lines of shorter circuits, that is to say, from 1 to 30 miles, Mr. Edison prefers the arrangement shown in Fig. 3, which differs from that illustrated

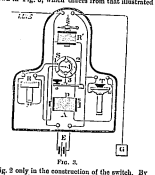


FIG. 3.

in Fig. 2 only in the construction of the switch. By inserting a plug in the upper hole, by which the pieces 1, 2, and 4 are connected, the telephone circuit is completed, but when the plug is placed in the lower hole, thereby connecting 4 and 3, the apparatus is connected for receiving and transmitting call signals, the sounder or bell B, the battery E, and the transmitting key being thereby brought into circuit.

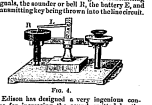


FIG. 4.

Mr. Edison has designed a very ingenious contrivance for increasing the sound emitted by the vibration of the diaphragm of a telephone by which

FRENCH TELEPHONIC EXHIBITION.

Attention, it has been necessary to give to readers a telephonic exhibition. Mr. Edison contains this exercise by Mr. Lassimone.

ENGINEERING.

FRIDAY, JUNE 21, 1878.

EDISON'S CARBON TELEPHONE.

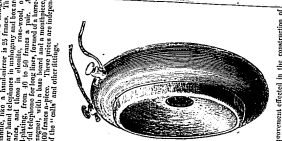
Attention has been directed to the invention of Professor Hughes noticed in a recent number of ENGINEERING, and to the instrument which were then described in this journal, but since then Mr. Edison has brought out a modification of his telephone, which differs from the original instrument in a manner which is of considerable importance, and which we have therefore thought it desirable to describe. The original instrument, as described by Mr. Edison, was constructed as follows:—A thin diaphragm of sheet iron, about 2 in. in diameter, was placed in front of the pole of a magnet, and at a distance from it of about $\frac{1}{100}$ in. The pole was surrounded by a coil of fine wire, and the whole was fixed in the ordinary manner in the mouthpiece of a telephone. The diaphragm was connected by a wire with a button of hard carbon, which was pressed against a second button of carbon by a spring. The second button was connected with the terminal of the coil, and the circuit was completed through the line wire, the receiving telephone, and the battery. The carbon buttons were mounted in a small cup of vulcanite, and the spring was adjusted by means of a screw. The vibrations of the diaphragm caused a variation in the pressure between the buttons, and consequently in the resistance of the circuit, and thus produced undulatory currents which reproduced sounds like the original ones. Although articulate talking resulted in the transmission of words, it was found that the instrument was not sufficiently sensitive for the purposes of ordinary conversation. Mr. Edison has therefore modified it in the following manner:—The carbon button has been replaced by a cup filled with carbon granules, and the diaphragm is connected with a platinum plate which presses upon the granules. The cup is mounted on a stout spring, and the pressure of the granules upon the diaphragm is adjusted by means of a screw. The vibrations of the diaphragm cause variations in the pressure of the granules upon the platinum plate, and consequently in the resistance of the circuit, and articulate talking resulted in the transmission of words. The instrument is, however, still imperfect, and Mr. Edison is now engaged in endeavouring to overcome the difficulties which still exist. He has found that the sensitiveness of the instrument is greatly increased by the employment of a local battery, and that the articulation is much improved by shunting the receiving telephone with a resistance of about 150 ohms. Mr. Edison has also found that the articulation is greatly improved by shunting the transmitting telephone with a resistance of about 30 ohms. The best results are obtained when the resistance of the shunt is equal to that of the telephone. The shunts are used in the following manner:—The receiving telephone is placed in a shunt of 150 ohms, and the transmitting telephone in a shunt of 30 ohms. The shunts are then placed in the circuit, and the instrument is ready for use. Mr. Edison has also found that the articulation is greatly improved by the employment of a condenser in circuit with the telephones. The condenser is composed of sheets of tinfoil separated by sheets of paper, and has a capacity of about 2 microfarads. It is placed in circuit with the telephones, as are also previously mentioned shunts. With the instrument as modified by the above arrangements, Mr. Edison has succeeded in transmitting articulate talking over a circuit of 1,000 miles of ordinary telegraph wire. Mr. Edison has also found that the articulation is greatly improved by the employment of a microphone transmitter in connection with the telephone. The microphone transmitter used by Mr. Edison is that invented by Professor Hughes, and described in ENGINEERING, vol. xxv., page 417. Mr. Edison has found that the articulation is greatly improved by the employment of a microphone transmitter in connection with the telephone. The microphone transmitter used by Mr. Edison is that invented by Professor Hughes, and described in ENGINEERING, vol. xxv., page 417. Mr. Edison has found that the articulation is greatly improved by the employment of a microphone transmitter in connection with the telephone. The microphone transmitter used by Mr. Edison is that invented by Professor Hughes, and described in ENGINEERING, vol. xxv., page 417.

* See ENGINEERING, vol. xxv., page 417.

FRENCH PERAMBULATIONS AT THE PARIS EXHIBITION.

The collection of locomotives from the French railways presents an interesting feature at the Exhibition. I am not sure that the "whole" form of half the engines does not belong to the "ugly" class of half the engines. Be that as it may, it is hard to find anything more ugly than the locomotive, unless it be the tender. Both, however, have their uses, and I suppose we must not look for beauty in anywhere like a watch. In running long lines of railway, the question of coal is a very important one, and in the north the great parts of the journey are performed by coal, which is carried round from the tender, instead of being supplied from the side of the line, as in England. The tenders are therefore very large, from 40 to 50 French a yard. The engines are also large, and the cylinders are outside. The central compound engine was noticed. It is a "Mallet" engine, and is known in France as of the "Mallet" system. It consists of a pair of high-pressure cylinders, and another pair of low-pressure cylinders, placed under the smoke-box, and driving on the second pair of wheels. The high-pressure cylinders are 15 inches in diameter, and the low-pressure cylinders 30 inches, and the stroke of the piston is 24 inches. The steam is used expansively in the high-pressure cylinders, and then passes into the low-pressure cylinders, where it is used expansively. The engine is said to work well, and to consume little coal. The boiler is of the ordinary type, and has a working pressure of 10 kilos. per square centimetre. Coal decreases the pressure, May [illegible] pressure upon the [illegible]

M. Nicolas has also exhibited a locomotive, which is fitted with Edison's tramway, and the telephone improvements in connection therewith. The engine is fitted with the telephone, so that a man in front can hear what is going on behind. The telephone is partly fastened to the roof of the cab, and partly fastened to the front of the tender, so as to be partly protected from the weather. The line between these two points is a distance of 20 yards, with a battery of four cells between them.



An improvement effected in the construction of Edison's "Motograph" has been introduced into America. *Mr. Kennedy* points out that Edison was the first to suggest the use of a vibrating armature in connection with the electro-magnet of the telephone. The difficulties of the articulation of the human voice are due to the inertia of the diaphragm with respect to the pole or the magnet—a pressure, while having sufficient force for it to move, is unable to move it with sufficient rapidity. It is found, however, that different degrees of pressure may be exerted upon the diaphragm at more than one point, and hence the idea arose of using a vibrating armature, which, by its own inertia, would be less liable to follow the vibrations of the diaphragm, and thus to produce a more perfect articulation. In certain cases, however, as in the Edison "Motograph," the inertia of the armature is used to the advantage of the instrument, as it is thereby rendered capable of receiving impressions from a greater number of vibrations than would otherwise be the case. The addition of the vibrating armature to the "Motograph" has, it is stated, increased its articulating power to a very great extent.

* See Discussion, page 499 ante.

STEAM ENGINES AT THE PARIS EXHIBITION.—No. I.

No one can complain that there is any deficiency, so far as quantity goes, in the show of steam engines at Paris. We have succeeded in counting altogether 285, not including the semi-pumping engines and several others exhibited, chiefly for the sake of driving some special machines rather than as separate exhibits, such as the large engine in the Pierlot industries or another in the Austrian bakery. Including all these the number is very closely 300, if it does not exceed it. Of the 285 engines, 53 are exhibited along with their boilers, mostly as "semi-portables" of some form (in some cases, however, of a size quite precluding the notion of portability), and of these 52 are vertical engines (including 39 French and 17 British), and the remainder horizontal (23 of them

[There was unfortunately a misunderstanding on the part of the [illegible] of the drawings of the Paris Exhibition, which were to be published in this number, and they will appear in the next issue. We regret the delay, which has been unavoidable.]

it is capable of calling attention. This telephonic call, which is represented in Fig. 1, consists of a simple stand I, in which the receiving telephone R is suspended in a vertical position, having its mouth pierced with holes, and directed upwards. Upon the centre of its diaphragm rests, when the instrument is not in use for speaking purposes, the end of a light free lever L, pivoted to the central pillar of the stand, and the excessive blows against this lever when the diaphragm is in vibration, and the consequent rebounding of the lever from the vibrating surface, produce a sound which may be heard at some little distance from the instrument, and must necessarily be much louder than the sound emitted by the telephone without the aid of the lever. The principle of its action is very similar to that of the well-known acoustical experiment of suspending around a glass bell a number of pellets, which by being thrown away by the vibrations of the bell render those vibrations apparent to the eye, and cause them to become louder to the ear.

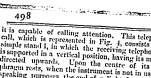


FIG. 5.

Fig. 5 is another arrangement experimented with by Mr. Edison for calling attention in telephonic circuits. At each end of the line, and in circuit with it, is placed an electro-magnet, represented in the figure by M and M′, and in front of the poles of each is fixed a magnetised steel tuning-fork A and B. When one of these forks is set into vibration by mechanical or electrical means, a vibratory electric current is induced in the coils of the magnet opposite the vibrating fork, which current, traversing the coils at the distance station, sets into sympathetic vibration the tuning-fork at the other end, whose period of vibration being precisely equal to that at the transmitting station, receives the successive attentions impulses exactly synchronously with its own period, and the consequence is that its amplitude of vibration increases until its further progress stretches against a bell, there being one at each station, represented by C and D, and gives a call signal. A somewhat similar arrangement is shown in Fig. 6,

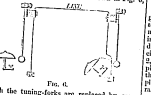


FIG. 6.

in which the tuning-forks are replaced by magnetised pendulums of equal length, opposite which are placed electro-magnets in circuit with the line. Upon causing one of the pendulums to swing in the presence of its electro-magnet or magneto-inductor a vibratory current is transmitted through the line, and the pendulum at the distant station is set swinging by impulse synchronous with its own period of vibration, and a bell is struck when its amplitude has sufficiently increased. Both in this and in the previous arrangement provision is made for stopping the bell out of the way at the transmitting station, while a call signal is being sent.

Fig. 7 represents an idea which has been suggested by Mr. Edison for constructing a telephone in which electrostatic currents are employed instead of voltaic or magneto-electric. In this curious arrangement an electrophorus is placed at each end of the line represented in the figure by B and C. Over each electrophorus is placed a metallic disc, plug-ended, and mouthpiece E or A, which in its vibration approaches and recedes from the highly-charged electrophorus below, and in so doing is supposed to induce an electrical disturbance at the distant station, and to produce sounds and articulate speech. This idea beats upon the face of it a paper stamp, and we venture to say that it never arrived at greater maturity than being sketched upon paper. Another equally visionary telephone is shown in Fig. 8, in which A and B represent two of De Luc's dry piles, having their opposite poles joined by the line wire. Each pile is supposed to contain some 20,000 discs, and the vibration of the diaphragm at either end is intended to cause an electrical disturbance in the discs in its immediate neighbourhood, transmitting an undulatory current through the line, and reproducing, by a process which Mr. Edison does not explain, articulate speech at the distant station. Mr. Edison has also been conducting experiments with a view of constructing a diaphragm of vulcanite. In this arrangement delicate thermo-pile placed in front of a leg instrument at the further end. Mr. Edison states that he has found that the temperature of such a diaphragm is, during its vibration, much lower in its forward motion than in its return, and upon this principle he hopes to construct a telephone to be worked by those variations of temperature producing corresponding variations in a thermo-electric current, and traversing a receiving instrument at the distant station.

FIG. 7.

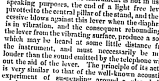


FIG. 8.

FIG. 9.

Fig. 9 represents an interesting and very ingenious experimental telephone, which was constructed by Mr. Edison in the course of his experiments prior to the production of his carbon instrument; in this apparatus the vibrations of the diaphragm were caused to throw into or cut out of circuit one or more of a series of resistance coils, 1, 2, 3, 4, &c., arranged in a circle below the diaphragm, the number of coils in the circuit, and therefore its total resistance varying with the amplitude of vibration of the diaphragm. In this arrangement, as in the carbon telephone, an induction coil C is employed, the transmitting and receiving instrument being in circuit with the secondary wire and battery, and the secondary coil being connected to the line and to earth. Mr. Edison states that with this instrument articulate utterances were transmitted, but the results were harsh and disagreeable. This result could have been anticipated, as the variation of resistance in the circuit must make a sudden change on passing each coil in drawn into or cut out of the circuit, and all the delicate variations consisting between each are lost when their corresponding variations of electrical current in between that produced by throwing in and that produced by cutting out one of the resistance coils—or, to express it by a graphical illustration, the variations of the voice would be represented by a gradually rising or falling curve or wave, while the electrical resistance of the circuit in the telephone figured in Fig. 9, and therefore the strength of current, could only be represented by a series of steps.

The last to which we shall refer of Mr. Edison's experimental telephones is represented in Fig. 10. In this arrangement, to which Mr. Edison has given the name water telephone, the variation of resistance is obtained by attaching to the diaphragm of the transmitting telephone a wire bent in the shape of the letter U, the ends of which, as the diaphragm vibrates, being plunged more or less deeply into two cells of water which are connected thereby, a variation of resistance is produced and an undulatory current is transmitted to a receiving telephone at the other end of the line.

We believe the first suggestion of the employment of water for this purpose is due to Mr. Varley, of Dublin, who by placing a drop of water between the contacts in a Reis's transmitter was enabled to obtain an undulatory current, and thereby to transmit through a telegraph wire certain articulate sounds.

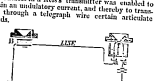
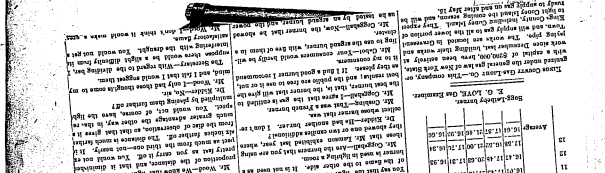


FIG. 10.

In all the telephonic instruments which have been described in this notice, the importance of using a diaphragm for causing sonorous vibrations to produce variations of electrical resistance is pronounced in every instrument described by Mr. Edison and Professor Hughes, however, has through his great discovery been enabled to show that variations of resistance can be imparted to an electrical current not only without a diaphragm, but with very much better results where no such accessory is employed, for in the conversion of the physical forces the one into the other, there must always be some loss at each change; and those physical processes which involve the fewest conversions must of necessity be accompanied with the least aggregate loss. The microphone of Professor Hughes may be looked upon as an acoustical relay by which sonorous vibrations are enabled to throw into a telephonic circuit an undulatory current from a powerful constant source, and thereby produce a great augmentation of the minute sounds which actuate the sensitive relay, and the result is that otherwise inaudible sounds are magnified into loud tones. This is its great difference from a result from all other systems, which receive a strong voice at the transmitting end, giving it out at the receiving end in far feebler tones. This difference may be illustrated by looking through a telescope with the eye at one end or the other. In the microphone, sounds are enlarged as objects are by a telescope used in the usual way, while to all other telephones they are diminished as objects are when seen through a telescope with the eye against the object glass.

Some time ago we published a description of a new form of [illegible] invented by Mr. Edison, and which he called the "Motograph." We have since received from Mr. Edison a letter, in which he states that the instrument described by us was not the latest form of the "Motograph," and that the improvements effected in it were not described in our notice. We regret that this should be the case, but we were unaware that any improvements had been made in the instrument, and could only describe it as we found it. We have since received from Mr. Edison a letter, and, in consequence, recall from our readers the "Motograph" described in our last issue.

WALLACE'S DUPLEX MAGNETO MACHINE



LE MONDE DE LA SCIENCE ET DE L'INDUSTRIE 14 JUILLET 1878

l'appareil servant dans les opérations chirurgicales et dans toutes les circonstances qui requièrent cette qualité particulière de l'éponge, de s'imbiber facilement et d'absorber les liquides. Soutenue et constamment superchargée en eau, aussi ne saurait-elle trouver d'équivalent, bien moins encore être surpassée pour les soins qu'exige la propreté, du l'emploie beaucoup dans le commerce pour l'emballage d'objets fragiles ; verre, cristaux, etc. Elle est dans ce cas bien préférable au coton, à la paille, aux copeaux. Les matelas et les coussins d'éponge ne sont ni rares, ni nouveaux. Les différents emplois de ce produit maritime sont si variés qu'on ne saurait les énumérer tous, aussi peut-on aisément prévoir que le commerce des éponges est encore à son début, que, dans quelques années, il sera mis au rang des branches importantes, et que de grands capitaux, des flottes entières, et des milliers d'hommes seront employés à la récolte d'un objet de commerce dont on trouve chaque jour une nouvelle application.

Dans le courant de l'année 1877, 250,000 livres d'éponges, représentant 625,000 fr. environ, furent exportées de Bahama. De ce nombre 100,000 livres furent importées aux États-Unis et le reste dans le Canada et en Angleterre. La récolte augmentera encore cette année.

Les variétés d'éponges connues dans le commerce sont nombreuses ; leur finesse et leur qualité déterminent leur valeur. Les pêcheries emploient environ 500 vaisseaux qui stationnent habituellement dans les eaux des différentes îles, et 2000 hommes, la plupart de couleur. Les meilleures éponges sont celles d'Alcove. La durée d'une pêche varie de deux à six semaines et dépend de la grandeur du navire et de l'état du temps ; les plongeurs ne pouvant travailler dans une eau crue.

A sa sortie de l'eau, l'éponge est noire et forme une masse gélatineuse exhalant une odeur fétide, qui s'accroît avec la putréfaction de la masse. Dès que la quantité d'éponges recueillie a été jugée suffisante, on les amène au rivage ; là on les fait exposer au soleil où elles sont entièrement dans le sable pendant plusieurs jours. Quand la décomposition est achevée, on frappe ces masses noirâtres avec d'énormes maillets ; les corps des polypes s'en détachent alors et tombent en poussière. A cette opération succède le lavage à l'eau de mer, puis les éponges sont chargées à bord.

Anciennement on se servait d'un procédé tout différent. Après avoir retiré les éponges du sable où on les avait préalablement enterrées, on les exposait dans une cage de fer, à l'action des vagues, qui les purifiaient de tous les corps étrangers, mais le sel de mer qui corrodait les éponges fit bientôt abandonner ce moyen.

Arrivées à destination, les éponges sont triées suivant leur qualité et le produit de la vente est partagé, après déduction faite des frais d'approvisionnement, entre les plongeurs et les armateurs. Une dernière préparation consiste à émonder l'éponge, c'est-à-dire à enlever toutes les parties dures et pierreuses, après quoi elles sont vendues, à la livre, aux commerçants qui les expédient dans tous les pays du monde.

L'AVENIR DU PHONOGRAPHE PRÉDIT PAR EDISON

Tout ce qu'on a déjà dit du phonographe n'est rien en comparaison de ce que nous promet M. Edison dans le dernier numéro de la *North American Review*. Le célèbre inventeur va appeler, dans un avenir rapproché, des perfectionnements considérables à son merveilleux instrument.

De fait, il suffit d'un peu d'attention pour se convaincre que les applications du phonographe sont illimitées et qu'elles créeront une véritable révolution dans les relations humaines. Comme il est possible que le phonographe, avec ses perfectionnements, combine à la suppression, dans une certaine mesure, de l'écriture et de l'imprimerie, on pourrait croire cependant, à première vue, que vouloir chercher de telles applications à cet instrument, c'est, pour ainsi dire, faire un pas en arrière.

Qu'on s'étonne aujourd'hui de la solidification des gaz ? Le phonographe nous permet de solidifier quelque chose de bien plus subtil : la parole et la pensée humaine. Au lieu des boîtes à musique et des orgues de Barbarie, dont les sons plus ou moins harmonieux écorchent nos oreilles, on aura maintenant le phonographe, qui reproduira fidèlement les chefs-d'œuvre des grands artistes vivants, les charmantes mélodies écloses par la Patti, Deux cents qui soupirent l'un pour l'autre pourront se dire à travers les monts et les mers ce qu'ils sentent, ce qu'ils craignent, ce qu'ils espèrent. Le phonographe reproduira exactement à l'oreille de l'un les accents de l'autre. M. Edison s'occupe actuellement à perfectionner l'instrument dans ses détails mécaniques. « La principale utilité du phonographe, écrit-il, consiste en ce qu'il permet d'écrire les lettres à la dictée. C'est vers ce perfectionnement que tendent ses efforts. Voici comment est construit son dernier appareil imaginé pour ce but.

Sous le stylet est disposé un disque de cire portant sur l'une de ses faces des rainures en spirale ; ce disque est mis en mouvement par un mécanisme d'horlogerie ; les rainures sont si rapprochées que l'on peut imprimer environ 40,000 mots sur une seule feuille d'étain de 30 centimètres carrés.

Une feuille d'étain est placée dans le phonographe, le mécanisme d'horlogerie mis en mouvement, et la dictée faite comme à l'ordinaire dans l'embouchure d'un cornet acoustique. La feuille est ensuite enlevée, placée dans une enveloppe *ad hoc*, et expédiée par les moyens ordinaires à son correspondant. Celui-ci, plaçant cette feuille dans son phonographe, met en mouvement le mécanisme d'horlogerie et prête l'oreille. Il entend alors la voix et les paroles qui ont été dites dans l'instrument.

On peut conserver les feuilles et reproduire leur contenu à volonté. Rien de plus aisé que de graver deux feuilles à la fois en les superposant ; on peut ainsi conserver un double de sa lettre phonographique plus facilement que des lettres ordinaires. Inutile de faire ressortir la rapidité avec laquelle ces dictées peuvent se faire. La personne qui suit la reproduction de la lettre peut entendre 150 à 200 mots par minute, tout en vaquant à d'autres occupations. Ajouter à cela le ton, l'accent, l'expression, l'émotion même avec lesquels ces missives sont transmises, et vous aurez une idée des merveilleux résultats de cet appareil.

Les avantages de cette invention sur les moyens de correspondance dont nous disposons actuellement n'échapperont à personne. Il faut espérer qu'on ne tardera pas à en faire l'expérience sur une grande échelle.

Qui sait si l'usage des lettres ne disparaîtra pas un jour ; si, au lieu de lecteurs, il n'y aura plus que des auditeurs ? Serait-il permis de supposer que la connaissance de la lecture et de l'écriture devînt superflue ?

Ainsi que le dit avec raison M. Edison, en écoutant son-

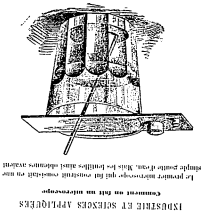
vue des divers objets que nous venons de décrire, on peut se faire une idée de la richesse et de l'importance de cette partie de l'Exposition. Elle est vraiment digne de fixer l'attention des savants et des hommes d'étude, et elle ne le cède en rien aux autres parties de l'Exposition pour ce qui est de l'intérêt qu'elle offre à la curiosité générale.

Après avoir examiné le photocalque perfectionné et l'héliographie, nous nous sommes arrêté devant un appareil très-simple et très-ingénieux, destiné à donner des épreuves positives de dessins au trait, sans avoir recours à l'emploi de la chambre noire. Cet appareil, qui est dû à M. Poitevin, est connu sous le nom de *Copiste*. Il se compose d'une planche de bois, sur laquelle on place le dessin à reproduire, et d'une glace qui vient s'appuyer sur le dessin. Cette glace est recouverte d'une couche de gélatine bichromatée, qu'on a préalablement exposée à la lumière, et qui a été ensuite lavée à l'eau froide. Cette couche, qui est devenue insoluble dans les parties qui ont été frappées par la lumière, est restée soluble dans les autres parties. Pour obtenir une épreuve, on expose le dessin à la lumière, et on le laisse pendant quelques minutes. Puis on lave la glace à l'eau froide, et on la fait sécher. Le dessin apparaît alors en traits blancs sur un fond jaune. Il ne reste plus qu'à le reporter sur du papier ordinaire, ce qui se fait très-facilement par un simple frottement.

Nous avons vu fonctionner cet appareil, et nous avons pu nous convaincre de la facilité avec laquelle il donne des épreuves très-satisfaisantes.

Nous signalerons encore, dans la classe de la photographie, les appareils de M. Lerebours, qui sont très-remarquables, et qui ont été récompensés par le jury international. Nous citerons également les appareils de M. Dubosq, qui sont très-ingénieusement disposés pour la projection des images photographiques, et qui ont été employés avec succès par M. Duboscq, dans ses cours de physique.

Nous ne pouvons pas entrer dans de plus longs détails sur cette intéressante partie de l'Exposition, et nous nous bornerons à dire que les photographies exposées par MM. Bayard, Bingham, Blanquart-Evrard, Bisson frères, Cuvelier, Delamarche, Disdéri, Fortier, Gaudin, Gustave Le Gray, Mestral, Nègre, Robert, Salmon, Thiesson, Vallou de Villeneuve, Victor Regnault, etc., etc., sont remarquables à tous les points de vue, et qu'elles ne le cèdent en rien à celles qui ont été exposées par les photographes anglais.



MICROSCOPE A LENTILLE DOUBLE. 1

Fonctionnant dans l'obscurité, ce microscope est destiné à éclairer par réflexion les objets opaques.

MICROSCOPE A LENTILLE DOUBLE.

Construction and Use of the Microscope.

L'INSTRUCTION ET LES SCIENCES APPLIQUÉES.

Nous avons vu, dans les quelques lignes qui précèdent, que le microscope est un instrument destiné à faire connaître à l'homme les infiniment petits, c'est-à-dire les objets qui échappent à son regard, à cause de leur petitesse. Nous allons maintenant donner quelques détails sur la construction et sur l'usage de cet instrument.

Le microscope le plus simple est celui qui est représenté dans la figure 1. Nous le mettrons sous les yeux de nos lecteurs, afin de leur faire mieux comprendre ce que nous allons dire.

Cet appareil simple se place sur un pied support en bois, ou en métal, et il se compose d'une petite lentille de verre, ou d'une petite boule de verre, qui est fixée dans un petit cadre de métal. Cette lentille est placée au bout d'une tige de métal, qui peut monter ou descendre à volonté, et qui est munie d'une vis de rappel, afin de pouvoir donner à la lentille la distance convenable pour que l'objet soit bien au point. Enfin, la tige de métal est fixée à une tige horizontale, qui peut tourner autour d'une autre tige verticale, et qui est elle-même fixée au pied du microscope. Cette dernière tige est munie d'un petit miroir, qui peut prendre toutes les positions nécessaires pour recevoir la lumière du jour, ou celle d'une lampe, et la renvoyer sur l'objet à observer.

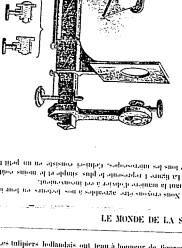
Pour se servir de cet instrument, on place l'objet à observer sur la petite table, et on le dispose de manière à ce qu'il soit bien éclairé par le miroir. On met ensuite l'œil à peu de distance de la lentille, et on regarde l'objet à travers cette lentille. Si l'on a bien disposé le miroir, et si l'on a donné à la lentille la distance convenable, on aperçoit l'objet très-grossi, et on peut alors l'examiner à son aise.

Le microscope que nous venons de décrire est le plus simple de tous ceux qui ont été construits, et il ne donne que des résultats très-peu satisfaisants. Aussi ne l'emploie-t-on que dans les cas où l'on n'a besoin que d'un grossissement très-faible, comme, par exemple, pour examiner les petites bêtes qui vivent dans l'eau, ou pour observer la structure intime de certains tissus végétaux ou animaux.

Pour obtenir un grossissement plus considérable, on emploie un microscope composé, qui est représenté dans la figure 2. Nous allons donner quelques détails sur la construction de cet instrument, afin de faire bien comprendre à nos lecteurs la manière dont il fonctionne.

Le microscope composé se compose d'un pied support en bois ou en métal, d'une tige verticale, qui peut monter ou descendre à volonté, et qui est munie d'une vis de rappel, d'une tige horizontale, qui peut tourner autour de la tige verticale, et qui est munie d'un miroir, d'une petite table, et d'un tube de métal, qui est fixé à l'extrémité de la tige horizontale. Ce tube est formé de deux parties, qui peuvent glisser l'une dans l'autre, et qui sont munies chacune d'une lentille. La lentille qui est placée à l'extrémité inférieure du tube est appelée *objectif*, et celle qui est placée à l'extrémité supérieure est appelée *oculaire*.

Pour se servir de cet instrument, on place l'objet à observer sur la petite table, et on le dispose de manière à ce qu'il soit bien éclairé par le miroir. On met ensuite l'œil à peu de distance de la lentille oculaire, et on regarde l'objet à travers cette lentille. Si l'on a bien disposé le miroir, et si l'on a donné à la lentille oculaire la distance convenable, on aperçoit l'objet très-grossi, et on peut alors l'examiner à son aise.



MICROSCOPE A LENTILLE DOUBLE. 2

Les tulipiers hollandais ont tenu à honneur de figurer à l'exposition, en offrant aux amateurs l'occasion de contempler leurs plus riches collections de tulipes.

On peut voir en avant du palais du Trocadéro, à droite, une vaste corbeille de 12 mètres de diamètre, dans laquelle ils ont planté 10,000 tulipes qui toutes, aujourd'hui, sont d'une belle venue et qui commencent à s'ouvrir de fleurs.

Cette corbeille, qui sera d'un effet ravissant lorsque toutes les plantes aux mille nuances qu'elle contient seront fleuries, fait partie de l'exposition florale de la Hollande. Elle ne sera certes pas un des moindres attraits des jardins du Trocadéro.

L'AME DES PLANTES

Le sommeil des plantes

III

Les plantes des champs et des jardins fournissent, comme les plantes d'eau, des faits dignes de frapper l'attention de l'observateur et l'esprit du penseur.

Les plantes se marient ; le moment du mariage est annoncé par l'apparition des fleurs. Il y a des fleurs qui, comme la primevère, le fuchsia, la mauve, etc., renferment des anthères et des étamines que d'autres plantes possèdent également, et dont le concours est nécessaire pour que les plantes donnent des fruits et des graines. Tandis que dans les fleurs que nous venons de citer, la fécondation a lieu par des causes que nous pourrions appeler accidentelles, d'autres possèdent, hors de l'époque de leur nuptiale, des mouvements volontaires. La vératrine, une herbe assez commune qui croît au fond des eaux tranquilles, se passe du bon office du vent ou des insectes, entremetteurs ordinaires. Les fleurs pistillées s'épanouissent, à l'extrémité, des pédoncules qui peuvent s'allonger assez pour les amener à la surface de l'eau ; elles ne s'épanouissent que lorsqu'elles sont arrivées dans cette patrie. Les fleurs staminées ou mâles, sont groupées au fond de l'eau sur de courts pédoncules qui ne peuvent s'allonger. Lorsque le moment de l'union est arrivé, le groupe de fleurs mâles se détache brusquement du pied qui le porte, monte à la surface de l'eau et s'approche successivement à l'aide des mouvements de l'onde, de chaque fleur pistillée. L'acte accompli, le long pédoncule remonte au fond de l'eau la fleur femelle qui mûrit son fruit.

Le phragmome est plus curieux encore dans la Rue (*Ruta graveolens*). Les dix étamines de la fleur s'épanouissent l'antière ; déjà on distingue au centre de la fleur ; lorsque l'époque de la fécondation est arrivée, chacune approche du pistil à son tour, selon son numéro d'ordre. Par ces contacts répétés, la fécondation n'en est que mieux assurée.

Enfin, voyons le *Cyclamen*.

Lorsque les semences sont mûres, la tige de la fleur se tord en spirale, jusqu'à ce qu'elle touche le sol et, pénétrant de force dans la terre, elle y loge les semences. Celles-ci reçoivent la nourriture de la racine-mère, car, transportées ailleurs, elles périssent.

Nous pourrions multiplier les exemples, mais nous croyons en avoir assez dit pour que l'on ne puisse nier l'intelligence des plantes. On prétend que les animaux sont doués d'une vie supérieure à celle des végétaux ; nous croyons, au contraire, que celle des plantes est au moins égale.

EDISONIANA

La carrière d'un homme célèbre. — Un nouveau thermomètre ; Le microtasimètre Edison. — Un duel phonographique. — Le téléphone à poupe de charbon. — Edison, inventeur du microphone.

Thomas Elva Edison est le nom d'un homme qui, par ses talents et ses découvertes, semble personnifier le génie de l'invention.

Né à Milan dans l'Erié, Ohio (États-Unis d'Amérique, le 11 Février 1847, il dut subvenir lui-même à son existence, dès l'âge de huit ans. Il demanda d'abord son pain aux modiques bénéfices qu'il trouvait dans la vente des journaux ; mais par l'essor de son tempérament nerveux, par la sagacité de son intelligence et la fermeté de sa volonté, il ne tarda pas à se distinguer au milieu de ses compagnons. A douze ans, il s'était déjà assuré le monopole de la vente des journaux sur toute la ligne de Detroit, dans cette nouvelle sphère, son article favorite et ses talents trouvèrent un vaste champ de travail. Il prit à son service d'autres jeunes gens et fonda un journal, le *Grand Trunk Herald*. Il l'imprimait dans un atelier ambulant, établi dans un fourgon. Il en était à la fois le rédacteur et l'imprimeur. Tous les employés de la ligne lui fournissaient des articles. Son rapide d'abonnés compta bientôt plus de 400 noms. Pour répandre plus facilement son journal, M. Edison s'arrangea avec les chefs de diverses stations, pour qu'ils empruntassent sur de grands tableaux noirs les titres des articles de fond de son journal qu'il leur adressait par le télégraphe ; cela augmenta beaucoup la vente de son *Herald*. Tout jeune encore, il se procurait ainsi les moyens de parvenir à sa future carrière. L'emploi fréquent du télégraphe l'initia bien vite à tous les phénomènes et à toutes les lois connues qui concernent l'électricité, et, à 12 ans, il abandonnait le journalisme pour établir un atelier de physique, en vue surtout de se vouer à des recherches sur les perfectionnements à apporter aux divers systèmes télégraphiques en usage. Là, il eut occasion de déployer tous ses talents.

Il passa ensuite quelque temps au service du télégraphe des chemins de fer, puis il entra dans une administration privée.

A un âge, nous le trouvons à Cincinnati, cherchant à établir l'idée, en germe encore, de son télégraphe duplex, et, quelques années plus tard, M. Edison était considéré comme l'un des plus habiles et des plus savants physiciens des États-Unis. Le nombre des brevets qu'il prit pour des inventions est incroyable ; on en compte plus de deux cents. En dernier lieu nous le voyons s'établir à Menlow Park, New-Jersey, travaillant dans de vastes ateliers, et disposant de fonds considérables qui lui permettent de réaliser ses idées.

Aujourd'hui, le monde entier connaît le nom à jamais illustre de M. Edison.

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Edison, l'inventeur du phonographe, vient de découvrir

1. Poche terminale de l'étamine contenant le *pollen*.

un nouvel appareil appelé le micrato-mètre, qui sert à mesurer la pression infinitésimale.

Cette invention laisse bien derrière elle la pile thermo-électrique, destinée à indiquer les plus faibles changements de température, et le radiomètre, qui indique la puissance motrice des forces les plus subtiles.

Le professeur Edison a eu projet une foule d'applications de son nouvel appareil, parmi lesquelles des thermomètres et hygromètres d'une sensibilité inconnue jusqu'ici. L'inventeur croit pouvoir parvenir à mesurer la chaleur des étoiles les plus éloignées et à peser les rayons du soleil.

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Le phonographe s'est distingué dernièrement par la perfection avec laquelle il a réussi à reproduire des *soli* de cornet à piston, exécutés par le célèbre Levy, à New-York. Cet artiste possède la remarquable habileté de faire rendre à son instrument des sons qui « n'ont pas », c'est-à-dire qu'il peut jouer des airs une octave plus bas que tous les autres cornettistes. Le phonographe sorti à son honneur de la lutte qu'il soutint contre son redoutable adversaire, aux applaudissements des sympathiques auditeurs qui avaient tenu à fêter la présence de M. Edison à New-York.

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En même temps que l'on signalait dans l'ancien monde la découverte du microphone, M. Edison faisait paraître dans les journaux scientifiques américains une notice sur un nouveau téléphone qu'il avait imaginé, il y a quelque temps déjà. Depuis plusieurs années, M. Edison était occupé à des recherches sur les propriétés remarquables que possède le charbon préparé d'une certaine manière. Il est parvenu à produire un téléphone *sans membrane vibrante* ; il lui a substitué un simple disque de charbon de corne.

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M. Edison vient d'adresser au *Scientific American* une réclamation de priorité sur l'invention du microphone dont la découverte lui appartient, dit-il.

M. Edison déclare que le principe du microphone de Hughes n'est pas seulement identique à celui de son téléphone à charbon, mais encore que les plus petits détails sont empruntés à ce dernier instrument. La subdivision du charbon a fait l'objet de nombreuses expériences lors de ses recherches sur son nouveau téléphone, et quant à la métallisation du charbon, il la pratique depuis nombre d'années.

Le passage le plus intéressant de la lettre de M. Edison, est celui où il attribue à M. W. H. Preece, collaborateur du professeur Hughes, à Londres, le plagiat scientifique du microphone. M. Edison avait nommé M. Preece son représentant en Europe pour ses inventions, et lui communiquait par lettres privées ou bulletins scientifiques, ses recherches et les résultats de ses travaux. Il paraît qu'en avril dernier, Edison lui avait adressé des notes sur ses recherches sur l'emploi du charbon pour mesurer un infime degré de chaleur ; or, on sait que c'est ce qui forme l'un des caractères spéciaux du microphone. C'est ensuite de ces communications, dit M. Edison, que ses idées et ses inventions furent mises à profit par MM. Preece et Hughes, et que ceux-ci réinventèrent le microphone. En terminant sa lettre, M. Edison déclare qu'il considère la conduite de M. Preece en cette circonstance, « non-seulement comme une violation de son droit d'inventeur, mais comme un véritable abus de la confiance qui M. Preece avait su s'attirer sous des dehors d'amitié. »

Nous sommes curieux d'apprendre ce que répondront MM. Hughes et Preece à ces graves accusations de M. Edison.

UN NOUVEL ÉLECTRO-AIMANT

Un nouveau genre d'électro-aimant a été décrit récemment dans l'*English Mechanic* ; sa force doit être considérablement plus grande, à dimensions égales, que celle des électro-aimants en fer à cheval. L'invention en est due à M. Joule.

UN NOUVEL ELECTRO-AIMANT FIG. 1

quoiqu'on lui ait donné quelquefois le nom d'aimant Jamin. Voici comment on peut fabriquer soi-même à peu de frais et facilement un aimant Joule.

Prenez un bout de tuyau à gaz ordinaire, de la longueur de 10 centimètres environ et d'un diamètre de 3 centimètres,

UN NOUVEL ELECTRO-AIMANT FIG. 2

et limez-le de manière à lui donner une base plate, fig. 1 ; l'ouverture A doit avoir à peu près 1 centimètre de largeur. Chauffez au rouge le tuyau ainsi préparé, puis recouvrez-le, dans le sens de sa longueur, de fil de cuivre protégé par du coton ou de la soie, fig. 2. Plus le nombre de tours est grand et plus le fil est fin, plus la force de l'aimant est grande jusqu'à une certaine limite cependants. Avec un électro-aimant ainsi construit, on peut enlever un poids de 100 kilogrammes, en employant une pile de quatre éléments Bunsen seulement.

L'IMPRIMERIE AU JAPON

Les avantages de l'imprimerie à caractères mobiles ne sont plus à établir. Chez les Européens dont l'alphabet se réduit à un petit nombre de lettres, rien n'est plus facile que de former les mots. Mais c'est une tout autre affaire dans les pays qui, comme la Chine et le Japon, ont besoin d'un caractère particulier pour exprimer chaque idée, chaque mot-

1 Voir *Monde de la Science et de l'Industrie*, p. 68, (1re année n° 5).

Pendant tout le temps de notre navigation, nous pûmes causer de navire à navire aussi facilement que si nous nous fussions trouvés dans le même cabinet. Nous croyons même avoir remarqué que le retour par la mer donnait plus de netteté au son.

Depuis, un des officiers du *Iecate*, M. le lieutenant de vaisseau des Portes, a eu la très-heureuse pensée d'appliquer le merveilleux instrument à la manœuvre des scaphandres. On a remplacé une glace du casque par une plaque en cuivre dans laquelle est enchâssé le téléphone; ce qui fait que le scaphandrier n'a qu'un léger mouvement de tête à faire, soit pour recevoir des communications de l'extérieur, soit pour en adresser. On comprend tout l'avantage d'un pareil dispositif.

Nous avons à visiter nos cavènes; les scaphandriers descendent et peuvent nous rendre compte de tout ce qu'ils voient ou font, *sans qu'il soit besoin de les ramener hors de l'eau*, comme cela s'est fait jusqu'à ce jour.

Grâce au téléphone, un homme parcourant les profondeurs des mers peut rester constamment en communication parlée avec son semblable resté à la surface.

LE TÉLÉPHONE

A L'ACADÉMIE DES SCIENCES

Dans la dernière séance de l'Académie des sciences M. du Moncel a présenté deux communications importantes relatives au téléphone; — la première est de M. J. Lavrid qui rend compte des deux expériences suivantes :

1° Dans un électro-aimant creux en fer à cheval, dont la rapidité n'était que de quelques centièmes exiles, j'ai versé une assez grande quantité d'eau pour que les deux extrémités de cet électro-aimant dont horizon, le liquide pût apparaître dans un tube capillaire adapté à l'un des branches. De cette manière les plus petites variations dans la capacité de la partie creuse de l'électro-aimant étaient accusées par une ascension ou une descente de la colonne liquide, or, en faisant traverser l'électro-aimant par un courant électrique interrompu de différente intensité, depuis la plus faible jusqu'à celle de 8 éléments Bunsen, je n'ai observé aucun changement dans le niveau de l'eau dans le tube, et par conséquent, je pouvais conclure qu'il n'y avait aucun changement dans la capacité du réservoir électro-magnétique.

2° Atteignant le résultat négatif précédent à la politesse de mon électro-aimant, j'en ai fait construire un de 30 centimètres de longueur, d'un diamètre extérieur de 40 millimètres et de deux millimètres d'épaisseur. Sa capacité était de 150 c. c. et les deux extrémités étaient fermées avec deux disques de fer dans que y étaient vissés et dont l'un portait le tube capillaire. Cet appareil étant rempli d'eau, j'ai fait passer à travers son hélice magnétisante toutes sortes de courants, et je n'ai encore jamais constaté le moindre changement dans le niveau de l'eau dans le tube. Avec cette disposition, j'aurais pu cependant observer un changement de volume de $\frac{1}{20}$ de millimètre cube, variation qui, dans les conditions de mon appareil, aurait correspondu à celle que produirait dans le même noyau un changement de plus de degré C. J'avais du reste constaté que les parois intérieures du noyau étaient magnétisées.

L'auteur en conclut que les changements magnétique l'action magnétisante dans une masse M. du [illegible] utilis[illegible] dans les téléphones aux vibrations moléculaires dont parle M. de la Rive dans ses Mémoires de 1816, est complétement dans le vrai.

Il ajoute d'autres considérations sur lesquelles nous pensons avoir prochainement l'occasion de revenir.

—

M. des Portes, ayant établi à bord du *Iecate* un circuit d'environ 100 mètres de fil de sonnerie avec retour par la mer, a mis à l'une des extrémités un téléphone Bell, et à l'autre, un aimant de téléphone portant sa bobine et suspendu verticalement par un fil de *soie*, la bobine en haut.

A l'aide de ces dispositifs, il a ensuite exécuté cinq expériences dont il rend compte en ces termes :

« *Première expérience.* — On frappe sur l'aimant transmetteur avec un morceau de bois. Les bruits sont parfaitement distincts au récepteur, et ils augmentent d'intensité à mesure qu'on frappe plus près de la bobine. Si l'on met en contact avec la partie supérieure de l'aimant transmetteur une plaque vibrante ordinaire en fer doux, les bruits entendus au récepteur sont plus forts, mais moins nets. Si, au lieu de bois, on prend un morceau de cuivre pour frapper l'aimant, les bruits perçus sont très-peu *différents*.

« Les effets obtenus dans ces deux cas ne sauraient être que la conséquence du mouvement vibratoire imprimé par le choc à l'aimant, *mouvement d'un certain ordre* que les fils métalliques transmettent à toute distance, s'ils sont dans de bonnes conditions d'isolement.

« *Deuxième expérience.* — On frappe avec un barreau de fer doux. Les bruits entendus au récepteur sont beaucoup plus forts qu'avec le morceau de bois, et, en mettant une plaque vibrante au contact de la partie supérieure de l'aimant, on saisit, en même temps que le bruit du choc, une vibration de la plaque.

« *Troisième expérience.* — On frappe sur l'aimant avec un autre aimant. Les pôles de même nom frappés l'un contre l'autre produisent un bruit semblable à celui du fer doux; mais, si ce sont deux pôles de noms contraires, on entend, après chaque coup, un second bruit produit par l'arrachement de l'aimant et qui paraît être un coup frappé beaucoup moins fort. Les bruits augmentent d'intensité, si l'on met une plaque vibrante au contact de l'aimant. La personne qui est au récepteur arrive très-rapidement à reconnaître [illegible] pour, avec quelle matière on a frappé sur l'aimant.

« *Quatrième expérience.* — Si l'on parle sur une plaque vibr[illegible] mise au contact de l'aimant transmetteur, [illegible] entend au téléphone récepteur des sons, [illegible]bles, assez semblables à ceux que produisent les vibrations d'une corde à violon. Le bruit que fait la plaque vibrante au moment où on la retire du contact de l'aimant est parfaitement entendu au récepteur.

« *Cinquième expérience.* — [illegible] quand on [illegible] au téléphone récepteur, la parole [illegible] appliqué sur la plaque vibrante

Menlo Park Scrapbook, Cat. 1030

No. 19A. "Phonograph"

This scrapbook covers the years 1877-1880 and 1887 and contains clippings about the phonograph. There are 136 numbered pages.

Blank pages not filmed: 76-136.

Thomas Ash 1030

19 A

EL SIGLO DIEZ Y NUEVE.
Octubre 21 de 1878.

SAN LUNES DE FIDEL.

Guillermo Prieto

EL FONOGRAFO.

Hace dos años, pico mas, pico menos, que andando en New-York de paseo por la parte alta de la ciudad, despues de haber visitado la fábrica de pianos de Steeway, y al doblar una esquina, con un compañero muy querido que me serviá de guia, pasó frente á nosotros un hombre de aspecto vulgar, cargado de hombros, de trajo maltratado y de sapo—to como uno de tantos obreros de los que pueblan aquella parte de la ciudad. El compañero me dijo:

—¿Se fijó usted bien en ese hombre?

—No: apenas llamó mi atencion.

—Volveremos por esta calle para encontrarlo de nuevo.

En efecto, lo cortamos la vuelta al desconocido, y á poco, ponia á su frente el daguerrotipo de mi memoria.

Era un hombre de mas que medianas estaturas, angosto y anguloso, de gran desórden en su trajo, y hasta me pareció distinguir huellas de tizne en su cara. El rostro largo y pálido, el cabello en lacios hilos sobre la frente y bajando á los ojos. La frente resguida en las sienes y como de balcon, con una prominencia saliente muy notable.

Pero lo que realmente me admiró de aquel jóven fué la mirada, iluminada por una claridad y una lluvia futima, como un rayo de sol reverberando en un topacio.

—¿Quién es ese jóven? preguntó á mi amigo sin perder de vista al hombre sobre quien se habia llamado mi atencion.

—No sino á responder á usted si hemos visto á un hombre extraordinario, típico de este siglo de fenómenos sorprendentes, ó un loco desgraciado; pero siempre sorprendente, llamado á sepultar su existencia dentro de pocos dias en *Bluteland*.

—¿Qué me está usted diciendo?

—Ese jóven se llama Eddison, nació en el Ohio, en 1847; de familia pobre, recibió una educacion comun y ganaba su vida vendiendo papeles y repartiéndolos en las calles y los ferrocarriles.

No sé por qué truco alto entró en una oficina telegráfica como uno de tantos dependientes.

Un dia llamó á uno de los directores del telégrafo, y mostrándole uno de los alambres por su parte superior, le dijo:

—Vea usted, por aquí va y viene un mensaje; pues yo creo que por aquí debajo podria ir y venir otro.

Poco esto lo dijo con tal ardor y con un tono tan convencido, que acabó el confidente por temer que saltase por una ventana aquel inventor de nuevo género, y fué despedido Eddison por loco, en virtud de su maravillosa indicacion.

A poco tiempo, como usted ha visto, iban y venian los dos mensajes y van y vienen cuatro, haciendo camino real el alambre, segun y como lo ha visto usted funcionar en la oficina de «Wester-Union Telegraf.»

La realizacion del cuento del loco dividió, respecto á Eddison, la opinion, teniéndolo los unos por génio extraordinario, y aplicándolo los otros el dictado de demente.

Eddison de nada se cuidaba ni parecia hacer caso de la misma madre que lo parió; ensimismando, semibramas, marchando al acaso, sin pretensiones de gran sabiduría ni estudios profundos, visitaba á un amigo, fabricante de pianos, y por vía de tarjeta, y como recuerdo de cariño, le sugirió una modificacion en la estructura de sus manufacturas, que le valió inmenso crédito y valiosas patentes de invencion.

Los que se acercaban á Eddison veian poco menos que con la cabeza trastornada; les hablaba á los unos de subdivisiones de corrientes eléctricas, como si se tratara de hacer tejidos de rayos ó de mecer á un mozito la Catarata del Niágara; es decir, un mar que se despecha á dia se quisiera meter el en el bolsillo ó establecer un carril aéreo para ponernos en contacto con los habitantes de la luna.

No obstante que para mis adentros, si aquel chico no estaba loco, merecia un exorcismo, por tener un diablo de mucha cuenta en el cuerpo, yo ví á aquel jóven con admiracion profunda, no sé por qué, y está fija en mi memoria su rostro, y hasta sus manos de tendones salientes, largas y tiznadas.

Han pasado dos años: la fama prodigiosa del Fonógrafo comenzó á circular en el mundo científico, y el nombre de Eddison se ha colocado en primera fila de esos genios que parecen responder arrogantes al ¿*quién como Dios?* del arrogante vencedor de Satan.

Yo, rudo é ignorante de mio, luego que ví la maquinilla parlante, me dije: esto es cosa de los yankees, espacio de hacer hablar á las piedras cuando se trata de sacar dinero.

Y al llevar la noticia del invento prodigioso á la casa de mis comadres, me decian:

—Oiga usted, Fidel, eso ha de ser cosa de hechizos; vayas usted, por Dios, con mucho tiento, y si lo llaman á usted, lo mas seguro es santiguarse, aunque sea con mucho disimulo, con la señal de la Cruz.

[illegible] por ser la glorificacion de la ciencia.

4

UNA SESION DE FONOGRAFIA

Oct 12/78

EL FONOGRAFO DE EDISON.

Cortesmente invitados por el Sr. Wise, tuvimos tambien el gusto de asistir en la noche del Jueves al ensayo del fundgrafo de Edison.

El acto se verificó en el testro de la Sociedad Nezahualcoyotl; y á su presencia de unas cincuenta personas, en su mayor parte miembros de la prensa de la capital.

Despues del tradicional *Señoras y Caballeros*, el Sr. Wise dió lectura á un discurso, glorificando los grandes conquistas del espíritu humano, especialmente en las aplicaciones de la electricidad. Nos habló del rayo, donado primero como una flora, y convertido despues en humilde mensajero del hombre para llevar su palabra á través de las tierras y de los mares, dirigió dulces quejumbres á la rasa latina, como bicicletadora, á verse, y como perfeccionadora, amenudo, de los grandes inventos científicos, y terminó esta parte de su discurso, solicitando la indulgencia de la sociedad mexicana para los ensayos que iba á emprender del aparato fonográfico.

Trasó en seguida y á grandes rasgos la biografía de Edison. Nació en Nueva York y repartidor de periódicos en los ferrocarriles, fué despues empleado en una oficina telegráfica, de donde se le despidió, porque tuvo el atrevimiento de sostener que un cierto aparato podia conducir simultáneamente dos mensajes telegráficos.

Comenzado desde entonces á sus estudios y y experimentos sobre aplicaciones de la electricidad, tuvo la gloria de alcanzar resultados maravillosos. Halló el medio de trasmitir simultáneamente no solo dos, sino hasta cuatro dispach. a telegráficos por un solo hilo; tiene muy adelantados sus estudios y cuenya para usar de la electricidad como productora de la luz; para emplearla como motor de gran potencia, y para utilizar las grandes caidas de agua, por ejemplo, la catarata del Niágara, á fin de que ofrezcan su fuerza motriz á grandísimas distancias. Por último, á la edad de 31 años, Edison es autor de ciento cincuenta descubrimientos, entre los cuales merecen particular mencion el fundgrafo, el teléfono y el micrófono.

El fundgrafo es un instrumento de extremada sencillez. Consiste en un cilindro metálico de cinco pulgadas inglesas de diámetro en su base por seis de altura, estriado en el sentido de esta, y colocado horizontalmente sobre una barra cilíndrica y estriada á su vez, que le atraviesa, y á la cual imprime rotacion un manubrio. Como las ranuras ó estrías de la barra corresponden exactamente á las del cilindro, la rotacion de aquella imprime movimiento horizontal á este. Sobre el cilindro, se adapta perfectamente una finísima lámina de papel de estaño.

Aunque esta pieza es la mas visible del aparato, podiera decirse que desempeña un papel secundario. El principal corresponde á una lezquilla, (1)a por una barra al pié de sustentacion del cilindro, que corre por delante de ella. A esta lezquilla está adaptada una membrana metálica montada en dos cojinetes de goma, cuyas vibraciones se trasmiten á una aguja, por medio de un delicado resorte.

Hablando en la lezquilla, las ondas sonoras hacen vibrar las membranas; y la aguja va marcando con extraordinaria precision una série de puntos en el papel adaptado al cilindro, al cual se imprime simultáneamente un movimiento, para que corra ante la aguja. Estos puntos son la notacion fidelísima de las inflexiones de la voz.

Pásase en comprobarlo. Colóquese el cilindro en su primera posicion, y la aguja en contacto con la superficie aguijereada, á medida que vaya ser penetrando en los puntos que ella misma trazó, repitiendo las vibraciones, que le fueron trasmitidas, á la membrana trasmisora, y esta á su vez á la columna de aire, formando los mismos sonidos articulados que se confiaron; aunque con grandes diferencias en alturs, intensidad y timbre. Por esto y para aumentar la intensidad, conviene aplicar á la lezquilla, como lo hizo el Sr. Wise, un tubo cónico, que desempeñe, las funciones de una bocina ó porta-voz.

La poca elasticidad del papel de estaño y su facilidad para ceder á la presion, son la especialidad de nuestro oido para apreciar vibraciones de amplitud infinitesimal, por decirlo así, son las agentes que producen esta maravilla. La impresion que la aguja registradora deja en el papel se conserva por las propiedades antedichas, y cuantas veces la aguja pase por ellas la trasmitirá las mismas vibraciones. En cambio, por muy pequeña que sea la amplitud de las vibraciones de la membrana, produce un sonido perceptible, pues lord Rayleigh ha demostrado que hasta para oido un movimiento de un milloncésimo de milímetro.

El *fundgrafo* no es mas que una feliz modificacion del *teléfono* articulado, realizado por el ingenioso y ya célebre M. T. A. Edison, de Nueva York. Sin que pretendamos amenguar el aprecio que merece su invencion, no nos parece fuera de propósito recordar que en 1874, presentó M. W. K. Barlow á la Sociedad Real de Lóndres un instrumento llamado *logógrafo*, fundado en el mismo principio de la reproduccion de las vibraciones sonoras por los cuerpos elásticos puestos en su trayecto. La diferencia sin embargo es notable, pues el *logógrafo* no logra mas que *pintar* la palabra por medio de líneas quebradas y curvas que indicaban el tono, intensidad y timbre de los sonidos.

El Sr. Wise, despues de haber descrito el aparato, se extendió en diversas consideraciones sobre su utilidad práctica: la lámina de estaño puede conservar y reproducir, siempre que se la pida, una aria de la Patti; el esposo ausente puede escuchar á millaresde leguas de distancia la voz de su consorte, grabada en una lámina que le trasmitan las últimas de correos; y el amante puede saborear cuanda le venga en gana, la dulce confesion de amor que unos labios de rosa hayan asomrado únicamente sobre la consabidhoja de estaño.

Procedióse en seguida al ensayo del instrumento, comenzando por el himno nacional, y repitiéndose por espacio de una hora las experiencias. El Sr. Wise platicó con un querido aparato, gritó cuan los vendedores de cuetitos, cerró como los serenos de antaño, bostezó, estiló, y pronunpió en frenéticos hurras y en *carrancleas* que hacian temblar los desatalados corredores de Bellavista; todo esto sin perder un gravedad augusta, y sin arrugarse los paños al descomprenerse el lazo de la corbata blanca.

El Sr. Wise dió por terminada la sesion á las once de la noche, y los concurrentes fuimos invitados á pasar al comedor, donde se habian dispuesto los agasajos. Allí pusimos comentarios á nuestro sabor, y el Sr. Wise llevó su amabilidad hasta el extremo de colocar una nueva hoja de estaño para que no apreciara de cerca el mecanismo del instrumento. D. Clemente Villaseñor y algunos otros artículistas dijeron frases que la aguja fonográfica anotó con maravillosa exactitud; bastaba (4) A. Alegría, mustió una cancion endemoniada, y, por último, el jóven Calva recitó una bonita octava real, glorificando al inventor del fonógrafo. Todo, incluyendo la cancion satánica, fué reproducido por el *fundgrafo*, y con esto terminamos los ensayos, por los cuales felicitamos cordialmente al Sr. Wise, deseando al mismo tiempo los ejemplos de la afabilidad y cortesanía con que se sirvió sotisfacer á todas nuestras preguntas sobre el maravilloso instrumento que ha venido á exhibir entre nosotros.

Y ahora, aventuremos dos observaciones. Sea la primera que, al verificarse la reproduccion de los sonidos, se hace perceptible al mismo tiempo cierto runnrullo sordo, profundo tal vez por el movimiento de rotacion que no limpian á los cilindros. Creemos que este pudiera remediarse fácilmente; y sea segunda que, al bien el Sr. Wise posee el idioma castellano, no puede articularlo con toda precision y claridad, y estas imperfecciones, aumentadas en la reproduccion de los sonidos hecha por el fonógrafo, alcanzan el efecto que produce el instrumento de Edison. No permitimos, pues, insinuar al Sr. Wise que para sus sesiones públicas se procure el auxilio de algun actor de buena voz y de articulacion limpia y correcta.

¿Y el teléfono y el micrófono de Edison?..... Paciencia; ya nos avisará el Sr. Wise cuando se verifica el primer ensayo, y de nuevo relataremos cuanto á nuestros lectores.

Prensa

EL FONOGRAFO. Oct 15/78

Admirados nos dejó el viérnes pasado, el ensayo del fonógrafo, en el teatro de Nezahualcoyotl; de ese aparato que tan bien escribe y reproduce la voz humana, la música, el canto y toda especie de sonidos. La funcion fué precedida por un buen discurso leido por Mr. Heredales, sobre los diversos descubrimientos alcanzados por el genio americano de Mr Edison. Despues varios experimentos invirtieron lugar y concluida la sesion, los diversos miembros de la prensa que concurrieron, fueron á hacer que el maravilloso aparato reprodujera sus gritos, sus cantos y sus juegos de palabras.

Los Sres. Wenzel y De Gante, 1, de Plateros, núm. 5, son los únicos agentes en México del fonógrafo y teléfono de Edison.

El dia 10 del actual tuvo efecto un acontecimiento bastante significativo para el mundo científico. Me refiero á la cátedra experimental, que próvia invitacion á todos los miembros de la prensa, hizo ante ellos, el fonógrafo, teléfono y micrófono, en el cuadro, ameno elegante teatro de la sociedad Nezahualcoyotl, el Dr. E. C. Wise.

Cincuenta ó sesenta individuos, pertenecientes casi todos al periodismo científico, presenciaron la experiencia, que dando poco menos que admirados unte el poder intelectual del hombre.

Y eso poder qué hace hablar á los sires inertes para importante para despertar la conciencia dormida de los relatorios al patriotismo y á la dignidad? Creo que no; porque esperar que la diputada de la Cámara de diputados, por honor propio, se convertirá en mínima é insignificante minoría.

Tabi. Oct 15/78

CHARLA DE LOS DOMINGOS.

El fonógrafo del fonógrafo!

Por fin ha llegado á México el admirable aparato que reproduce la voz humana. El jueves último la prensa fué invitada á la primera audición del prodigioso invento; interesantes fueron los experimentos practicados, y de ellos pasamos á dar cuenta á nuestros lectores.

En el salon de la sociedad «Netzahualcoyotl,» estaba reunida una regular concurrencia, ante la que se verificaron las pruebas más concluyentes. En la escena, veíase el retrato de Edison, el jóven inventor; al frente sobre una mesa estaba el fonógrafo, y de uno y otro lado el micrófono y el teléfono, todo debido al genio de ese hombre extraordinario.

La sesion comenzó por un discurso del Sr. Eduardo Wise, que en seguida insertamos, y cuya lectura no podemos ménos que recomendar, porque encierra la historia del inventor y sus grandiosos proyectos para el porvenir.

El Sr. Wise comenzó por un breve exordio, pidiendo la indulgencia de su auditorio, y en seguida dijo:

* * *

Este siglo ha sido fecundo en sus maravillosos descubrimientos é invenciones.—Cantaremos de prodigios en prodigio cada dia de nuestras nuevas pruebas de que es verdaderamente el Rey de la Creacion.—Por todas partes la naturaleza se somete á sus mandatos, y las leyes fieles esperan sus órdenes para servir á sus necesidades, sus caprichos. Un dia encadena un rayo, como quien sujeta una fiera, hoy le maneja á su placer, y la confia sus pensamientos para que los lleve á través de tierras y mares, y el relámpago le obedece como un cordero.

Tengo el honor ahora de presentar ante vdes., una [illegible]-traccion práctica de algunos aparatos del inventor Cesaneable, más grande y más notable de la época.—El Sr. Tomás A. Edison—Tendré el gusto de exhibir ante vdes., esta noche, algunas de las invenciones de este señor, cuplicando al indulgente público me dispense, si no soy capaz de hacer justicia al eminente inventor.

Unas cuantas observaciones pueden demostrar, cómo un jóven, en unos cuantos años, ha conseguido más, que lo que han podido soñar los sábios antiguos, y aun los modernos, con la instruccion del siglo.

El Sr. Tomás A. Edison, comenzó su vida como casi todos los grandes hombres de los Estados-Unidos. Nació en el Estado de Ohio en 1847, de padres humildes y honrados, y no hay sinó una edad en la que el Sr. Edison no haya principiado á dar cuenta á nuestros lectores.

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Unas cuantas observaciones pueden demostrar, cómo un jóven, en unos cuantos años, ha conseguido más, que lo que han podido soñar los sábios antiguos, y aun los modernos, con la instruccion del siglo.

El Sr. Tomás A. Edison, comenzó su vida como casi todos los grandes hombres de los Estados-Unidos. Nació en el Estado de Ohio en 1847, de padres humildes y honrados, y no hay sinó una edad en la que el Sr. Edison no haya principiado á dar cuenta á nuestros lectores.

Continuó sus investigaciones no solamente en teoría, sino prácticamente. En muy poco tiempo consiguió desquitar hasta cien mil pesos en cualquiera direccion por el mismo alambre ó conductor. Este estableció su reputacion. Una invencion siguió á la otra sucesivamente. Hasta hoy el mundo civilizado debe al Sr. Edison más de 150 invenciones, todas científicas, y que marcan el adelanto del siglo y la grandeza de su inteligencia, por ejemplo, el teléfono, el micrófono, el megáfono, el aeróligno, la pluma-eléctrica, y como si esto no bastara, ha venido por último Mr. Edison, y ha inventado el fonógrafo.

El fonógrafo sirve para conservar los sonidos, sean ó no articulados ó artículados; de manera que no solo los reproduce una vez, sino que los reproduce cuda vez que uno quiere poner en accion el aparato. Este guarda la palabra como una arca cualquier objeto, y no hay más que abrirla para encontrarlo. Los experimentos hechos con el fonógrafo ante la Academia de ciencias de Paris y el Instituto real de Lóndres, y en presencia del prodigio, los sabios acadé micos no pudieron dominar su entusiasmo y rompieron en aplausos atronadores.

En la gran Exposicion Internacional de Paris, la comision científica le regaló una medalla de oro, como el inventor más notable de la época.

De sus últimas invenciones, el teléfono y el fonógrafo, pueden considerarse entre las más elevadas. Son unos futuros y sus importancia no pueden ser apreciados actualmente. Segun las últimas noticias recibidas del Sr. Edison, sabemos que ha logrado la aplicacion del gran problema de aplicar la electricidad para producir la luz, y como un motor para la maquinaria más extensa.

Hasta ahora los científicos más distinguidos solo han podido dividir la luz eléctrica en diez partes. El Sr. Edison ha descubierto la manera de dividirla en diez mil luces. Tambien porque utilizar el poder de las cataratas ó cascadas, ríos, etc., que ahora se pierde, por medio de la electricidad; y se dice que por este medio, el poder de cien millones de toneladas de agua que se precipitan en el abismo del Niágara cada hora, con una caida de ciento cincuenta piés, se podria trasmitir, por medio de la electricidad en todo el Estado de Nueva-York para mover la maquinaria de la fábrica de Valiant, que emplea 300 hombres, y que dista del rio la cantidad pierde de una milla, y se dice que en esta trasmision solo se pierde 20 por ciento del poder del rio.

Tengo el placer de presentar á vdes., finalmente, el fonógrafo. Este aparato es prodigio la voz humana, el canto, silbidos y

la música instrumental—la voz humana, sea cantando ó hablando, ó cualquier otro sonido; no solo lo repite por una sola vez, sino por todas cuantas veces se desee ya sea ahora, ó dentro de un mes, un año ó un siglo.

Este aparato, tan sencillo, reproduce la voz humana por medio de la insculpcion,—resultado deseado por tanto tiempo, y lo que no han podido lograr miles de hombres de la más alta inteligencia, despues de muchos años de estudio.

Me propongo ahora demostrar prácticamente los trabajos de este aparato, siguiendo el programa, y empezemos con el Himno nacional.

Ahora tenemos grabado el glorioso Himno nacional en una lámina delgada de estaño (como esta) por medio de un disco, cuyo diafragma vibrante contiene un pequeño punzon, puesto en movimiento por la vibracion de la voz, y dando al mismo tiempo vuelta al cilindro para recibir la impresion de los sonidos en su órden.

Para reproducir este Himno nacional, palabra ó sonido cualquiera, no se requiere más sino que el punzon vuelva á recorrer su mismo camino. El punzon, al pasar sobre las impresiones anteriormente causadas por la voz, pone en vibracion otra vez el diafragma, y de consiguiente reproduce el mismo sonido, como vdes. oirán en seguida. (Repeticion del Himno nacional por el fonógrafo.)

En seguida continuaremos con algunos experimentos prácticos. (Se hicieron los experimentos.)

Como dije antes, esta invencion está en su infancia é en embrion. Este aparato simplemente hasta un principio hemos hace muchos años, y al fin encontrado por el Sr. Edison.

Imaginemos que se pueda hablar por medio de esta pequeña lámina de estaño, mandándola en un sobre por el correo á un amigo, á miles de leguas distante, quien podrá, agitándolo en su máquina, oir de viva voz lo que se le dice.

Dentro de pocos años de la fecha este aparato le podrá estar en toda familia.

Ayudará al esposo, cuando tenga que viajar, á dejar sus instrucciones á su esposa. Ayudará á un enamorado para hablar á su amante sin verla, y ella podrá oir sus palabras de amor cuando lo desee.

Las más sublimes canciones é melodías de la Penatini ó de Adelina Patti podrán mandarse como una carta á cualquier punto del mundo. No tienen ya los usos á que este simple aparato podrá aplicarse dentro de pocos años!

Tambien tengo el honor de presentarles el teléfono del Sr. Edison. Este instrumento hará desaparecer al telégrafo,—como existe hoy, en pocos años, y aun hoy existe en uso general en Nueva-York y otras grandes poblaciones, especialmente para los cambios de bierro, banqueros, comerciantes, etc., y como comunicacion particular.

Hay varios teléfonos construidos bajo distintos principios. El teléfono de Bell, como el colocado entre Chapultepec y el Paseo, depende de una magnesia para conducir sonidos, mientras que el pretendo que la invencion del Sr. Edison es enteramente original, pensado únicamente en un disco de carbon, del tamaño de una peseta, que sirve para trasmitir la voz. Debo decir á vdes. que el descubrimiento del Sr. Edison, de la propiedad y sensibilidad del carbon, es una de las maravillas del siglo—casi todas las invenciones, como el micrófono, dependen de esto.

Con este aparato, la voz ó cualquier sonido puede ser trasmitido á 500 ó 1,000 millas.

Este precioso aparato es el micrófono y teléfono combinados; hablando por conducto de esta boquilla, aunque sea á tres ó cuatro pies de distancia, se pueden oir á 20 ó 40 millas, clara y distintamente todas las palabras que se digan.

Imaginemos que un padre haya colocado un pedazo de carbon en la sala, en donde su hija tiene una entrevista con su amante. (Ahora sorprenderán no quedarán ciegos al saber que él, en su recámara, está al tanto de toda la conversacion entre los dos amantes por medio de su micrófono! Si no lo creen, usad el carbon y lo verán.

* * *

En seguida principiaron las esperiencias, un caballero cantó el himno nacional entre la pequeña bocina del aparato, y este lo reprodujo con toda fidelidad, pero perceptible, nada se perdia de la cadencia de la música, y las palabras del canto se conservaron asimismo.

Despues el Sr. Wise habló varias veces, el fonógrafo reprodujo sus palabras repitiéndolas con toda claridad. En seguida á la bocina una corneta, tocó una diana, el aparato la devolvió perfectamente; se imitaron los gritos de diversos animales, se tararon canciones, silbidos, se tocó por medio del piston la marcha de Aida, y por último, se agruparon gritos, silbidos y música; todo se reprodujo con la vibracion de la delgada lámina de estaño que, grabados en pequeños puntos, conserva las inflexiones de la voz.

El invento está en la infancia y no pero deja de ser maravilloso la voz se escucha débil pero se percibe clara, y cuando las palabras se pronuncian bien y fuerte, entonces el aparato las devuelve con notable perfeccion. La concurrencia aplaudia entusiasmada á cada nueva prueba.

Porque en preciso admirarse delante de aquel maravilloso aparato que ya cantaba, ya hablaba, ya silbaba, y remedaba los gritos de los animales, todo con gran fidelidad.

El problema está resuelto, el complicado aparato de la laringe humana, está ahí convertido en un rodanito, un cilindro y una agnia insertada sobre una lámina de talco; la dificultad que en contra de el fonógrafo [illegible] como todos los inventos, se sencillo en sus construccion y fácil en sus diversas aplicaciones, [illegible] de [illegible] de la [illegible] que todavia [illegible] máquina [illegible] [illegible] [illegible]

prerenciado no pueden ser más satisfactorias, porque debe decirse que asistimos á la infancia del aparato, y tal vez puede que también esta reciente práctica para manejarlo, y que á favor de ella los resultados deben ser más brillantes todavía.

De todas maneras nos cabe la satisfacción de haber visto y escuchado á la maravillosa máquina que en estos momentos es la admiración de Londres y París. México también ha tributado ya un homenaje de respeto al genio de Edisson, le ha aplaudido, le ha enviado al través de la distancia el más sincero y entusiasta parabien.

Los Sres. Wise y Bardisco se proponen dar algunas sesiones de audicion del fonógrafo en el mismo teatro de la Netzahualcoyotl. Suponemos que acudirá una numerosa concurrencia, porque el objeto vale bien la pena, el aparato es digno de verse; todo lo que pudiéramos decir á nuestros lectores es poco; hay cosas que es necesario palpar las para creer en ellas.

Cuando hace algunos meses nos llegaban las primeras noticias del fonógrafo, sonreíamos con desdén creyendo que no trataba de algun *humbug* americano; mas cuando los mas sabios las avalaron con los cuerpos científicos han intentado al inventor, y sobre todo, cuando hemos visto y oido el aparato, no hemos podido ménos de abismarnos en la contemplacion de tanto, el vuelo que alcanza la sublime inteligencia humana, y de todos los adelantamientos que verifica nuestro siglo.

La voz de nuestros dias.

Obsequiando la invitacion que el Dr. E. G. Wise hizo á la prensa para que asistiese el jueves en a noche al teatro de la «Sociedad Nezahualcoyotl,» donde iba á pronunciar un discurso científico y hacer una prueba práctica de... el fonógrafo, microfono y fonógrafo del renombrado Edisson, fuimos, y ocupamos un asiento en uno de nuestros palcos de los espectadores. No nos arrepentimos, sino que, por el contrario, quedamos satisfechos de no haber faltado á la cita.

¿Quién no sabe á la ciencia? ¿Quién no asiste á sus triunfos, y celebra y aplaude como propias sus victorias? No tiene duda que el siglo XIX vive en gran intimidad con la naturaleza física, y que este premia el trabajo de las inteligencias que solo consagran, abriéndoles el *sancta sanctorum* de sus leyes y revelándoles el misterio de sus secretos.

Cada dia se suceden unos á otros nuevos inventos, que sobre ser asombro y maravilla del mundo, motivo de gloria, de inmortalidad y de fama del inventor, es para los demas un particular y para la sociedad en general, un medio de que se sirven para adelantar un paso siquiera en el áspero y difícil camino de la perfeccion intelectual, y á la vez un elemento que explota de mil suertes y con múltiples fines, al grado de convencerse de que casi no hay imposibles para el hombre en el reino de la materia. Dios le entregó el mundo, no solo para que lo dominase como rey, sino para que con sus investigaciones, con sus estudios y aún con sus controversias, crisas á hiciese brotar en él otra luz ese no fuera la del sol, pues el sol ilumina los cuerpos, es su esplendor; pero no puede ilustrar las almas, ni ser su antorcha.

Los tres aparatos científicos que hemos nombrado son un testimonio brillante de hechos que en épocas mas remotas del pasado, se habrian negado por absurdos, ó puesto en duda por inexplicables. Cada uno de ellos habria bastado para honrar á su siglo, á una nacion entera.

Hoy los tres juntos son preciosos engastes de una corona, en que resplandecen otros ciento de mayor ó de igual estima. Edisson, jóven aún, pues apénas tiene treinta y un años, ha hecho con la electricidad, lo que tantos sábios como le han precedido no se habieran atrevido ni á soñar. Con ella ha logrado trasportar la palabra á una distancia de quinientas millas, sin que los instantes le aventajen en rapidez. El teléfono, es una prueba de ese increible portento. Con ella se ha aumentado la intensidad de los sonidos, á fin de que, no por ser imperceptibles, se escapasen á la observacion. El ruido que hace una mosca cuando vuela, ó cuando se posa en nuestros cabellos, bajo la audicion por medio del *micrófono*, parece el estruendoso aleteo de un condor que desde la altísima cumbre de los Andes, se precipita sobre nosotros y se nos acerca, ó una herrada caballgadura, la que pone en planta en nuestra cabeza. Con ella ha alcanzado á escribir la palabra y los sonidos concertados en el bronce, y hacer que la escritura sea una verdadera lengua que habla al oido, y los signos acústicos á notas de la nueva gama musicos instrumentos que toquen á la voluntad alegres sonatas y sublimes pinturas.

El lector se ha menester para leer lo escrito, de haber aprendido el alfabeto, ni los amantes de la armonía para concurrir con las bellezas de Euterpe, necesitan haber cursado las aulas del Conservatorio. Todo mortal, en el hombro sobre la tierra, manos su voz, que depositada en una lámina de estaño y en otra de oro, podrá hacerse oir dos siglos despues de haber sido llevadas á la sepultura los labios y el sér querido que la pronunciaron. Inaudito prodigio! testimonio maravilla! Gloria á la ciencia! Loor y gloria á los cultivadores incansables de la ciencia.

* * *

El fonógrafo fué el aparato que mayor sorpresa causó en los concurrentes. Si no la concitaran nuestros lectores acompañaremos su descripcion, y diremos algo sobre la manera con que obra. Es efecto, es para sorprender.

El aparato repitió sin perder una sola palabra los parabienes que le acababa de dar el Dr. Wise, personificándolo; el himno nacional cantado por Quesada, la marcha de Aida tocada en el piston por no sabemos quién, y varios de nuestros toques militares, sonidos en el clarin. Lo oimos silbar con Emilio Duran, y reir alegremente, ladrar y cacarear con Calderantes, no, el autor del Q. Pito, sino un gallinero de la calle de Zuñiga. Lo escuchamos mandar una batalla con la voz de un general que podria encontrarse del otro lado del oceano. Reprodujo la algazara de una zambra mechuitombre, en la que unos rian y otros lloraban; unos hablan y otros cantan; unos se alaban y otros se llenan de vituperios; unos estornudan y otros gritan desaforadamente.

Aunque todos los trabajos del fonógrafo nos dejaron satisfechos, á decir verdad, no le creemos tan diestro para los sonidos articulados como para los concertados. El fonógrafo es más músico que parlante, ó nosotros más parlantes que él.

Volvamos á repetir: gloria á la ciencia! ¡Loor y gloria á los cultivadores de la ciencia! ¡Loor y gloria al inmortal Edisson!

EL FONOGRAFO DE EDISON.—Pro-

Anticipamos en nuestro número de ayer ocuparnos hoy de la sesion fonográfica con que el Sr. Dr. Eduardo Wise obsequió anteanoche, en el teatro de la Sociedad Netzahualcoyotl, á la prensa de la capital, y sin presunciones y divertidas inconsecuencias, hemos, al fin que nos proponemos, pasmos á llenar ese compromiso.

A las ocho y media se hallaban reunidos en el salon un gran número de periodistas y otras personas distinguidas que, deseosas de conocer el nuevo invento de Mr. Edisson, se habian dado cita allí, correspondiendo á la amable y atenta invitacion del Sr. Wise.

Pocos minutos despues se presentó en la plataforma el jóven doctor americano Sr. Wise, y dió lectura á un discurso que versaba sobre los grandes conquistas de la inteligencia humana, y muy particularmente sobre las aplicaciones de la electricidad.

Hizo tambien una breve reseña biográfica de Mr. Edisson, quien nacido de humildes padres, en la ciudad de Nueva-York, pasó los primeros años de su vida vendiendo periódicos en los estudios de ferrocarril para seguir la ocupacion, cuya hasta cierto punto, no con formaba las aspiraciones de la gigantesca alma del que mas tarde debia prestar grandes servicios á la humanidad, con su asombrosa invencion, y al niño Edison logró un lugar en una oficina telegráfica, donde se dedicó al aprendizaje del arte de Samuel Morse.

Trascurrido muy poco tiempo, concibió la idea de trasmitir á la vez dos diferentes telegramas por un mismo alambre, y al revelar sus pretensiones á su superior, éste lo tuvo por loco, y en medio de la burla de sus compañeros, tuvo que abandonar aquella oficina.

Como todo hombre de talento, poco ó nada se preocupó esta nueva decepcion, y con mayor entusiasmo se dedicó á sus estudios, al grado de lograr trasmitir algunos telegramas por un solo alambre telegráfico.

Entre los muchos descubrimientos que ha dado al mundo son, quizá, los principales el teléfono, el micrófono y el fonógrafo.

Habiéndonos de este último, que es el que tuvimos ocasion de conocer en la sesion de anteanoche.

Consiste en un pequeño cilindro metálico puesto horizontalmente sobre una barra tambien cilíndrica, á la que en el extremo de mas pequeño de su mandrin. Sobre el mandrin se extiende una delgada lámina de estaño, en la que se van grabando una serie de puntos pequeños, que marca una aguja, á la que transmiten vibraciones la membrana de una boquilla fija al pié de sustentacion del cilindro.

Al hablar en la boquilla se ondes sonoras hacen vibrar la membrana esta imprime á la aguja á donde va sujeta. En puntos de que hemos hablado, y al volverse á colocar la aguja en el mismo punto que estaba al empezarse á hablar, el fonógrafo, puesto en movimiento, repite palabra por palabra, sonido por sonido, con una exactitud verdaderamente fabulosa, que la admiracion que en esos momentos inspira la inteligencia humana, va creciendo gradualmente.

Volvamos á la sesion.

Despues del discurso del Sr. Wise, el Sr. Quesada cantó sobre la boquilla del fonógrafo nuestro entusiasta himno nacional, que repitió fielmente el nuevo aparato, y la concurrencia aplaudió en una nutrida y prolongada salva de aplausos.

La voz del fonógrafo es fuerte y si se quiere sonora; con frecuencia se nota en ella cierta confusion que hace ininteligibles algunas palabras; pero esto, segun lo manifestó el mismo Sr. Wise, depende de la poca regularidad con que hacia girar el cilindro la persona que lo manejaba, siendo á veces el movimiento mas precipitado que otras.

No obstante, entre ya hemos dicho, el himno nacional y algunas otras piezas que cantó el Sr. Quesada, fueron reproducidas por el fonógrafo con una perfeccion admirable.

El Dr. Wise hizó repetidas veces en el fonógrafo, y en la reproduccion de sus discur-

los notamos poca claridad y hasta algun confusion, tal vez por los ligeros é inevitables defectos de que adolece su pronunciacion castellana; lo que nos hace creer que el fonógrafo se adapta mejor al español que á cualquier otro idioma extranjero, sin duda por su extremada sonoridad, pues la misma confusion notamos cuando al Sr. Wise dijo algunas frases en frances, inglés ó aleman.

Concluida la sesion, los concurrentes fueron invitados á pasar á la piñonferos para examinar aquel maravilloso aparato.

Estos actos tendrá lugar una sesion públicas, cuyo precio de entrada es un peso, y recomendamos á nuestros lectores no dejen de concurrir á ella, pues seguros estamos de que pasarán un rato sumamente divertido en el elegante salon de la sociedad Netzahualcoyotl.

UNICOS AGENTES

DEL "COMBATE."

PARA LOS ANUNCIOS Y PUBLICACIONES DE ESTE PERIÓDICO EN EUROPA Y LOS ESTADOS-UNIDOS,

LOS SRES. EMILIO BIERCOCK Orlieb y Comp.ª 17 y 19.

REVISTA DOMINICAL.

—o—

TELÉFONOS, FONÓGRAFOS Y MICRÓFONO.—LO QUE SE TIENE QUE OIR.—LO QUE OIR-SE NO DEBIERA.—ESCENAS FONOGRÁFICAS —HISTORIA DEUN CRITERIO.—PELIGROS DEL FONÓGRAFO.—MANÍA DE LAS FARO-LAS.—DE LOS MONUMENTOS.—DE LOS JARDINES.—DE LOS EUCALIPTOS.—DE LOS FERROCARRILES.—TODOS CONTENTOS Ó SEA LA JIRA DE NOS.—ASCENSION DEL SR. ALEXAE.—LA SOMBRA DE D. FERNANDO. —LA CARIDAD.—DE D. COSME.—EL CACOS.—TEATRO HIDALGO.—TEATRO ARDEU.

¡Oh tiempos y oh costumbres! dijo un filósofo, y yo, con el deseo de *fonografiar*, lo repito.

Hace unos cuantos meses los periódicos dijeron y volvieron á decir que habia un nuevo descubrimiento; el del teléfono; despues vino la noticia del fonógrafo y por fin la del micrófono.

Aquellos tiempos felices, nosotros sin teléfonos, fonógrafos ni micrófonos, oiamos claro y distintamente las voces de los afamados artistas que con la Patti-ni vinieron: oiamos las melodías agradables de la orquesta; oiamos las dulces voces de las hermosas que al teatro concurrian, y hoy ¡oh suerte mil veces impia! hoy que poco hay que desear oir, se nos presenta el fonógrafo que por lo que se vé no es mas que un utilidor y no de grandes dimensiones, en derredor del que se extiende una lámina de metal, por cierto bastante dulzada, estando en contacto con éste, una punta ó lengüeta palpadña qué hace vibrar la voz.

¿Pero qué voces hace vibrar? no la de la Peralta cantando, no la de la Pezzana declamando, sino la de algunos que pondrán las fuerzas agarrocera, la de otro que dice que hace frio, la del de mas allá dí guien le picó una pulga.

Por otra parte, convenid conmigo en que el fonógrafo llega al mundo en el momento y época mas inconvenientes: pues será de nosotros el dia que este instrumento terrible se propague! Puesto en el congreso nos dirá que el diputado N., que hoy pone al pian de Tacuyos, por ejemplo, sobre los cuernos de la luna, mañana lo pondrá bajo las pezuñas de los caballos; llevado al hogar dirá á la esposa los rasgiieros que en su ausencia prodigó al marido á la criada; repetirá el *angel mio*, de la recien casada á la esposa á quien ya el marido llama *demonio*; dirá al esposo tierno lo que su mujer dijo al amante. Yo os digo, os repito, os anuncio á que no llevais á vuestro hogar el peligroso instrumento. Tened la conviccion de que la vida es tolerable á causa de que nuestras pincelladas van mezcladas con un poco de olvido, y figuraos que cuando vais olvidando, obligais al fidelísimo fonógrafo á que os repita lo que os hace mal.

Hace poco tiempo que un enamorado habia ido á ver á su novia á la casa de ésta; se le condujo al salon en que estaba preparado el repetidor instrumento, pero el jóven no lo sabia, la novia entre tanto se pintaba en el tocador y el adorador esperaba.

Un cedrillo albergado indebidamente en el vientre del jóven, hizo sentir á éste el deseo de recobrar la perdida libertad; mas tuvo miedo se vió solo y no encontró un sério inconveniente en libertar al cautivo, y éste salió dando un suspiro tan sonoro como prolongado al verso libre; momentos despues apareció la jóven con un efecto la mas bella pintura, digna del pincel de Rafael ó Miguel Angel. Despues del saludo y de los besos de rigor, pasaron al mayor salon, donde estaba el instrumento y lo hizo repetir. Mientras la voz metálica repitió en todas sus inflexiones el suspiro del cedro.

Yo supongo á todos mis lectores de talento, y es seguro, en consecuencia que piensen por cinco minutos solamente en lo peligroso de tener en casa un fonógrafo. No; hoyos debe llevársela al viento, y hoy tanto mas; hoy que ya ni se escribe, por temor de que lo escrito escrito quede.

LOS INVENTOS

DEL SR. TOMAS A. EDISON.

EL FONÓGRAFO,
EL TELÉFONO

Y EL MICRÓFONO.

Sesion de experimentos y pruebas prácticas, celebrada en la noche del juéves 10 de Octubre de 1878, en el teatro NETZAHUALCOYOTZL ante los representantes de la prensa mexicana y varios hombres científicos, por el DR. EDUARDO CLAY WISE y el DR. F. A BEARDLEE.

El siglo en que vivimos—dijo aquí el sabidísimo inventor con caracteres indelebles en los registros de la historia, ha dicho Flammarion:

La tierra está trasformada.

No por el *milagro* de Josué.

No por las lenguas de fuego de Pentecostes.

No por el paso del mar Rojo.

Está trasformada por los pesados marillos de la industria, por el rechino de las cizallas de hierro, por el silbido del vapor, por el conductor del pensamiento, por las sondas de Paterson, por el rédio-sendro, por el telescopio y el *sextor* de los siglos futuros.

¡La tierra está trasformada!

¡No es Carlo Magno quien la lleva en su manga!

Es el compas del geómetra, el hélice, el dragon flanjuero de la locomotora, el telégrafo que nos permite contar en un minuto la pulsacion de la humanidad entera; por el *fonógrafo* que reproduce eternamente y de viva voz, nuestras palabras, nuestros discursos, nuestros suspiros, nuestra risa y aún el canto que sale de nuestro pecho. ¡El *fonógrafo!* que repite por centenares de años y un número ilimitado de veces la voz de los que ya no existen y el sonido de la bocina que dió la voz de ataque á un sitio de batalla, de triunfo, de victoria!

Es el fonógrafo que hará perfectamente hablar á una distancia de 600 millas ó mas, con un Parisino, un Americano, cuya voz escuchamos ó cuyas palabras oimos como si estuviera a nuestro lado habladonos al oido.

No estamos trasformandos en nosotros mismos, sino en lo que nos rodea, en lo que vivimos, en el medio que habita nuestro ser físico, moral y material. Estamos trasformandos por el *Microfono* que nos hace oir las palabras que se han hablado á una distancia que se ha tocado en cualquier lugar de una pieza distante 20 millas del lugar en que vivimos; el zumbido de un insecto, la pisada de un visitante ó la conversacion de dos ó mas personas; estamos regenerados por los grandes adelantos de la ciencia.

Dejaremos para otra ocasion cuanto pudiera decirse de estos preciosos inventos con que ha honrado al Siglo presente el inteligente Sr. Edison, y sin comparos con la extension que desafianos de la primera sesion de *Fonógrafo* ó máquina de hablar, que hemos presenciado en Méxieo, presentamos á los lectores del *Combate* el discurso científico que en esos momentos pronunció el Sr. Dr. Wise, con motivo del espresado prodigio de que fué invitada la prensa de esta capital, y algunos hombres de ciencia.

Há aquí el discurso de nuestro amigo y compañero el Dr. Wise, á cuya amabilidad debemos el poderlo comunicar á los lectores de nuestro periódico.

Señores:

Al presentarme por primero vez ante la respetable é inteligente sociedad mexicana para tratar sobre una materia científica, y en una forma á mi entender sin precedente en este pais, no se me ocultan las dificultades que deberé vencer si mi discurso ha de ser inteligible y agradable á la mayoría de la concurrencia que bondadosamente se ha reunido para escucharme en la noche de hoy.

No mi desconfianza, sin embargo, ni mi defectuosa elocucion, ni mis pocos conocimientos en el bello, suave y expresivo idioma castellano; cuanto desde luego con la importancia de la materia, por una parte, y por la otra con la tradicional y caballerosa indulgencia que tanto ha distinguido y distingue á la raza latina en donde quie-

ra que la humanidad en suerte constituirse en Nación.

Este siglo ha sido fecundo en sus maravillosos descubrimientos é invenciones.

Continuamos de prodigio en prodigio; cada día dá un hombre nuevas pruebas de que es el verdadero el rey de la creación.

Por todas partes la naturaleza se somete á sus mandatos y las leyes físicas esperan sus órdenes para servir á sus necesidades, sus placeres ó sus caprichos. Un día sucedió el rayo, como quien sujeta una fiera; hoy la maneja á su placer y le confía sus pensamientos para que los lleve á través de tierras y mares, y el reló pago le obedece como un cordero.

Tengo el honor ahora de presentar ante vdes. la prueba práctica de algunos aparatos del inventor incansable, más grande y más notable de la época—el Sr. Tomás A. Edison—Tendré el gusto de exhibir ante vdes. esta noche, algunas de las invenciones de este sabio, suplicando de antemano al indulgente público, me disimule si no soy capaz de hacer justicia al eminente inventor.

Unas cuantas observaciones pueden demostrar cómo un jóven, en unos cuantos años, ha conseguido más que han podido soñar los sábios antiguos y aún los modernos con la ilustración del siglo.

El Sr. Tomás A. Edison, comenzó la vida como casi todos los grandes hombres de los Estados-Unidos. Nació en el Estado de Ohio, en 1847, de padres humildes y honrados; tiene apénas 31 años. Logró obtener la edución primaria. Vendió periódicos en el trayecto de los caminos de fierro, y despues entró en una oficina telegráfica, para aprender la profesion; de esta oficina fué despedido porque inició la idea de que dos mensajes podian despacharse al mismo tiempo, por el mismo alambre. Fué considerado por este motivo, inútil en materia de la electricidad y sus usos. Esto no le hizo desmayar; continuó sus investigaciones, no solamente en silencio, sino privadamente. En muy poco tiempo adelantó bastante, hasta conseguir mandar un mensaje á distancia por el mismo alambre ó conductor. Esto estableció su reputacion. Una invencion siguió la otra sucesivamente hasta hoy; el famoso diplomado debe al Sr. Edison más de ciento cincuenta invenciones, todas científicas, que merecen el adelanto y la grandeza de su inteligencia; por ejemplo: el Teléfono, el Micrófono, el Magnófono, el Micro-Telmetro, el Motógrafo, el Aerófono, la Pluma Eléctrica, etc. etc. y como si esto no bastara, ha venido por último, Mr. Edison y ha inventado el Fonógrafo.

El Fonógrafo sirve para conservar los sonidos, sean ó no comunes, ó articulados: de manera que no solo las reproduce una vez, sino que los reproduce cada vez que quiere uno poner en accion el aparato. Este guarda la palabra como una arca cualquier objeto, y no hay más que abrirla para encontrarlo.

Los experimentos hechos con el Fonógrafo en la Academia de Ciencias de París, en el Instituto Real de Lóndres y en presencia del prodigio, los sábios académicos no pudieron dominar su entusiasmo, y rompieron en aplausos atronadores.

En la gran Exposicion Internacional de París, la comision científica le dió una medalla de oro, como inventor más notable de la época.

De sus últimas invenciones, su Teléfono y Fonógrafo, pueden considerarse entre las más elevadas. Sus usos futuros y su importancia, no pueden ser apreciados actualmente.

Segun las últimas noticias recibidas del Sr. Edison, sabemos que ha logrado la solucion del gran problema; de aplicar la electricidad para producir la luz, y no un motor para la maquinaria más exterior.

Hasta ahora, los científicos más distinguidos solo han podido dividir la luz eléctrica en diez partes. El Sr. Edison ha descubierto la manera de dividirla en diez mil veces: tambien, propone utilizar el poder de las cataratas, cascadas, ríos, etc., que ahora se pierde, por medio de la electricidad; y no dice que por este medio, el poder de 100.000.000 de toneladas de agua que se precipitan del salto del Niágara cada hora, con una caida de 160 piés, se podrá trasmitir, por medio de la electricidad en todo el Estado de Nueva-York, para mover la maquinaria de sus innumerables fábricas. Cuando advertimos que este poder sería igual al vapor producido por 260.000.000 de toneladas de carbon, cuya suma es lo que se consume anualmente por el mundo entero, se podrá formar una idea de la inmensidad del proyecto.

Como ensayo de este gran descubrimiento, se trasmite en la actualidad por la electricidad, el poder suficiente de un pequeño rio en el Estado de Connecticut, para mover la maquinaria de la Fábrica de Walker, que emplea 200 hombres, y que dista del rio la cuarta parte de una milla, y se dice que en esta trasmision solo se pierde 20% del poder del rio.

Tengo el honor de presentar á vdes. primeramente el Fonógrafo. Este aparato reproduce la voz humana, el canto, los silbidos, y la música instrumental; la voz humana, sea cantando ó hablando, ó cualquier otro sonido; no solo lo repite por una sola vez, sino por todas cuantas veces se desee; ya sea ahora, ó dentro de un mes, un año ó un siglo; siempre lo mismo.

Este aparato tan sencillo, reproduce la voz humana por medio de la mecánica—resultado deseado por tanto tiempo, y lo que no han podido lograr miles de hombres de la más alta inteligencia, despues de muchos años de estudio.

Me propongo ahora demostrar prácticamente los trabajos de este aparato, siguiendo el programa, y empezaremos con el «Himno Nacional.»

(Se cantó el Himno Nacional y el Fonógrafo repitió el canto.)

Ahora tenemos grabado el glorioso himno nacional en una lámina delgada de estaño, como este. (El Dr. Wise presentó al público la lamina donde queda grabado el Himno Nacional, para verlo repetido *in eternam*, por el Fonógrafo) por medio de un disco cuya diafragma vibrante contiene un pequeño pezon puesto en movimiento por la vibracion de la voz, dando al mismo tiempo vuelta al cilindro para recibir la impresion de los sonidos cantados.

Para producir este himno nacional, palabra ó sonido cualquiera, no se requiere más, si no que el pezon vuelva á recorrer su mismo camino. El pezon, al pasar sobre las impresiones anteriormente cansadas por la voz, pone en vibracion otra vez el diafragma y de consiguiente reproduce el mismo sonido, como ustedes oirán:

(Volvió á repetirse el canto del Himno Nacional, sin variar en nada al primero.)

En seguida continuaremos con algunos experimentos prácticos.

(Se ejecutaron varios experimentos de canto, de palabra y de músics, etc., etc., todos satisfactorios.)

Como dije ántes, esta invencion está en su infancia ó en embrion.

Este aparato simplemente, ilustra un principio basado hace muchos años, y al fin encontrado por el Sr. Edison.

Imaginemos que se puede hablar por medio de esta pequeña lámina de estaño, mandándola en un sobre por el correo á un amigo, miles de leguas distante, quien podrá aplicándola en una máquina, oir á vivo voz lo que se le dice. Dentro de pocos años de la fecha, esto será lo general en todas partes.

Ayudará al esposo cuando tenga que viajar, á dejar sus instrucciones á su esposa. Ayudará á un enamorado para hablar á su amada sin verla, y ella podrá oir sus palabras de amor cuando lo desee.

Las más sublimes canciones ó melodías de la Peralta, ó de Adelina Patti, podrán mandarse como una carta á cualquier parte del mundo. No tiene fin los usos á que este simple aparato podrá aplicarse dentro de pocos años.

Tambien tengo el honor de presentarles el Teléfono del Sr. Edison.—Este instrumento hará desaparecer al Telégrafo como existe hoy, en pocos años. Y aun hoy mismo está en uso general en Nueva-York y otras grandes poblaciones, especialmente para los caminos de fierro, banqueros, comerciantes y etc., como comunicacion particular.

Hay varios Teléfonos construidos bajo diversos principios. El Teléfono de Bell, como el colocado entre Chapultepec y el Palacio Nacional depende de una magneta para conducir sonidos; mientras que yo pretendo que la invencion del Sr. Edison es enteramente original y depende únicamente en un disco de carbon, del tamaño de una peseta, que sirve para trasmitir la voz. Debo decir á vdes. que el descubrimiento del Sr. Edison de las propiedades y la sensibilidad del carbon, es una de las maravillas del siglo; casi todas las invenciones, como el Micrófono, dependen de esto. Con esta aparato, la voz ó sonido cualquiera, puede ser trasmitido á 20 ó 1.000 millas.

Este pequeño aparato es el Micrófono y Teléfono combinado. Hablando por conducto de esta boquilla, aunque sea de tres ó cuatro piés de distancia, se puede oir á 20 ó 40 millas, clara y distintamente todas las palabras que se digan.

Imaginaos que un padre haya colocado un pedazo de carbon en la sala en donde su hija tiene una entrevista con su amante. ¡Cuán sorprendidos no quedarán estos al saber que él, es su reconvenzo, está

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al tanto de toda la conversacion entre los dos amantes por medio de un Micrófono.

¡Un pedazo de carbon, señores, es hoy el receptáculo del pensamiento universal!

Nuestro amigo Wise, terminó su discurso y á continuacion puso en prácticas su variedad de experimentos fonográficos, que dieron motivo para que la concurrencia colmara con atronadores aplausos, los primeros experimentos hechos en el país, con el invento sublime de este siglo, que es mecánico y ficticio será llamado el siglo de Edison.

Terminados los experimentos y puestas prácticas del Fonógrafo, el Sr. Wise, con esa amabilidad que lo caracteriza, invitó á los concurrentes á que ellos mismos examinaran é hicieran uso de los aparatos fonográficos, telefónicos y micrófonos. Unos pasaron en accion al Teléfono, otros al Micrófono y los más, profirieron al Fonógrafo, cuyo mecanismo es admirable por su sencillez y cuyo uso es fácil para todo el mundo.

Las varias mexicanas tuvo su ámina especial y algunos periodistas hicieron del Fonógrafo, para dedicar expresiones de admiracion hácia su autor. El jóven poeta Sr. Calvo, pronunció una elegante poesía dedicada á Edison y al Fonógrafo que fué recibida con aplauso de todos los concurrentes.

Quisiéramos comunicar á los lectores del Combate cuanto la pasado en la sesion del dia 10, pero sus columnas no lo permiten por hoy, reservándonos hacerlo en otra ocasion con la amplitud que merecen los inventos mas sorprendentes de un siglo ya rico y fecundo en invenciones.

Concluimos, pues, agradeciendo á nuestro compañero y amigo el Dr. Wise la gentil invitacion con que nos honró, para que pudiéramos observar y admirar los últimos inventos del Sr. Edison y saludando con entusiasmo el recuerdo del eminente inventor cuyo nombre es para nosotros tan grande en la ciencias y en la física, como Dupuytren en la medicina, Shakespeare, Voltaire y Rousseau en la literatura, como Cristóbal Colon en la navegacion, como Fulton en la locomocion, como Miguel Angel, Murillo, Velazquez, Claudio, Gallet y Cellini en el arte, laborioso como Palissy, constante como Colon, revolucionario como Morse, valeroso como Chenier, constante como Watt y sereno como Fulton, no retrocede, no desmaya ante las asechanzas y la befa de la ignorancia, sino que lucha y trabaja, revela y propaga la idea de unir el pensamiento y la palabra, el canto y la música en toda la extension de nuestro planeta. Los Lores de Inglaterra escudian sus sueños puros con una chispa eléctrica que veia de Madrid, hoy se recogerá la chispa, y la voz de toda la humanidad que llegará por el teléfono, se repetirá en el Micrófono y quedará grabada eternamente en la lámina fonográfica.

¡Los mundos se mueven por Colon!

¡Los espacios se sondearon por Kepler!

¡Galileo mandó moverse á la tierra, la iglesia la esclavizó, pero la tierra obedeció á Galileo!

¡Gutemberg nos legó la imprenta!

¡Franklin domió el rayo!

¡El pensamiento unió de humanidad por Morse!

Las distancias se extrecharon por Fulton!

¡Lebon dió luz á la humanidad!

¡Tomás A. Edison nos ha dado aparatos, á quienes ha dicho ¡¡¡Parlad!!!

El lápiz, el brazo y la electricidad declaron, y á la voz de su genio ¡están parlando ya! con su otro dón la humanidad que no reconoce fronteras ni leyes á la naturaleza y los secretos á ¡¡¡Dios!!!

J. G. Puncn.

The National Democrat.

HAIWAIN, N. A., NOVEMBER 7, 1878.

Ha! Ha! Ha! Ho! Ho! Oh-h-h! We would have to put one of Edison's phonographs to do justice to the occasion. The daily *Herradura* says we clip items from it. Why, those poor dear little soul—we have been watching for a chance to clip something ever since the day of our adopty, and have not yet found a single paragraph worth a clip—except a death notice one day. But it is quite remarkable that for a day or two after our paper is read the daily items will come a reeling, if not clipped, from our columns.

Chanity Entertainment.—The entertainment at the Opera House last Friday evening proved a success both as to attendance and performance. The programme was quite lengthy, but it had been arranged with a view to fill up the time in case the phonograph could not be present, which was not certain until within a few days of the time. The exercises opened with quite a brilliant piano solo by Miss Sadie Malloy, followed by a tableau of the "Pansies," consisting of nineteen pretty little girls tastefully dressed in white and grouped together. Then came a solo and chorus "Hide-a-Cot," conducted by Prof. Blacker, the "o being taken by his little nephew, who has a very pleasing voice with fine compass. Frank Elliott then gave a little address stating that the object of the entertainment was to raise money to relief a large family of colored people who have had to be helped by citizens, back to the South where they came from. Misses Lillie Hereford and Jennie Liggett then gave recitations which were well rendered and received with applause. Next was a piano solo by Miss May Frost well executed, followed by a tableau "Lt. Artist's Dream." Miss Jessie Glassbore then recited "Mamma Obliges" in excellent style. A humorous dialogue "The Wrong Man" was well performed by a number of young ladies and gentlemen.—Then followed a solo and quartet "The Little Ones at Home," followed by a tableau "Out in the Cold," a very effective representation of a poor little boy sing in the street with the snow fal[illegible] upon her while a song was sung in the d[illegible] by Miss Lillie Tepper with beautiful effe[illegible]. Next was a recitation by Jos. Kemper, [illegible] a duet quartet "The Swiss [illegible] Misses Clara, Wilson, Tepper, [illegible] Mooney, Perkins, Reed, Morse and [illegible] next a recitation by Miss Clara Ellis, and another double quartet "Uncle John." Miss Carrie Osborn then executed a very nice solo on the piano, followed by a tableau in three scenes "The Bridal"—first, bidding good bye to her father; second, renewal [illegible] bound; third, the wedding. Master Roy Avery, a little midget, then gave a recitation, and was repeatedly encored. Master Percy Glassford, another little one, also recited a piece, showing much talent for one so young. "Nancy Lee" was then sung as a solo and chorus, Jr. S. G. Perkins taking the solo. This was followed by a piano solo duet by Misses Jessie and Maggie Liggett. The next on the programme was a very amusing thing, called the "Pink Sisters," consisting of [illegible] dozen or more young ladies with high white hats ending in a shiny peak, black dresses, white handkerchiefs about the shoulders, and large pink bead fans, with which they brought on their mandies on the stage in Hutchinson Family style, singing "We're a band of sisters," a "Station" by one of the sisters and a song and chorus were the novelties presented.

The most interesting part of the entertainment to most of the audience was the exhibition of Edison's Phonograph by two of his assistants. The machine worked splendidly and demonstrated the wonderful invention to perfection, in all the different experiments of talking, laughing, coughing, whistling, etc. Mr. Perkins tipped a little of "Dolly Brown's Baby," and Miss Wilson sang "Auld Lee" which were repeated with precision, except when the gentleman who turns the crank gave a sudden jerk, when the tone would be considerably elevated; if the cylinder is turned very rapidly the tone will be sent up several octaves.

Much credit is due to Mr. and Mrs. Morrow, Mr. Jones and other teachers and scholars of the city, to Miss Palmer who arranged the "Misses" and others who assisted in the entertainment, all of whose names we are not possessed of.

We have received the following for publication in t[illegible] connection;

Haiwain, Nov. 6th, 1878.

Thomas A. Edison, Esq.,

Dear Sir:—I have been deputed by the school children, of this city, to get up the Charitable Entertainment at the Opera House on the 1st inst., to communicate to you their thanks for the loan of your phonograph on that occasion. The instrument was a source of great interest and gave universal satisfaction. Yours, very respectfully,

J. W. Bayard, Jr., Chairman.

N[illegible] William Cassaday, [illegible]

—I have been requested by the school children of this city, who got up the Charitable Entertainment at the Opera House on the 1st inst., to return to you their thanks for your valuable services on that occasion, [illegible]ibiting that unrefined instrument, the [illegible]ph. Yours, very respectfully,

W. Bayard, Chairman.

Receipts of the entertainment.....$81 00
Expenses,.....16 00

Balance,.....$64 50

H. G. McFarland, Treasurer.

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EL FONOGRAFO.—Ayer tuvimos el gusto de hacer una nueva visita á este personaje, que no nos atrevemos á llamar máquina, porque para ello nos ha dado razones convincentes.

Parece que algunos dudaban sobre el invento, que otros creian que la expuesta era una suplantacion de la máquina de Edisson, sin faltar quien atribuyese á ventriloquismo ó prestidigitacion las maravillas de que ya hemos hablado.

La sesion privada del fonógrafo se verificó sin etiqueta ni aparato, en la casa número 14 del callejon de Santa Clara y esquina del Cinco de Mayo, casa de todo punto desocupada, que sin esfuerzo se sujetaba á la mas escrupulosa inspeccion.

Entre las personas que recordamos como asistentes á la entrevista con el fonógrafo, mencionaremos á las siguientes:

Lics. Ignacio Mariscal, Joaquin Alcalde, Luis Mendez, Manuel G. Prieto. Sres. Mariano Bárcena, Gumesindo Mendoza, Pedro Santacilia, Francisco Urquidi, José Antonio Gamboa, Lomelí y algun otro que no tengo en este momento en la memoria.

El exámen, las experiencias y sus resultados fueron brillantísimos, produciéndose en tan distinguida reunion un entusiasmo sincero y apasionado, que equivale á una ovacion espontánea y espléndida al inmortalizador de la palabra humana.

El Sr. F. de Grees que estaba en la reunion propuso que cada uno de los circunstantes confiase unas cuantas palabras al fonógrafo, diciendo su nombre en seguida para remitirlas á Edisson: el pensamiento fué acogido con entusiasmo, y uno á uno dirigimos nuestro saludo al inverosímil inventor.

Quisiéramos haber podido conservar en la memoria los pensamientos elevados y los rasgos de verdadera elocuencia que se confiaron al fonógrafo.

La conmocion era intensísima, no obstante tratarse de un pequeño círculo de amigos, las palmadas sonaban á cada revelacion del invento singular, y como todos rodeaban el aparato y es tan sencillo, tan independiente de adminículos y de manifestacion tan patente, se disipó hasta la mas leve sombra de duda sobre los expositores, aunque la duda y aun la detraccion cuando se trata de estas maravillas, son los únicos puntos de contacto que tienen las pretenciosas mediaufas al tratarse de las obras del génio.

Próximamente se dará una exposicion del fonógrafo, y nosotros excitamos á todas las personas amantes del progreso á que hagan conocimiento con una de las maravillas mas sorprendentes del presente siglo.—*Guillermo Prieto.*

Siglo XIX Oct 23/78

ВЪ ГОСТЯХЪ У ЭДИСОНА.

Не трудно себѣ представить что человѣкъ обогатившій Америку такимъ громаднымъ количествомъ новыхъ изобрѣтеній, какъ Эдисонъ, знаменитый изобрѣтатель фонографа, долженъ быть чрезвычайно популяренъ въ своемъ отечествѣ. Дѣйствительно, жилище этого ученаго съ утра до поздняго вечера осаждается цѣлыми полчищами журналистовъ, репортеровъ, фотографовъ и т. п. Такое вниманіе вскружило бы несомнѣнно голову всякому другому смертному; что же касается Эдисона, то единственное желаніе флегматичнаго профессора поскорѣе отвязаться отъ этой толпы докучливыхъ гостей. Тѣмъ не менѣе, уступая чувству любопытства, какъ Американцы, такъ и иностранные посѣтители продолжаютъ направлять свои шаги къ порогу Эдисона чтобы поглядѣть, какъ они выражаются на „the papa of the phonograph" (отца фонографа). Всѣ журналы единодушно воспѣваютъ ему хвалебные гимны. Вотъ одна изъ такихъ статей, заимствованная нами изъ американскаго журнала *World*. Она любопытна какъ своимъ заглавіемъ, въ чисто американскомъ вкусѣ, такъ въ особенности потому что знакомитъ насъ ближе съ такою геніальною личностью какъ Эдисонъ. Вотъ ея заглавіе:

Знаменитый Эдисонъ

или

усовершенствованіе фонографа далеко за предѣлы самой пылкой фантазіи, усовершенствованіе обѣщающее исполненіе полной оперы, не говоря уже о романѣ въ 500 страницъ.

На дняхъ корреспондентъ газеты *World* посѣтилъ профессора Эдисона въ его лабораторіи въ Менло-Паркѣ. Послѣ обмѣна обычныхъ привѣтствій, корреспондентъ спросилъ: „Какъ поживаетъ сегодня вашъ фонографъ, г. Эдисонъ?"—„О! почти также какъ и всегда", былъ отвѣтъ;—„впрочемъ вы лучше справьтесь объ этомъ у него самого." Корреспондентъ послѣдовалъ за Эдисономъ въ обширную и свѣтлую мастерскую, находящуюся въ верхнемъ этажѣ его лабораторіи, гдѣ и увидѣлъ фонографъ на одномъ изъ многочисленныхъ столовъ мастерской. Репортеръ *World*'а закричалъ шутливымъ тономъ, въ то время какъ самъ Эдисонъ сталъ медленно вращать цилиндръ фонографа: „Какъ поживаете, м. г.?" и тотчасъ же получилъ, при обратномъ вращеніи цилиндра, отвѣтъ въ томъ же самомъ шутливомъ тонѣ и въ тѣхъ же словахъ. Эдисонъ между тѣмъ расположился на стулѣ возлѣ своего любимаго открытія; говорилъ, бранился, пѣлъ, свисталъ предъ отверстіемъ фонографа, получая то серіозные, то шутливые отвѣты, смотря потому какіе были вопросы. По истеченіи нѣсколькихъ минутъ профессоръ сказалъ съ усмѣшкой, вставая со стула: „Какъ странно и въ то же время смѣшно что человѣку для того чтобы посвистать нужно сдѣлать страшную гримасу, между тѣмъ какъ фонографъ обходится безъ этого. Эй, Мартинъ!" закричалъ онъ, обращаясь къ одному изъ своихъ рабочихъ (всѣхъ мастеровыхъ у Эдисона, несмотря на обширность его мастерской и массу получаемыхъ имъ ежедневно заказовъ, всего только пять. Но самолюбивый ученый не желаетъ довѣрить своихъ секретовъ большему числу людей, и съ этою цѣлью заручился преданностью только этихъ пяти мастеровъ, преданностью, на которую онъ можетъ вполнѣ разсчитывать въ виду громаднаго жалованья которое онъ имъ платитъ: каждый изъ нихъ получаетъ по 400 долларовъ въ мѣсяцъ), „спой-ка мнѣ что-нибудь басомъ у фонографа." Къ отверстію остроумнаго прибора были прикрѣплены двѣ каучуковыя трубки съ воронкообразными концами, и въ то время какъ Эдисонъ пѣлъ теноромъ „John Brown's body" (американская національная пѣсня), Мартинъ съ своей стороны подпѣвалъ ему густымъ басомъ. „Ты недостаточно громко поешь", сказалъ профессоръ, вертя цилиндръ въ обратномъ направленіи. „Я что-то охрипъ сегодня", отвѣчалъ нѣсколько сконфуженный мастеръ. Тогда Эдисонъ, думая поправить дѣло, снова спѣлъ ту же пѣсть, на этотъ разъ уже одинъ. Результатъ превзошелъ ожиданіе. Когда привели въ дѣйствіе снарядъ въ обратномъ направленіи, пѣсня до мельчайшей нотки была повторена инструментомъ съ удивительною отчетливостью. Между тѣмъ Эдисонъ присѣлъ отдохнуть, а корреспондентъ воспользовался этимъ временемъ чтобъ окинуть взоромъ всю комнату съ ея обстановкой. Надъ его головой находилась настоящая сѣть изъ телеграфныхъ проволокъ, похожая на паутину гигантскихъ размѣровъ и соединенная съ огромною гальваническою батареей, помѣщенною въ сосѣдней комнатѣ. „Что, вы употребляете всѣ эти проволоки?" спросилъ репортеръ. „О! да", былъ отвѣтъ. „Что это тамъ за трубка?"—„Это часть моего аэрофона".—„А тамъ въ углу та пластинка надъ которою трудится рабочій?"—„Это штифтикъ для моего электрическаго пера." Тогда корреспондентъ, пользуясь любезнымъ приглашеніемъ хозяина, началъ гулять по мастерской, дѣлая подробный обзоръ окружавшимъ его предметамъ. Тутъ были цѣлыя тысячи маленькихъ и большихъ стклянокъ и флаконовъ наполненныхъ различными химическими снадобьями и расположенныхъ на полкахъ вдоль всѣхъ стѣнъ лабораторіи.—„Съ какою цѣлью у васъ тутъ цѣлая аптека, г. Эдисонъ?" спросилъ репортеръ.—„Вотъ видите", отвѣчалъ профессоръ, „всѣ эти вещи у меня собраны безъ всякой опредѣленной цѣли, а только такъ, чтобъ имѣть ихъ подъ рукой на всякій случай. Каждый разъ когда я вижу какой-нибудь новый реактивъ, я его пріобрѣтаю, не торгуясь. Во время всего этого разговора электрическій звонокъ помѣщенный на другомъ концѣ комнаты не переставалъ звонить, давая знать что идетъ депеша. Прочитавъ ее Эдисонъ обратился къ корреспонденту со словами: „Мнѣ сообщаютъ что профессоръ Бартлеттъ изъ Пенсильванскаго университета собирается читать лекцію, часть которой будетъ произнесена предъ фонографомъ. Тогда я прикрѣплю къ нему телефонъ и пошлю такимъ образомъ лекцію въ Филадельфію."—„Какія приложенія фонографа намѣрены вы сдѣлать?" спросилъ репортеръ. „Я имѣю въ виду фонографировать какъ романы, такъ и вообще всякія другія литературныя произведенія и въ особенности музыку. Листы съ оттисками будутъ сняты съ фонографа и воспроизведены въ тысячахъ экземпляровъ новымъ электрическимъ способомъ."—„А что будетъ стоить листъ такой музыки?"—„Около двадцати пяти центовъ."—„Но какъ вы поступите чтобы фонографировать піесу исполняемую [illegible]ымъ оркестромъ?"—„Тогда фонографъ будетъ приведенъ въ сообщеніе съ отверстіемъ на днѣ боченка, на противоположномъ концѣ котораго будетъ прикрѣплена трубка похожая на тѣ которыя употребляются для вентиляціи на пароходахъ. Такого рода воронка будетъ собирать звуки всего оркестра; звуки же фортепіано будетъ принимать особаго рода гуттаперчевымъ капюшономъ, помѣщеннымъ подъ самымъ инструментомъ; напряженность звука въ немъ будетъ равна приблизительно четверти напряженности дѣйствительнаго." — „А какъ вы примѣните вашъ приборъ къ чтенію литературныхъ произведеній?"—„Я разсчелъ что обыкновенный романъ цѣной въ два съ половиной франка можетъ свободно помѣститься на моемъ снарядѣ", сказалъ Эдисонъ, ударивъ по поверхности цилиндра фонографа, имѣвшаго около пятнадцати центиметровъ въ діаметрѣ. „Романы и прочія литературныя произведенія будутъ читаны предъ отверстіемъ фонографа лучшими чтецами, а листы будутъ воспроизводиться тѣмъ же электрическимъ способомъ какъ и музыка. Такимъ образомъ вы теперь видите что можно имѣть у себя въ гостиной фонографъ, а рядомъ съ нимъ альбомъ, наполненный фонографированными музыкальными піесами или литературными произведеніями. Вамъ стоитъ только взять листъ изъ альбома, помѣстить его на фонографѣ чтобъ имѣть удовольствіе прослушать [illegible] фонію Бетговена или сонату Моцарта. Перемѣнивъ только листъ, вы можете выслушать страницу интереснаго романа. Наконецъ, чтобы доставить удовольствіе молодежи, вы заставите фонографъ сыграть какой-нибудь вальсъ или польку. Такимъ образомъ при помощи фонографа вы разомъ избавляетесь отъ трехъ различныхъ затратъ: отъ необходимости держать чтеца, нанимать тапера и

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Schwäbische Kronik,

des Schwäbischen Merkurs zweite Abtheilung. III. Blatt.

den 19. December 1878.

ляющемъ. Вы легко можете видѣть, продолжалъ Эдисонъ,—какую выгоду получить фонографъ въ рукахъ сквалыгъ; а уже теперь получилъ около ста заказовъ отъ лицъ страдающихъ этимъ недугомъ. Да и для лицъ здоровыхъ онъ не останется безъ пользы. Адвокатуру, напримѣръ, стоитъ только пропишется предъ этимъ спарадическимъ своимъ рѣчь въ этомъ видѣ въ какомъ онъ думаетъ сказать ее въ судѣ и, заставивъ инструментъ повторить ее, онъ самъ себѣ можетъ дать отчетъ о силѣ того впечатлѣнія которое онъ произведетъ на присяжныхъ и публику. Теперь, продолжалъ Эдисонъ, спокойнолюбо улыбаясь,—наиболѣшій вопросъ можетъ заставить фонографъ творить самъ всѣ тѣ вещи рѣчи которыя онъ говорилъ ему а такимъ образомъ давать для себя всякаго отсутствовать въ отсутствіе. Вамъ, вѣроятно, извѣстна карикатура помѣщавшаяся въ какомъ изъ нашихъ журналовъ, изображающая семью сидящую за столомъ; въ ней члены ея заняты каждый своимъ дѣломъ, занимаютъ отъ отца курящаго сигару, небрежно разговаривающаго съ гостьей, и кончая ребенкомъ которого кормитъ съ ложечки его мать. Въ это время на столѣ стоитъ фонографъ. Благодаря ему, каждый членъ семьи можетъ изъ отсутствовать, шпарить действительно автоматически и дать возможность всему семейству слушать роман, изображенный на его цилиндрѣ, безъ того чтобы кто-нибудь утомлялся отчего-нибудь.—Что ставитъ фонографъ?" перебилъ репортеръ.—„Около 100 долларовъ; есть, впрочемъ, инструменты различныхъ цѣнъ, смотря по тщательности отдѣлки и украшенія." —„Поговоримтесь объ атрофіи."—„О! охотно," отвѣчалъ Эдисонъ. —„И теперь такъ-называемый помощникъ фонографовъ. Аэрофонъ, сказ ... объ немъ просятъ сообщить. Онъ не требуетъ особой квалитуры и заказчикъ могъ. У него только одна нота, и слюнообразование производится въ немъ мгновенно подъ вліяніемъ дѣйствія паровой струи." Репортеръ собирался предложить еще вопросъ, когда замѣтилъ что Эдисонъ, кусая губы, вертитъ, надежду, ему своею докучливостью", подумалъ, забуждение это продолжалось не долго. Черезъ минуту Эдисонъ возвратился, сопровождаемый лакеемъ, несшимъ огромный подносъ. Подносъ поставили на столъ, и когда лакей сладострастно прикрашенную репортеръ проглотилъ рюмочки рюмочной энергіи,—„Теперь мы можемъ продолжать," сказалъ улыбаясь Эдисонъ. „Такимъ былъ процессъ всѣхъ концовъ разговора о высокопучныхъ предметахъ.

A. J.

den 19. December 1878.

In Eßlingen den 17. Dec. fand Vierstellung des Gewerbevereins und der Bürgergesellschaft wurde hier gestern Abend das Wunderkind der neuesten Erfindungen, der Phonograph, einer äußerst zahlreichen Versammlung vorgeführt. Der Vortrag hatte sich in 2 Theile; ein mehr theoretischer, den Prof. Mach behandelte, verbreitete sich mit experimentaler Illustration über das Wesen und die Gesetze des Schalles und legte in die wissenschaftlichen Grundlage. D. Strenger, ein gebovener Amerikaner, bezeigt in Ludwigsburg, sei in Stuttgart bei Prakt. Techn hie günstigen von Hall, Heilbronn ꝛc. ihren vorausgegangenen Beifall auch hier geschmeichelt. In zum Theil, pfunkfeier Rede sagte er die Grundprinzipien des Instrumente und den Modus seiner Thätigkeit auseinander. Sehr interessant und ansprechend war die kurze Skizze über den praktischen Erfinder des Telephonen, den Amerikaner Edison. Die Brodem D. Sprengers waren überaschend. Ohne nur die in einer deutschen Sprache aufgesprochene Rede den Schall- oder Vibrationsfortgang entsprechend aufsprichet, sondern auch Nichtsprechendes, sofern es nur laut und hörbar ist, gesprich auch und sogar getreu wiedergibt z. B. Orchester, Gesänge, Pfeifen, ein gelungenes Lied. Die Erfindung liegt, das liegt wenn noch so unter Kinderlachen, aber es ist kein Zweifel, es ist einer großen Entwicklung

Übertragen am 19. Dec. 1878.

The Phonograph.—The phonograph is being exhibited daily in action at the various establishments of the London Stereoscopic Company, who are sole licensees of Mr. Edison's patent. As the nature of the point of the stylus is found to be important in affecting the articulation, these points are now made of ruby. Any improvements Mr. Edison makes on this, his favourite invention, will be reproduced by Mr. Senk, the maker in England. The Stereoscopic Company have also issued an interesting shilling pamphlet on the phonograph, including extracts from Mr. W. H. Preece's lecture before the Physical Society, and the reports and interviews of several American journalists with Mr. Edison.

7. Whether the unaided force of voice impinging upon the diaphragm, and proximity of the mouth to the diaphragm to effect a record?

These depend in a great measure upon the volume of sound delivered into the reproduction. If the reproduction is to be made audible to an audience, considerable force is requisite in the original utterance; if for the individual only, the ordinary (subdued). In both cases the original utterances are delivered directly in the mouth-piece of the instrument. An audible reproduction may, however, be had by speaking at the instrument from a distance of from two to three feet in a loud tone. The application of a conical tube or funnel to collect the sound waves, and the construction of an especially delicate diaphragm and embossing point, &c., are the simple means which suggest themselves to effect this. The writer has not as yet given this stage of practical difficulty in gathering up and retaining a vertical part of the sound waves diffused about the original source within a radius of, say, three feet (sufficiently removed not to be annoying to a speaker or singer).

THE PHONOGRAPH AND ITS FUTURE.

By T. A. EDISON. *

Of all the writers' inventions, none has commanded such prominent and earnest attention throughout the civilized world as has the phonograph. This fact he attributes largely to that peculiarity of the invention which brings its possibilities within range of the speculative imaginations of all thinking people, as well as to the almost universal applicability of the foundation principle, namely, the gathering up and retaining of sounds hitherto fugitive, and their reproduction at will.

From the very abundance of conjectural and prophetic opinions which have been disseminated by the press, the public is liable to become confused, and less accurately informed as to the immediate result and effects of the phonograph than if the invention had been one confined to certain specific application, and, therefore, of less interest to the masses. The writer has no fault to find with this condition of the discussion of the merits and possibilities of his invention: for, indeed, the possibilities are so illimitable, and the probabilities so numerous, that he—though subject to the influence of familiar contact—is himself in a somewhat chaotic condition of mind as to where to draw the dividing line. In point of fact, such line cannot with safety be defined in ordinary inventions at so early a stage of their development. In the case of an instrument of the nature and scope of the phonograph, it is practically impossible to indicate it to-day, for to-morrow a truth may extend it almost indefinitely.

There are, however, certain stages in the development process which have thus far been actually reached; certain others which are clearly within reach; and others which, though they are in the light of to-day to be classed as possibilities, may to-morrow become probable, and a little later actual achievements. It is the intention of the writer in this article to confine himself to the actual and the probable, to the end that a clearer conception of the immediate realization of the phonograph may be had. He contradicts to the public press and the world of science the imaginative work of pointing and commenting on the possible. It is in view of the liberal manner in which this has already been done, and the handsome treatment he has received at their hands, that he for the first time appears in print in discussion and comment upon the merits of one of his own inventions.

In order to furnish a basis upon which the reader may take his stand, and accept or combat the logic of the writer in his presentment of the possibilities of the phonograph, a few categorical questions are put, and answers given upon the essential features of the principle involved:

1. Is a vibrating plate or disc capable of receiving a complex motion which shall correctly represent the peculiar property of each and all the multifarious vocal and other sound-waves?

The telephone answers affirmatively.

2. Can such complex movement be transmitted from such plate by means of a single embossing point attached thereto, to effect a record upon a plastic material by indentation, with such fidelity as to give such indentations the same varied and complex forms; and, if so, will this embossing point, upon being passed over the record thus made, follow it with such fidelity as to retransmit to the disc the same variety of movement, and thus effect a restoration or reproduction of the vocal or other sound-waves, without loss of any property, essential to producing upon the ear the same sensation as if coming direct from the original source?

The answer to this may be summed up in a statement of the fact that by the application of power for uniformity of movement, and by attention to many seemingly unimportant and minor details, such as the form and material of the embossing point, the proper dampening of the plate, the character of the material embossed, the formation of the mouthpiece over the plate, &c., the writer has at various times during the past week reproduced the wares with such degree of fidelity in each and every detail as to astonish his assistants to read, without the loss of a word, one or more columns of a newspaper article unfamiliar to them, and which were spoken into the apparatus when they were not present. The only perceptible loss was found to be in the quality of the utterance—a non-essential in the practical application of the apparatus. Indeed, the articulation of some individuals has been very perceptibly improved by passage through the phonograph, the original utterance being mutilated by imperfection of lip and mouth formation, and these mutilations eliminated or corrected by the mechanism of the phonograph.

3. Can a record be removed from the apparatus upon which it was made, and replaced upon a second without mutilation or loss of effective power to vibrate the second plate?

This is a mere mechanical detail, presenting no greater obstacle than having proper regard for the perfect interchangeableness of the various working parts of the apparatus—not so nice a problem as the manufacture of an American watch.

4. What as to facility of placing and removing the record-sheet, and as to its transportation by mail?

But ten or fifteen seconds suffice for placing or removal. A special envelope will probably be required for the present, the weight and form of which, however, will but slightly increase the cost of postage.

5. What as to durability?

Repeated experiments have proved that the indentations possess wonderful enduring power, even when the reproduction has been effected by the comparatively rigid plate used for their production. It is proposed, however, to use a more flexible plate for reproducing, which, with a perfectly smooth stone point, dimmed or sapphire, will render the record capable of from 50 to 100 repetitions, enough for all practical purposes.

6. What as to duplication of a record and its permanence?

Many experiments have been made, with more or less success, in the effort to obtain electrotypes of a record. This work has been done by others, and though the writer has not as yet seen it, he is reliably informed that, very recently, it has been successfully accomplished. He can certainly see no great practical obstacle in the way. This, of course, permits

* From *The North American Review*, May-June, 1878.

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Tel Journ Sept 15. 78
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ARTICULATION.—We make the following quotation from an exhaustive and excellent paper on "Speaking Machines," in *Good Words* for July:—"Articulate sounds we all know can be separated into two elements, vowels and consonants, the former being the groundwork of the latter, or, as Max Müller remarks, 'consonants fall under the category of noises,' due to the working of the mechanism producing them. The pure vowels are produced by a con tinuous expiration, the mouth being kept open, but the size of its cavity varied by altering the position of the lips and palate. The vibration of the vocal chords yield as indiscriminate mixture of sounds—a compound tone; the mouth forms a resonant chamber, like a cave; and by adjusting the size of this chamber certain elements of the compound tone are strengthened to the exclusion of the rest; just as the sound of a Jew's harp, when held between the teeth, is intensified by the resonance of the mouth, and modified by the size we permit our tongue to give the cavity. These changes can be recognised if we pronounce successively *e* (as in he), *a* (as in hay), *o* (as in oh), *oo* (as in cool).

"The theory of vowel sounds was first enunciated by Wheatstone, and confirmed by the experiments of Donders, whilst the classical researches of Helmholtz, leave but little doubt as to the origin of these sounds. Helmholtz, in fact, has not only dissected the vowel sounds, and discovered their constituent elementary tones, but he has put together these elementary tones yielded by different tuning forks, and so built up the entire series of vowels by mechanical means.

"Certain consonants, as *b*, *t*, *d*, *v*, &c., may also be produced by continuous currents of air, modified by the tongue and lips. Other consonants, such as *m* and *n*, or *b* and *p*, &c., can only be produced by momentarily stopping the current of air, and commencing or finishing the vowels by a kind of explosion, thus, *ba*, *at*, *ne*, &c.

"It is possible to make a rough imitation of the larynx by simply rolling a sheet of *indiarub* into a narrow tube, and over one end, tying side by side, a couple of strips of thin india-rubber; on blowing through the tube a musical note is obtained, which can be varied in pitch by squeezing the tube, and so altering the tension of the india-rubber vocal cords. Nay, more, when speech has been lost by disease or removal of the natural vocal chords, artificial ones, formed of a vibrating tongue, or' reed' of metal or ivory, have been made, and inserted in the larynx of the sufferer, restoring to him at once the power of speech. In fact, so successful is this artificial substitute, that the only difference noticeable, appears to be the peculiar monotone of the speaker; who, however, has the advantage of having a variety of voices at command, for by selecting a grave 'reed,' to-day, he can roar like Bottom, the weaver, and by using a high pitch to-morrow, speak with the shrillness of a shrew."

Tel Journ Octobr 15 78
Del Jne Sept 15. 78

THE *Scientific American* for August 24, gives a detailed description with drawings of a simple and inexpensive phonograph which can be made by amateurs. It consists of a straight rod or square of wood run with two parallel V grooves along its face; and a mouthpiece with diaphragm, and spring point, constructed to glide along the rod by means of guides cut in the frame of the mouthpiece in such a position that the probe is over the grooves. A strip of tinfoil is smoothly lapped over the rod and held by bent cards. On moving the mouthpiece by hand along the rod and speaking into it the record is taken, and can be similarly reproduced.

Tel. Journ July 15 78
Del Journ Aug 15. 78

THE PHONOGRAPH.—It is said that Edison has improved the phonograph so that if spoken to at a distance of 15 feet it will intelligibly reproduce the speech. This increased sensitiveness is largely due to steel bearings having been supplied to the cylinder, so as to give it unvarying uniformity of motion.

LATIN is said to be the language which gives the best results with the phonograph.

SCIENCE may be elevated to a whistle by turning the phonograph recording it fast enough, and the whistle may be recorded by a second phonograph, revolving slower, so as to give out the original sound.

Tel Journ Apr 1. 78

THE PHONOGRAPH AND VOWEL SOUNDS.

It has been pointed out by Professor Fleeming Jenkin, and Mr. J. A. Ewing, in a letter to *Nature*, that whereas rotating the barrel of the talking phonograph at different speeds gives corresponding differences of pitch in the sounds, it does not alter their quality. This result appears to disagree with Helmholtz's theory that the characteristic quality of each vowel is given by the predominance of a constituent note of definite pitch in the sounds uttered. For the absolute pitches of the constituents of the vowel sounds in the experiments in question were all altered in the same proportion, so th.. the absolute pitches of the predominant notes varied greatly: yet the vowel quality was unchanged. Another fact has been elicited in these experiments, namely, that if a scale be sung into the phonograph with one vowel sound, such as O, the wave-form of the marks on the tinfoil does not remain unchanged at all pitches.

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EDISON'S Patent, No. 2927, dated July 31, 1877, of which we give an abstract in the present number, serves to illustrate how an invention is generally evolved. In this patent, Edison describes a means of recording ordinary Morse signals by the indentations of a style on a sheet of paper enveloping a cylinder or plate with a V shaped spiral groove cut in its surface. The indented record so obtained was afterwards to be utilised, if required, in sending the same message automatically by means of the indentations. In this contrivance we have, to all appearance, the groundwork of the phonograph. The inventor's mind was prepared by it to receive the suggestion, which would germinate into a recorder and reproducer of actual sounds. This priceless seed is said to have been sown by accidents. While experimenting one day with a telephone, a style attached to the diaphragm, when it was vibrating under the voice, pierced Edison's finger and drew blood. We suppose the idea of the phonograph at once flashed upon him, for he saw that there was force enough in the style to record speech by indentations on a yielding substance, as in his preconceived telegraph apparatus. If this interpretation be correct, we may also draw the moral from it that no original idea is utterly worthless, and no good work is ever thrown away: for, at least, it may in time become the root of something better. Edison's indenting telegraph may never be practically applied, but it has borne wonderful fruit in the phonograph.

It is stated that the Edison Phonograph was suggested in 1865 by an Italian mechanic of the Val d'Aosta (Signor Manetti), and published in the *Divitia* of Rome for July 10, 1865, and in the *Petit Journal* of Paris, for November 22, 1865.

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In my opinion this would be the only advanta of the proposed unit, an advantage of too sm importance to compensate the serious incon niences which its adoption would present fro other points of view. With the *volt*, the *weber*, t *ohm*, and the *farad*, we possess a complete syste of absolute electrical units, based on the cen metre-gramme-second. We are, furthermore, acce tomed to regard as derived units the multiples whi represent a million of the fundamental units, as the submultiples which represent the one-million part of such units; and we designate these deriv units by the special denominations formed by pr fixing "mega" or "micro" to the name of t fundamental unit. Either the fundamental unit, one or other of its derivatives is used, according which is best adapted to the electrical magnitude dealt with in telegraphy. Thus the *volt* is almo exclusively used to express differences of potenti the *megavolt* being so large and the *microvolt* small that it is very rarely these derived units e be made to represent differences of potential simple figures. The *megohm*, on the contrary, almost as often employed as the *ohm*, all resistanc of dielectrics being such more simple to express the *microhm* has only a thin than the *ohm*, while the *microhm* has only a thin vertical value. The *megohm* accords with the *farad* where the fundamental unit is so large a quantit that the *microfarad* is the only one of its derivative which corresponds to the quantities used in tel graphy. The whole capacity of a transatlan the insulated conductor, such as the cable, presents end of a piece of which springs, which presses against a small piece of india-rubber tubing fixed to the centre of the diaphragm. The piece of rubber acts as a cushion, and greatly improves the action of the apparatus, as it is found that if the stylus is attached directly to the diaphragm the action is not satisfactory. The diaphragm moves and the recording the impressions on the foil (lead) on the

EDISON'S PHONOGRAPH.

[1922.]—A VERY interesting experiment (in which the writer participated) was tried on Dec. 26th with Mr. Edison's phonograph. It was the transmission of the mechanical talking over a circuit, by the Edison Telephone Company, by means of telephones. The matter to be transmitted was deposited up on the phonograph, and during the repro duction of the same the telephone was held in front of it. A number of people at the other end heard it perfectly. JOHN TYNDALL.

ARTICULATION.—We make the following quotation from an exhaustive and excellent paper on "Speaking Machines," in *Good Words for July*:—"Articulate sounds we all know can be separated into two elements, vowels and consonants, the former being the groundwork of the latter, or, as Max Müller remarks, 'consonants fall under the category of noises,' due to the working of the mechanism producing them. The pure vowels are produced by a continuous expiration, the mouth being kept open, but the size of its cavity varied by altering the position of the lips and palate. The vibration of the vocal chords yield an indiscriminate mixture of sounds—a compound tone; the mouth forms a resonant chamber, like a cave; and by adjusting the size of this chamber certain elements of the compound tone are strengthened to the exclusion of the rest; just as the sound of a Jew's harp, when held between the teeth, is intensified by the resonance of the mouth, and modified by the size we permit our tongue to give the cavity. These changes can be recognized if we pronounce successively *e* (as in *he*), *a* (as in *hay*), *o* (as in *oh*), *oo* (as in *cool*).

"The theory of vowel sounds was first enunciated by Wheatstone, and confirmed by the experiments of Donders, whilst the classical researches of Helmholtz, leave but little doubt as to the origin of these sounds. Helmholtz, in fact, has not only dissected the vowel sounds, and discovered their constituent elementary tones, but he has put together these elementary tones yielded by different tuning forks, and so built up the entire series of vowels by mechanical means.

"Certain consonants, as *k*, *t*, *r*, &c., may also be produced by continuous currents of air, modified by the tongue and lips. Other consonants, such as *m* and *n*, or *b* and *p*, &c., can only be produced by momentarily stopping the current of air, and commencing or finishing the vowels by a kind of explosion, thus, *ba*, *ap*, *ma*, &c.

"It is possible to make a rough imitation of the larynx by simply cutting a sheet of foolscap into a narrow tube, and over one end, lying side by side, a couple of strips of thin india-rubber; on blowing through the tube a musical note is obtained, which can be varied in pitch by squeezing the tube, and so altering the tension of the india-rubber vocal cords. Nay, more, when speech has been lost by disease or removal of the natural vocal chords, artificial ones, formed of a vibrating tongue, or 'reed' of metal or ivory, have been made, and inserted in the larynx of the sufferer, restoring to him at once the power of speech. In fact, so successful is this artificial substitute, that the only difference noticeable, appears to be the peculiar monotone of the speaker; who, however, has the advantage of having a variety of voices at command, for by selecting a grave 'reed,' to-day, he can roar like Bottom, the weaver, and by using a high-pitch to-morrow, speak with the shrillness of a shrew."

THE *Scientific American* for August 24, gives a detailed description with drawings of a simple and inexpensive phonograph which can be made by amateurs. It consists of a straight rod or square of wood ran with two parallel V grooves along its face; and a mouthpiece with diaphragm, and spring point, constructed to glide along the rod by means of guides cut in the frame of the mouthpiece in such a position that the points lie over the grooves. A strip of tinfoil is smoothly lapped over the rod and held by beer-wax. On moving the mouthpiece by hand along the rod and speaking into it the record is taken, and can be similarly reproduced.

THE PHONOGRAPH.—It is said that Edison has improved the phonograph so that if spoken to at a distance of 13 feet it will intelligibly reproduce the speech. This increased sensitiveness is largely due to steel bearings having been supplied to the cylinder, so as to give it unvarying uniformity of motion.

LATIN is said to be the language which gives the best results with the phonograph.

SPEECH may be elevated to a whistle by turning the phonograph recording it fast enough, and the whistle may be recorded by a second phonograph, revolving slower, so as to give out the original sound.

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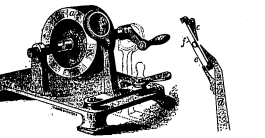
EDISON'S PHONOGRAPH.

FIGS. 1 and 2, for which we are indebted to the *Journal of the Franklin Institute*, Philadelphia, show the phonograph as at present constructed. Fig. 1 gives a general view of the instrument. Fig. 2



shows the diaphragm and stylus. The former is formed of a ferrotype plate, such as is employed in the ordinary telephone. The stylus is fixed to the end of a piece of watch spring, which presses against a small piece of india-rubber tubing fixed to the centre of the diaphragm. The piece of rubber acts as a cushion, and greatly improves the action of the apparatus, as it is found that if the stylus is attached directly to the diaphragm the action is not satisfactory. The diaphragm answers both for recording the impressions on the foil (lead) on the drum, and for reproducing the sounds, when the handle is turned. The diaphragm is mounted in a metal frame, attached to a moveable lever, which enables the point of the stylus to be withdrawn from the surface of the foil when the drum is to be screwed back to its starting position, after the impressions have been recorded. The dotted lines in fig. 1 show the position taken up by the frame and lever when the latter is turned back.

EDISON'S PHONOGRAPH.

[1878.]—A VERY interesting experiment, (in which the writer participated) was tried on Dec. 20th with Mr. Edison's phonograph. It was the transmission of the mechanical talking over a circuit, by means of wire. The circuit was worked by Edison's telephone. The matter to be transmitted was first stored up on the instrument, and during the reproduction of the sound the telephone was held in front of it. A number of people at the other end heard it perfectly. [illegible]

A WONDERFUL INVENTION.—SPEECH CAPABLE OF INDEFINITE REPETITION FROM AUTOMATIC RECORDS.

It has been said that Science is never sensational; that it is intellectual not emotional; but certainly nothing that can be conceived would be more likely to create the profoundest of sensations, to arouse the liveliest of human emotions, than once more to hear the familiar voices of the dead. Let Science now announces that this is possible, and can be done. That the voices of those who departed before the invention of the wonderful apparatuses described in the letter given below are for ever stilled is too obvious a truth; but whoever has spoken or whoever may speak into the mouthpiece of the phonograph, and whose words are recorded by it, has the assurance that the sounds may be reproduced audibly in his own tones long after he himself has turned to dust. The possibility is simply startling. A strip of indented paper travels through a little machine, the sounds of the air are vanquished, and our great grandchildren or posterity centuries hence hear us as plainly as if we were present. Speech has become, as it were, immortal.

The possibilities of the future are not much more wonderful than those of the present. The orator in Boston speaks, the indented strip of paper is the tangible result; but this travels under a second machine which may connect with the telephone. Not only is the speaker heard *now* in San Francisco for example, but by passing the strip again under the reproducer he may be heard tomorrow, or next year, or a next century. His speech in the first instance is recorded and transmitted simultaneously, and indefinite repetition is possible.

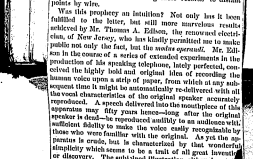
The new invention is purely mechanical—no electricity is involved. It is a simple affair of vibrating plates, thrown into vibration by the human voice. It is crude yet, but the principle has been found, and modifications and improvements are only a matter of time. So also are its possibilities other than those already noted. Will letter writing be a prevailing art of the past? Why not, if by simply talking into a mouthpiece our speech is recorded on paper, and our correspondent can by the same paper hear us speak. Are we to have a new kind of books? There is no reason why recitations of our modern Ciceros should not be recorded and indefinitely bound as they can be run the indented slips through the machine, and in the quiet of our own apartments listen again, and as often as we will, to the eloquent words. Nor are we restricted to spoken words. Music may be crystallized as well. Imagine an opera or an oratorio, sung by the greatest living vocalists, thus recorded, and capable of being repeated as we desire.

The invention, the credit of which is due to Mr. Thomas A. Edison, should not be confounded with the one referred to by us in a previous number, and mentioned in our correspondent's letter. That device is illustrated on another page of this issue, and is of much more complicated construction. Mr. Edison has sent us sketches of several modifications and different arrangements of his invention. These we shall probably publish in a future number.

To the Editor of the Scientific American:

In your Journal of November 3, page 273, you made the announcement that Dr. Rosapelly and Professor Marey have succeeded in graphically recording the movements of the lips, of the veil of the palate, and the vibrations of the larynx, and you prophesy that these, among other important results, may lead possibly to the application of electricity for the purpose of transferring these records to distant points by wire.

Was this prophecy an intuition? Not only has it been fulfilled to the letter, but still more marvelous results achieved by Mr. Thomas A. Edison, the renowned electrician, of New Jersey, who has lately permitted me to make public not only the fact, but the *modus operandi*. Mr. Edison has in the course of a series of extended experiments in the production of his speaking telephone, lately perfected, conceived the highly bold and original idea of recording the human voice upon a strip of paper, from which at any subsequent time it might be automatically re-delivered with all the vocal characteristics of the original speaker accurately reproduced. A speech delivered into the mouthpiece of this apparatus may fifty years hence—long after the original speaker is dead—be reproduced audibly to an audience with sufficient fidelity to make the voice easily recognizable by those who were familiar with the original. As yet the apparatus is crude, but is characterized by that wonderful simplicity which seems to be a trait of all great inventions or discovery. The subjoined illustration, although not a



actual design of the apparatus as used by Mr. Edison, will better serve to illustrate and make clear the principle upon which he is operating.

A is a speaking tube provided with a mouthpiece, O—[X is a metallic diaphragm which responds powerfully to the vibrations of the voice. In the center of the diaphragm is secured a small chisel-shaped point. D is a drum revolved by clockwork, and serves to carry forward a continuous fillet of paper, having throughout its length and exactly in the center a raised V-shaped boss, such as would be made by passing a fillet of paper through a Morse register with the lever constantly depressed. The chisel point attached to the diaphragm rests upon the sharp edge of the raised boss. If now the paper be drawn rapidly along, all the movements of the diaphragm will be recorded by the indentation of the chisel point into the skeleton boss—i.e., having no support underneath, is very easily indented; to do this, little or no power is required to operate the chisel. The tones of small amplitude will be recorded by slight indentations, and those of full amplitude by deep ones. This fillet of paper then receives a record of the vocal vibrations or air waves from the movement of the diaphragm; and if it can be made to contribute the same motion to a second diaphragm, we shall not only see that we have a record of the words, but shall have them re-spoken; and if that second diaphragm be that of the transmitter of a speaking telephone, we shall have the still more marvelous performance of having them re-spoken and *transmitted by wire at the same time to a distant point.*

The reproducer is very similar to the indenting apparatus, except that a more delicate diaphragm is used. The reproducer, B, has attached to its diaphragm a thread which in turn is attached to a hair spring, H, upon the end of which is a V-shaped point resting upon the indentations of the boss. The passage of the indented boss underneath this point causes it to rise and fall with precision, thus contributing to the diaphragm the motion of the original one, and thereby rendering the words again audible. Of course Mr. Edison, at this stage of the invention, finds some difficulty in reproducing the finer articulations, but he quite justified by results obtained, from his first crude efforts, in his prediction that he will have the apparatus in practical operation within a year. He has already applied the principle of his speaking telephone, thereby causing an electro-magnet to operate the indenting diaphragm, and will undoubtedly be able to transmit a speech, made upon the floor of the Senate, from Washington to New York, record the same in New York automatically, and by means of speaking telephones redeliver it in the editorial *sanctum* of every newspaper in New York. In view of the practical inventions already contributed by Mr. Edison, is there any one who is prepared to gainsay this prediction? I for one am satisfied it will be fulfilled, and that, too, at an early date.

EDWARD H. JOHNSON, Electrician.

(22593.)—Phonograph.—I do not think that the writing of either the phonautograph or the phonograph would be made larger by increasing the size of the diaphragm beyond certain limits because, as I understand, the sound waves which act on the latter do not exist also be increased, and often in a greater proportion. 2. The principle of the phonautograph and of the phonograph are the same, in so far as they both register sound vibrations. The character of the latter are, however, engraved upon the cylinder surface. A phonautograph could be so constructed as to be used as a phonograph. 3. A phonograph might be made to speak by drawing a straight slide covered with tinfoil under the point, but a cylinder is infinitely more compact and convenient.—BURDALT. *P. S.*

Le phonographe. — A peine sommes-nous revenus de la surprise que nous a causée la découverte du téléphone, qu'un nouvel appareil, peut-être plus merveilleux encore, s'impose à notre admiration. Le phonographe, en effet, ne se contente pas de transporter à une distance quelconque tous les sons qui l'ont impressionné, mais encore il les enregistre, les fixe et peut les répéter ainsi souvent qu'on le désire. Déjà M. Nimrod Bridgest, dans son intéressante communication à la Société des Ingénieurs civils, s'est consultre le principe sur lequel est appareil est basé. Mais, depuis, des simplifications y ont été apportées, et aujourd'hui le phonographe, comme le téléphone lui-même, nous étonne peut-être encore plus par sa simplicité que par les résultats qu'on en obtient.

M. Thomas A. Edison vient en effet de construire un

phonographe d'une simplicité telle qu'il semble impossible de le simplifier encore.

Une membrane vibrante, semblable à celle d'un téléphone, est armée en son centre d'une pointe métallique très-fine qui vient s'appuyer sur une mince feuille d'étain enroulée sur un cylindre. Ce cylindre peut être animé simultanément d'un mouvement de rotation et d'un mouvement de translation suivant son axe, ce qu'on obtient facilement en filetant l'axe qui le porte, et en remplaçant l'un des coussinets par un écrou. De cette manière, la pointe décrit sur la bande d'étain une hélice ayant le même pas que la vis de l'axe du cylindre. Quand la membrane entre en vibration, la pointe agissant sur l'étain y grave une série de points, plus ou moins profonds et plus ou moins espacés, suivant l'intensité et la rapidité des vibrations qu'elle exécute. C'est là pour ainsi dire une sténographie complète, et parfaite, de tous les sons qui ont provoqué les mouvements de cette membrane.

Pour reproduire les sons, une deuxième membrane, armée comme la première d'une pointe métallique, est mise en rapport avec le cylindre dont nous venons de parler, et un ressort délicat force cette pointe à rester constamment en contact avec la feuille d'étain. En conséquence la seconde membrane devra reproduire les sons reçus par la première et cela un aussi grand nombre de fois qu'on le voudra, et aussi longtemps qu'il sera possible de conserver la feuille d'étain sans altération.

Il faut bien entendre que la vitesse du cylindre reste toujours la même, sinon les vibrations devenant plus ou moins rapides, le son émis changerait de nature, une voix la basse pourrait, par exemple, si le mouvement du cylindre s'accélérait, devenir une voix de fausset ou inversement.

Nous ne chercherons pas ici à prévoir toutes les applications possibles de ce nouvel appareil, lorsqu'il aura reçu les perfectionnements qui en rendront l'usage facile et permettront d'amplifier les sons qu'il émet de manière à lui donner une intensité égale ou même supérieure à celle de ceux qu'il a enregistrés : c'est une besogne que nous laisserons à l'imagination de nos lecteurs, car il est difficile de toucher ce sujet sans paraître entrer dans le domaine du rêve et de l'utopie. L'avenir seul pourra nous faire connaître l'étendue des services que peuvent nous rendre ces merveilleux appareils.

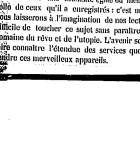
PHYSICAL SOCIETY.—March 2nd, 1878.

Professor W. G. ADAMS, President, in the chair.

THE following candidates were elected members of the society:—Messrs. J. P. Kirkman and Dr. W. J. Russell, F.R.S.

Mr. SIDNEY TAYLOR exhibited the colours produced in thin films by sonorous vibrations. A piece of thin brass was polished with a triangular, circular, or rectangular aperture, and bearing a thin film of soap solution, was placed horizontally on one end of a long, shaped tube; the beam of the electric lamp, after reflection from it, was received on a screen. It was shown that when a sound is emitted in the neighbourhood of the open end of the tube, as it is taken by a whistle the note which is indicated by the different colours of the reflected light, and each note has its own peculiar colour figure; and further, with different instruments we have different figures. When a violin bow was the sound employed, a figure of two lobes on a nodus was produced, which was exhibited by changing the note, and with a whistle the successive changes traversed by two lines at right angles were observed.

Mr. W. H. Preece exhibited and described the phonograph. After referring to the manner in which the preceding communication bore on the subject of the telephone, he went on to explain the construction of the two instruments exhibited, which have been made in accordance with the published accounts of the apparatus, and details received from the inventor, Mr. T. A. Edison, by Mr. Pidgeon and Mr. Stroh respectively. In the first of these the receiving and recording cones are distinct, the former being of ferrotype iron, and the latter of paper, whereas in the second form of apparatus, both these functions are performed by one and the same flattened cone of paper. They also differ in that, in Mr. Pidgeon's apparatus, the drum receives its motion by hand, and in that of Mr. Stroh a descending weight is caused to communicate motion by a suitable train of wheels, which motion can be controlled and regulated by an adjustable pair of vanes. In both cases the drum is of



brass, turned over by a spiral groove, and the whole is mounted on a screw of the same pitch. The manner of using the phonograph is extremely simple. The drum having been covered with the foil, a uniform movement of rotation is given to it, and a fine metal point, firmly fixed in the centre of the receiving plate is brought in contact with it, care being taken to place the point accurately over the groove. It was this plate be sung or spoken to, the tinfoil will be indented in accordance with the vibrations communicated to the metal point. The emitting plate having been provided with a retainer, its point is now brought into contact with the indented foil, the point of the receiving plate, and the drum caused to revolve at the same velocity, fairly, and the sounds are given out. It will be seen that Mr. Stroh's apparatus has an advantage over that of Mr. Pidgeon in that it secures a constant rate of rotation; but, on the other hand, the sounds emitted by the paper drum appear to be more distinct than those from the iron. A number of experiments were performed with the instruments. The sounds were reproduced at times with remarkable distinctness, and when Mr. Spagnoletti and Mr. Sedley Taylor sang "God Save the Queen," as a duet, through a double mouthpiece, the two voices could be clearly distinguished as its being reproduced. It was shown that even when an indented sheet of tinfoil has been employed to emit sounds, it retains its form with such perfectness, that the sounds can be reproduced by means of it a second and even a third time with nearly equal distinctness.

Prof. GRAHAM BELL pointed out that the articulation of the instruments was very similar to what he had observed in the earlier forms of telephone, and he had no doubt, judging from his own experience with that instrument, that the phonograph will ere long be so adjusted as to articulate much more perfectly. He anticipated that the quality of the sound would be found to vary as the rate of rotation was altered, as well as the pitch, and this proved on experiment to be the case.

Edison's Acrophone.

In our last issue we gave an illustration of Edison's Phonograph, taken from the patent issued to him, as it appears in the *Official Gazette* of February 19th, 1878. We have since examined the machine in operation in the *Tribune* building, where it is attracting a good deal of attention, and the cut we gave of it is substantially correct. What is the practical value of the phonograph?

Mr. Edison himself is not now prepared to answer this question. He says: "All the phonographs that have as yet been exhibited are imperfect, or rather very meagre in their results; they have been mere experiments." He has, however, as he states, made application for a patent for a talking-machine, or acrophone, which, when placed in a locomotive, will raise its voice and announce in giant tones, that can be heard for miles: "I am Engine Marmsduke, and will stop at Boonton Station," or, when placed on ship-board, lighthouses, or on dangerous rocks, sound out a warning to be heard over miles off.

This suggests something really valuable, and Edison is evidently the man to work it out. The phonograph, then, is at present, a mere curiosity, and certainly it is one which has required for its production the utmost sort of genius, and patience. Mr. Edison will please hurry up the acrophone. Many anxious voyagers upon the great deep, enveloped in dismal fog, will gratefully welcome the new fog horn.

Speaking of Edison's phonograph, the New York *Herald* remarks that "the Americans are the most inventive people in the world, and besides a multitude of minor inventions of more or less utility they have contributed more than their share to those greater conquests of man over nature which entrench all the other intellectual achievements of our time. Even in the early beginnings of our history, at a time when our population had not reached two millions, Franklin's discoveries in electricity gave him a pre-eminence in that fruitful branch of science which will never be eclipsed. When he announced his capital discovery of the identity of lightning and electricity the Royal Society laughed at his theory, but the laughers were soon subdued by the cogency of his experiments, and the Royal Society in 1753 made amends by conferring on him, unsolicited, its highest honor, the Copley medal. It was then an American who set in motion the train of discoveries whose most important practical result is the electric telegraph. It was our Morse who made the final success and established the first telegraph. It was our Fulton that made the first successful application of steam to navigation. Our Draper preceded Daguerre in making sun pictures, although the Frenchman got almost all of him in turning the discovery to use. That most beneficent discovery of the age, the use of anæsthetics in medicine and surgery, is of American origin. All the things on which we have now touched, as well as the latest invention of Edison, deserve a place in the highest ranks of successful physical research. Of inventions which consist in purely mechanical applications of well known principles Americans have distanced all competition in multitude, in variety, and in importance. A catalogue even of the most useful and noteworthy would be tiresome by its length. To say nothing of Whitney's cotton gin and other early inventions, enough has been done in the lifetime of persons still young to confer for lustre on American ingenuity. The sewing machine, the mowing and reaping machines, the machines for planting seeds and threshing grain, are a few among the many which are as the leaves of the forest for multitude. With our dwelling on achievements which have gone into history we may safely challenge all Europe to show an inventive genius who deserves to stand by the side of Edison."

Helmholtz's Vowel Theory and the Phonograph

THE results obtained by Messrs. Jenkin and Ewing in their experiments with the phonograph, described in NATURE, vol. xvii. p. 382, are so different from those reached in some experiments recently performed by Mr. Clarence J. Blake, of this city, and in connection with myself, that I venture to call attention to the fact.

With the design of solving the question of change of quality in vowel tones by reproducing the rate of rotation of the phonograph cylinder, we performed a number of experiments, of which I mention a few as briefly as possible.

1. The vowel *a* and *e* were spoken into the mouth-piece of the instrument, each four times in succession, while the cylinder was rotated at the rate of one revolution per second, as timed by the beats of a clock-pendulum. On rotating the disc so as to reproduce the vowel-sounds, there were by system, *aa*, *e*, each repeated four times, when the rate of rotation was one revolution per second, but on increasing the velocity to two revolutions per second, but the first sounds were indistinct, while the last gave the second. The first sounds were indistinct, while the last gave the vowel *e* very clearly. At half revolution per second, *ee*, *aa*, were distinctly heard.

2. The vowel *a* was sung while the cylinder rotated at different rates of speed. On reproducing the sounds, the cylinder being revolved more slowly than at first, the vowel *aa* was heard, changing to *ô*, *o*, *ŏ* falling to *a* again as the velocity was slackened a little.

3. The vowel *a* was spoken while the cylinder made one revolution per second. On reproducing the sound, the rate being half a revolution per second, *aa* was heard, changing to *a* when the rate increased to one revolution, and at three revolutions per second *i* was heard.

4. The vowel *a* was spoken several times in succession, the rate of the cylinder being gradually accelerated. On reproducing the sound by a uniform and slow rotation, *aa* and *ai* were heard; on rotating faster, *ê* and *i*.

Several other experiments were tried in the short time during which the instrument was at our service, all of which were strikingly confirmatory of Helmholtz's theory. Difficulty was experienced in reproducing the highest vowels *i*, *ê*, probably on account of want of resilience of response in the disc. The ball of a reed-pipe was placed over the mouth-piece of the instrument when the sound was to be reproduced, for which a piece of pasteboard was substituted in some of the trials.

We believe that no other these experiments were rigorously quantitative, as the phonograph promises to be a valuable aid to research in the future. Very probably others may have worked with the same end in view, and if so it would be interesting to learn what has been their experience. CHAS. R. CROSS

Boston, U.S., April 29

The Phonograph

SINCE writing our former letter on the phonograph (NATURE, vol. xvii. p. 382) I have had the advantage of seeing some of the work that Prof. Fleeming Jenkin is doing with his own instrument, which was most kindly sent down to the city that I examined. This work convinces me that the phonograph has already risen above the level of a mere illustration and plaything, and I have suggested this paper to the Royal Society of Edinburgh, should it be considered worthy of publication, as I think it will be by the point of the phonographic suggested conclusions. Some of these original tracings I had the pleasure of seeing yesterday, and they are full of interest. I have termed them "speech curves." They differ considerably from the phonautographic speech-curves of Leon Scott and Koenig, which only succeeded with the vowels, and from the logographic speech-curves of Mr. Barlow, which only succeeded with the consonants, in so much as they succeed with both. In such a word as *bab*, for example, uttered rather than sung, but not simply spoken, as the vowel would otherwise be not last long enough for subsequent study, we have first the "explosive" beginning, which the curve gradually, but irregularly, rises, then the "attack," where there is generally a bold serrated projection, with numerous rather sudden valleys; next the "glide" where there is a perfect, tumult of curvatures arising from the passage of voice through a continually changing resonance chamber, producing a rapidly and continuously changing but intricate series of vowel sounds, which gradually settle down into the "vowel" proper. In the vowel, if well intoned, the curve remains constant for a considerable number of periods, beautifully reproducing itself, but, as the intoner becomes exhausted, "vanishing" more gradually to silence, the distinctive peculiarities of the curve disappearing one by one, till a dead level is again reached. . . . .

Then Prof. Fleeming Jenkin suggests that these curve to "analysis," reducing it to the exquisite "simple" curves of which it can be composed. This corresponds to determining the "partial" tones (*partialtöne*, *theiltöne* of Helmholtz, on which all but the lowest are called *Ubertonreihe*, *oberthellton*, or *combination thones*, whence the unfortunate English word *overtone*, which is constantly confused with *partials*, thus assuming a part for the whole) out of which the whole "compound" tone is formed. The first two partials are much stronger than the rest. The second often stronger than the first (hence the frequent confusion of octave), the others generally very weak, although exceptionally one of the higher partials may be stronger. As many as five partials, as far as I remember, were traced out in the analysis. Prof. Jenkin showed me, which he had just received from Edinburgh, the results differ materially for different speakers, but that it is peculiarity in the "phase" with which the different partials enter into combination. Helmholtz showed that this difference of phase would materially alter the form of the curve, but would not alter the appreciation of quality by the ear depending upon the actual partials and their degrees of loudness alone.

The phonograph, as I have said, re-makes rather a worse "prise" than a "proof" of the human voice. This seems, of course, that the delicate upper partials, on which all the accuracy depends, are shaken. In some respects this is advantageous for the very elaborate inquiry which Prof. Fleeming Jenkin has in-stituted, for it enables him to catch the bold outlines on which genius depend, without being at first bewildered by the delicate details which make specific differences. Our speech sounds are, of course, individual, and what is recognised as the same speech sound varies in the same speaker within the limits of its genus, almost every time it is said. We shall do much if we establish the genus. The extent of Prof. Jenkin's researches, as he contemplates them, and the error with which

his initial experiments, tracings, and analyses have been conducted, lead us to hope that we have at least got an instrument which will enable us to solve the elementary problems of phonetics that have hitherto almost baffled us, although it is not united, as yet, to fix the results of its delicate work which save my own special object of investigation.

April 30 ALEXANDER J. ELLIS

On repeating the experiments with the phonograph mentioned by Mr. A. J. Ellis in NATURE, vol. xvii. p. 382, we have a different result to record from that of Mr. Ellis. Experience to differ in several respects from his. Doubtless each instrument possesses its own individual characteristics; hence it will be the more needful to exercise caution with respect to generalizations, until the following instruments are few and in the hands of few observers. Mr. Ellis has been careful to say that the failure of the instrument in which his results were obtained, and the same of Mr. Stroh is a guarantee for the correctness of the mechanism. The phonograph which I have been working is of homelier make, and not provided with a driving-train or governor, but simply turned by hand. The same disc—a three-inch foreatype plate—serves as receiver and transmitter of the sounds. The latter I have been, if anything, a little too thin for the purpose.

On trying the sounds *aahoo*, *aadoo*, &c., I found the consonants perfectly distinguishable, except the sibilants, *hoo*, which is similar to Mr. Ellis's *fu*, and *doo*, which is replaced by the intermediate, *voo* (perhaps *thoo*), and could be distinguished from *aadoo*. Neither the consonants *g* and *k* were ever heard *and* and *ant*; but *hoogoo*, with the soft *g*, was rendered clear by the instrument as *hôôd*. My phonograph makes the same two possible difference between the words *hoo* and *hôo* when carefully spoken, the diphthongal sounds coming out beautifully as *hôoôd* and *hôoôt*. On reversing the motion of the handle, *hôoôd* and *hôoôt* were unintelligible. The double nature of some of our consonantal letters is very clearly demonstrated by this process of reversal of motion, as Messrs. Fleeming Jenkin and Ewing have already shown. To the sounds they name let me add that of *sh* in the word *chapoo*, which we ordinarily pronounce *tshoo*. This word gives a very perfect result when uttered in the machine.

The greatest difficulty—that of getting an instrument to acknowledge the sibilants—is a difficulty that all who have worked with phonographs, phonautographs, or stethoscopes, admit. The remedy mentioned by Prof. Moyer, that of using a mouthpiece with a very small hole, has the inconvenience of diminishing materially the loudness of the articulation of the machine. I have found it better to fasten a strip of tin or matching across the opening, edgeways, so that the sound impinges on the edge of the strip. With this device sibilants are reproduced; the word *scissors* becomes practicable, though "Sarah" is still impossible. One of Dr. Stroh's instruments, which was shown at the Crystal Palace during Easter week, gave *s* and *z* fairly. In a shuffle (hence the *ea* are not much altered) *Steady, boys, steady*, is given with less marked

THE PHONOGRAPH AND ITS FUTURE.

By THOMAS A. EDISON.

Or all the writer's inventions, none has commanded such profound and earnest attention throughout the civilized world as has the phonograph. This fact he attributes largely to the wide scope of its practicability, and to its beneficial influence within range of the speculative imaginations of all thinking minds. It would also appear that the universal applicability of the population principle, namely, the gathering up and retaining of useful knowledge, is peculiarly met by the production of the phonograph.

From the very abundance of conjectural and prophetic opinions which have been advanced, and are continually by the press, the public is liable to become confused, and hence necessarily inclined not to consider the practical uses and effects of the phonograph thus if the invention had been accomplished without specific applications, and therefore of comparative interest to the masses. The writer has no fault to find with this condition of the discussion of the subject, and possibilities of his invention; for, indeed, the possibilities are in fact unlimited, the practicability so assured as to be entirely subject to the influence of familiar contact—is himself in a somewhat chaotic condition of mind as to where to arrange his thoughts like. In point of fact, such has current with safety in favor of development. In the case of an invention of the nature and scope of the phonograph, it is practically impossible to indicate it to-day, for to-morrow a trifle may extend it almost indefinitely.

There are, however, certain stages in the developing process which have thus far been perfected; certain others which are clearly within reach; and others which, though they are in the light of to-day discovered as possibilities, may to-morrow become probable, and a little later actual achievements. It is the intention of the writer in this article to confine himself to the actual and the probable, and to curtail a clearer conception of the immediate realization of the phonograph may be had. He conceives to the public the best view and the most accurate, the imaginative work of speculating and commenting upon the possible. It is in this line of development in which the has already been in those, and the most favorable treatment he has received at their hands, that he for the time being proposes to confine himself to discussing and comment upon the merits of one of his own inventions.

In order to furnish a basis upon which the reader may take his stand, and accept or combat the ideas of the writer in his present advocacy of the practicability of the phonograph, a few categorical questions are put and answered, given upon the essential features of the principle involved:

1. Is a vibrating plate or disk capable of receiving a complex motion which shall correctly represent the peculiar property of each and all the undulations of vocal and other sound-waves?

The telephone answers affirmatively.

2. Can such complex movement be transmitted from such plate, by means of a single embossing-point attached thereto, to effect a record upon a plastic material by indentation with such fidelity as to give to such indentations the same varied and complex form; and, if so, will this embossing-point, upon being passed over the record thus made, follow it with such fidelity as to reirreunit to the disk the same variety of movement, and thus effect a restoration or reproduction of the vocal or other sound-waves, without loss of any property essential to producing upon the ear the same sensation as if coming direct from the original source?

The answer to this may be summed up in a statement of the fact that, by the application of proper *modifications* of the movement, and by attention to many seemingly unimportant and minor details, such as the *form* and material of the embossing-point, the proper *steepening* of the plate, the character of the material embossed, the formation of the mouth-piece over the plate, etc., the writer has at various times obtained the spoken into the apparatus when they were put upon it. The only perceptible loss was found to be in the quality of the reproduced sounds, and this was traceable to application of the apparatus. Indeed, the modification of some individuals has been very perceptibly improved in passage through the phonograph, the subjective utterances being mutilated by imperfection of lip and mouth formation, and these mutilations eliminated or corrected by the mechanism of the phonograph.

3. Can a record be removed from the apparatus upon which it was made, and replaced upon a second without mutilation or loss of effective power to vibrate the sound-plate?

This is a more mechanical detail, presenting no greater obstacle than having proper regard for the perfect interchangeableness of the various working parts of the apparatus—but no nice a problem as the manufacture of the American watch.

4. What as to facility of placing and removing the record-sheet, and as to its transportation by mail?

But ten or fifteen seconds suffice for such placing or removal. A special cardboard will probably be required for the present, the weight and form of which, however, will not slightly increase the cost of postage.

5. What as to durability?

Repeated experiments have proved that the indentations possess wonderful enduring power, even when the reproducer has been effected by the comparatively rigid plate used for their production. It is proposed, however, to use a more flexible plate for reproducing, which, with a perfectly smooth steam polish—diamond or sapphire—will render the record capable of from 50 to 100 repetitions, enough for all practical purposes.

6. What as to duplication of a record and its permanence?

Many experiments have been made, with more or less success. In the effort to obtain electrotypes of a record. This work has been done by others, and, though the writer has not as yet seen it, he is reliably informed that, very recently, it has been successfully accomplished. He can certainly see no great practical obstacle in the way. This, of course, permits of an indefinite multiplication of a record, and to the preservation for all time.

7. What are the requisite force of wave impinging upon the diaphragm and the proximity of the mouth to the diaphragm to effect a record?

These depend in a great measure upon the volume of sound desired in the reproduction. If the reproduction is to be made audible to an audience, considerable force is requisite in the original utterance; if for the individual ear, only the ordinary conversational tone (even a whisper has been reproduced). In both cases the original utterances are delivered directly in the mouth-piece of the instrument. An audible reproduction may, however, be had by speaking at the instrument from a distance of from two to three feet in a loud tone. The application of a fueling tube or funnel to collect the sound-waves and the construction of an especially delicate diaphragm and embossing-point, etc., are the simple means which suggest themselves to effect this. The writer has not as yet attempted the use of the duplex sound-tube attention, but sees no practical difficulty in gathering up and bringing a sectional part of the sound-waves diffused about the original source, within a radius of, say, three feet (sufficiently convenient for the user) and causing to a speaker or a listener.

The foregoing presentment of the stage of development of the phonograph is reached by the several essential features of the phonograph demonstrates the following *ex facto* principles:

1. The capacity of all manner of sound-waves heretofore relegated as "fugitive," and their permanent retention.

2. Their reproduction with all their original characteristics as will, without the presence or consent of the original source, and after the lapse of any period of time.

3. The transmission of such captive sounds through the ordinary channels of commercial intercourse and trade in material form, for purposes of communication or as merchantable goods.

4. Indefinite multiplication and preservation of such speech, sounds or music, without regard to the existence or non-existence of the original source.

5. The capitalization of sounds, with or without the knowledge or consent of the source of their origin.

The foregoing are the primary or base properties of the phonograph to the various branches of commercial and social life industry generally indicated will require the exercise of more or less mechanical ingenuity. Conceding that the approximate is practically perfect in so far as the faithful reproduction of sound is concerned, many of the following applications will be made the moment the new field of opportunities, which the writer is now about completing, is thrown open to the public. Others, though conceived as practicable, may be closely trench upon other applications which will immediately follow, but it is impossible to separate these because they are all enumerated under the head of probabilities, and require specific consideration. Among the most important may be mentioned: Letter-writing and other forms of dictating, books, education, reader, music, family records and the phonographic typographic applications as books, musical boxes, toys clocks advertising and signalling apparatus, speaking-etc., etc.

Letter-writing.—The apparatus now being perfected in mechanical details will be the standard phonograph, and may be used for all purposes except such as require special form of matrix, such as toys, clocks, etc., for an indefinite repetition of the same thing. The main utility of the phonograph is, however, being for the purpose of letter-writing or other correspondence, and in this it is made with a view to its utility for dictating purposes.

The general principles of construction are a flat plate or disk, with a spiral groove on the face, operated by clock-work underneath the plate; the grooves are cut very closely together, so as to give a great total length to each inch of surface—close calculation gives as the capacity of each sheet of foil, upon which the record is made, a the subscription of 40,000 words. The sheets being but ten inches square, the cost is so trifling that but 100 words might be put upon a single sheet economically. Still, it is problematical whether a such number of grooves per inch might not be the better plan—it certainly would for letters—but it is desirable to have but one class of machine throughout the world; and as very extended communications, if put upon one sheet, could be transmitted more economically than upon two, it is important that each sheet be given as great capacity as possible. The writer has not yet decided this point, but will experiment with a view of ascertaining the best mean capacity.

The practical application of this form of phonograph for correspondence is very simple. A sheet of foil is placed in the phonograph, the clock-work set in motion, and the mutter then stated into the mouth-piece without other effort than that which is dictation to a stenographer. It is then removed, placed in a light envelope, and mailed to the party addressed, ordinary channels to the correspondent, for whom reproduction. The phonograph letters may be dictated at home, or in the office of a friend, the *presence* of a stenographer not being required. The dictation may be as hasty or deliberate as best to forward or the flow utter them. The recipient may listen to his letter at his leisure, and may have it read in words per minute, and at the same time have himself read the matter, interjections, explanations, emphasis of inflections, etc., may be thrown into such letters, and all *fixed*.

In the early days of the phonograph, ere it has become universally adopted, a correspondent in Hong-Kong may possibly not be supplied with an apparatus, thus necessitating a written letter of the old-fashioned sort. In that case the writer would use his phonograph simply as a dictating-machine, his clerk writing it out from the phonograph at leisure, causing as many words to be uttered at one time as his memory was capable of retaining until he had written them down. This clerk need not be a stenographer, nor need he have been present when the letter was dictated, etc.

The advantages of such an innovation upon the present slow, tedious, and costly methods are too numerous, and too readily suggest themselves, to warrant their enumeration, while there are no disadvantages which will not disappear coincident with the general introduction of the new method.

Dictation.—All kinds and manner of dictation which will permit of the application of the mouth of the speaker to the mouth-piece of the phonograph may be as readily effected by the phonograph as in the case of letters. If the matter is for future reference, he would much prefer in acting it up in type, to use his ears in lieu of his eyes. He has tried and found it useful. It would be even worth while to compel witnesses in court to speak directly into the phonograph, and thereby obtain a more unimpeachable record of their testimony.

The increased delicacy of the phonograph, which is in the near future, will enlarge this field rapidly. It may then include all the sayings of not only the witness, but the judge and the counsel. At all times also comprehend the utterances of public speakers.

Books.—Books may be read by the author's dictated preferential reader, or by such readers especially employed for the purpose, and the record thus made placed upon the shelves of the libraries, hospitals, the sick-chamber, or even with great profit and pleasure reached by the lady or gentleman whose eyes and hands may be otherwise employed; or, again, because of the greater enjoyment to be had from a book when read by an elocutionist than when read by the average reader. The ordinary record-book, containing the words from fifty to a hundred times as it will, would command a price that would pay the original reader well for the slightly increased difficulty in reading it aloud in the phonograph.

Educational Purposes.—As an elocutionary teacher, or as a literary teacher for instance, it will eventually be indispensable. By it difficult passages may be correctly rendered for the pupil ten, one, often score which he has only to apply to the phonograph for instruction. The child may thus learn to spell, commit to memory, a lesson or the like, etc., etc.

Music.—The phonograph will undoubtedly be liberally devoted to music. A *song sung* on the phonograph is rendered with marvelous accuracy and power. Thus a friend may sit in a concert hall and sing to a song which shall delight an evening company, etc. As a musical teacher it will be used to enable a pupil to master a new air, the child to form its first songs, or to sing him to sleep.

Family Records.—For the purposes of preserving the sayings, the voices, and *the last words* of the dying member of the family—as, for instance, a mother—the phonograph will unquestionably outrank the photograph. In the field of multiplication of voices and music, and the labor-saving invention of one and the same thing, the successful electrotyping of the original record is no exception. As this is a special step of publicity, it properly ranks among the probabilities. It cannot be long, after the invention, before a phonograph of the phonograph in this direction is in the production of

Phonographic Books.—A book of 40,000 words upon a single metal plate ten inches square thus becomes a strong probability. Duplicates, stereotypes, and privately these printed are too readily seen to need mention. Such books would be found to be of interest none are now in use. They would preserve more than the mental emanations of the brain of the author; and, as to books for the blind even, they would be unequaled. For the preservation of languages they would be invaluable.

Musical Boxes, Toys, etc.—The only element not absolutely necessary in the use of the phonograph is that which is already in the way of a perfect reproduction of sound. The fine finish of the plate, the high speed, the single sets of qualities, and even that is not totally lacking, and will doubtless be wholly absent in the reproducer. It should not, the musical box, or cabinet, of the present will be found equal to such a task with only the voice and the words of the human organism.

Toys.—A doll which may speak, sing, cry, or laugh may be safely promised as one of the first of the Christmas delights to be had from the phonograph. A cabinet of animal toy-and-so locomotives which may be supplied with material and set to work by sounds.

Clocks.—The phonographic clock will tell you the hour of the day, call you to lunch, send your lover home at ten, etc.

Advertising, etc.—This class of phonographic work is so plain to the foregoing that it is only necessary to call attention to it.

Speech and other Utterances.—It will be worth he proved the time to come when conversations the videos well as the telephone is in use—spoken phonograph letters will be the words of our Washingtons, Lincolns, Gladstones, etc., etc., and our children will be given as their "greatest store, etc., etc., and our children will be given as their "greatest store, etc., etc., and our children will be given as their "greatest store

defect of speech than if uttered *to Hendy, Leach, Alcock*. Another point of interest that has not, I think, been yet mentioned by observers is, that the marks corresponding to the vowel sounds differ when the sounds is at different distances from the vibrating plate, but that yet there is no difference in the sound of the vowel subsequently emitted by the machine; a result which confirms the previously known independence of the vowel sound of the phase of its component partials. For some time I thought my phonograph guilty of dropping its *h*'s [though not aside within the sound of *how hah*], but when that letter is spoken rapidly in a word it is recorded faithfully. *Happy land* is well heard in the instrument; and *How do you do?* is also registered. Curiously enough, this record is spoken almost as well backwards as forwards (except the *you*), and, especially if spoken to the machine with a strong Scotch accent. It is remarkable how useless an instrument without a checkwork regulator is for reproducing even the simplest of speech they are simply lost in noise. Altogether the study of speech by the phonograph is most interesting, and will furnish scope for valuable data to students of language and of elocution. It is impossible to make its performance without a tribute of admiration to the extreme ingenuity and skill of its inventor, Mr. Edison.

SILVANUS P. THOMPSON

University College, Bristol, May 1

the correspondent, if he is present, *to hear it while it is being recorded*. Thus we have a more perfect record of the action, but a complete and durable record of these words as the result of that action. The economy of time to society go further than to annihilate time and space, and hand up for posterity the mere utterance of man, without any other effort on his part than to speak the words?

In order to make this adaptation, it is only requisite that the phonograph shall be made slightly more sensitive to sound, and the telephone very slightly more sensitive to the beating force of the receiver, and it is accomplished. In the "Gower-Bell Telephone," invented and patented by the phonograph; as in its constantly improving use, it is found to cause a more decided vibration of the plate of the receiver. In this addition to the telephone may be looked for confidence with the other practical applications of the phonograph, and with almost equal certainty.

The telegraph company of the future—and that no distant one—will be simply an organization having a large system of wires, central and semi-central stations, managed by skilled attendants, whose sole duty it will be to keep wires in proper repair, and to give, by switch or shunt arrangement, prompt attention to a subscriber No. 921 in New York, when he signals his desire to have private communication with subscriber No. 1001 in Boston, for three minutes. The minor and totally inconsequential details which seem to arise as obstacles in the eyes of the present-traveling telegraph-man wedded to existing methods will wholly disappear before that remorseless Juggernaut—the needs of mankind—for will not the necessities of man summon rifles to compel to reap the full benefit of an invention which practically brings him face to face with whom he will, and, better still, doing the work of a conscientious and infallible scribe.—*North American Review*.

POWER FOR ELECTRIC ILLUMINATION.

THE electric light being simply the conversion into heat and light of the energy due to chemical action in a battery or of the energy derived from the consumption of fuel, and electric machine, the question which presents itself for consideration at the outset in contemplating the introduction of this mode of illumination is the cost of the necessary power. That the magneto-electric machine possesses numerous advantages over the battery in point of economy and efficiency needs no demonstration at this time, and it is to the employment of that apparatus to which we have reference. According to late investigations by M. Tresca, 1,000 burners supplied with a current from a Gramme machine required 7 horse power or 1 horse power per 100 burners; when, however, a less powerful apparatus was used, requiring but a little gas light, the expenditure was 15 horse power. So that, like all other commodities, the electric light is cheap at wholesale and dear at retail. Generally, however, it appears that 100 burners require 1 horse power, and for calculating the cost of the latter the direct expense of the fuel is reached. To this, however, must be added cost of machinery, interest on capital, maintenance, wages, etc. For an approximate idea of the relative outlay we again have recourse to Prof. Tresca's investigations. M. Jamin, in his recently published work, states that the electricity as a means of illumination is 75 per cent. cheaper than candles. M. Jamin, on the other hand, calls attention to published statements, wherein it is proved that the electric light is 62 per cent. dearer than gas. This assertion appearing in the *Annales des usines à gaz*, the explanation represent probably the extreme views of the advocates and opponents of the general introduction of electric illumination. M. Jamin adds, however, that the Lontin Company in Paris are now offering to rent magneto-electric machines and all apparatus for producing the light at a cost of 10 centimes per hour per hundred burners, the number of the latter for a period of ten to extend over certain contracted periods. The lights furnished to the Louvre by the Denayrouse-Bachhoff Company, according to the same authority, far surpass gas lights in brilliancy, and an economy of about 30 per cent. is effected.

In the above cases power is furnished by consumption of fuel. There are many instances, however, where natural sources of power may be utilized, and it is to these more especially that we desire here to draw attention. Whether it will ever be practicable to employ the rise and fall of the tides in New York Bay or the currents in the rivers to actuate motors which in turn shall drive magneto-electric machines is at least an open question. The destruction of the rocks at Hell Gate has for one result the augmenting of the force of the current at that point, and it would seem possible that some arrangement of water wheels could be contrived whereby this power might be utilized and a part of it used for supplying electricity for purposes of illumination. The same might be done on a small scale elsewhere. With a machine such as the Lontin, which is capable of giving a commercial divided current, or by the use of the simple Jablochkoff candle, where the entire paraphernalia of the electric lamp is abolished altogether, it would appear that the matter of lighting up a village or town by electricity has become an easy matter. A small water wheel, or even windmill, might furnish the power at little cost, and the remaining expenditures for maintenance would manifestly be small.

THE RADIOMETER AND THE SPHEROIDAL STATE.

THE following lucid exposition of the latest theories explaining the action of Crookes's radiometer, and the cause of the phenomenon known as the spheroidal state, was given by Professor Barrett in a recent address at the London Institution. He said: "To Mr. Stoney is unquestionably due the great honor of having been the first to try to explain the true theory of the radiometer." It was in the course of these investigations that Mr. Stoney has been recently led to show that the force which is so active in the high exhaustion that is necessary for the effective rotation of the radiometer is also present at ordinary atmospheric tension. Now, it is this force which forms the new explanation of the spheroidal state. In order to understand the calculation that occurs it must be recollected that, according to calculation, the number of molecules of air that at ordinary pressure occupy the space of a pin's head is 1,000,000,000,000,000; when the radiometer globe is exhausted of these molecules of air as far as we can do it by mechanical means, there are still some few millions remaining, and these are in constant motion. Heat makes them move more rapidly, cold more slowly. If we have two surfaces placed very near each other, one surface hot and the other cold,

THE PHONOGRAPH WINS A VICTORY.

The phonograph has been distinguishing itself lately in this city by its remarkably accurate reproductions of the correct notes of Mr. Levy, the famous performer on that instrument. Mr. Levy possesses the phenomenal ability of getting notes out of the cornet, which, he says, "are not there," or in other words, he plays airs in notes an octave lower than any one else has succeeded in producing on the cornet, and thus he has extended the range of his instrument over four full octaves. The phonograph, however, not only follows Levy, but surpasses him, by reproducing correct notes in entirely new octaves of its own origination, proving itself to have a compass of extraordinary range, if not especial tunefulness and brilliancy.

At a very pleasant reception given to Mr. Edison recently, in this city, a most interesting contest between Levy and the phonograph occurred. Messes. Edison and Johnson ably seconded the phonograph, and of course none but Levy could scientifically manipulate the cornet. Fresh tin foil being adjusted on the cylinder, the bell of the cornet was placed near the mouth piece, and "Yankee Doodle," first plain, and then garnished with variations of the most decorative character, assumed the form of dots on the foil. Without the loss of a note, the phonograph repeated it, and not only this, but even the peculiar expression imparted by the player, and the triumphant kind of a flourish which brought the tune to a conclusion, were reproduced with wonderful accuracy. A few several other popular airs had been similarly rephrased. Mr. Edison showed the effect of turning the cylinder at different degrees of speed, and then the phonograph proceeded utterly to rout Levy by playing his tunes in pitches and octaves of astonishing variety. It was interesting to observe the total indifference of the phonograph to the pitch of the note it began upon with regard to the pitch of the note with which it was to end. Gravely singing the tune correctly for half a dozen notes, it would suddenly soar into regions too painfully high for the cornet even by any chance to follow it. Then it delivered the variations on Yankee Doodle with a celerity that no human fingering of the cornet could rival, interspersing new notes, which it seemed probable were neither on the cornet nor on any other instrument—for instance. Finally the phonograph recited "Hagen on the Rhine" after its inventor, then repeated the poem with a whistling accompaniment, then in conjunction with two songs and a speech, all this on one tin foil, though by this time the remarks began to get mixed. Just here Levy returned to the charge, and played his cornet fiercely upon the much indented scrip. But the phonograph was equal to any attempts to take unfair advantage of it, and it repeated its songs, and whistles, and speeches, with the cornet music heard so clearly over all, that its victory was unanimously conceded, and amid hilarious crowing from the triumphant cylinder the cornet was ignominiously shut up in its box.

The occasion of Mr. Edison's reception was the exhibition of a fine organ made by Mr. Hilborne L. Roosevelt, of this city, for the Episcopal church in Rome, Italy. Some one, a reckless partisan of the phonograph, who was affected with enthusiasm over the victory of the instrument, and also by the fumes of the carbonic acid from a vicious beverage of French extraction, suggested that the phonograph be pitted against the grand organ. It was with difficulty that Mr. Edison, who, during the evening had repeatedly manifested a desire to do this, could be persuaded into confining himself to the simple exhibition that graph was thus saved the strain of a second struggle, with a more formidable competitor.

MR. THOMAS A. EDISON.

Many of our readers will recognize in the engraving the face of Mr. Thomas A. Edison, and others, who are not familiar with his appearance, may form a good idea of how the great inventor looks. Every one is acquainted with his telephone, phonograph, and other remarkable inventions, therefore we shall not notice them here.

Mr. Edison is above the medium height, and although he is only thirty-one years old, his iron gray hair and thoughtful eyes show the effects of continued study. He is genial, liberal, and entirely unostentatious. His mind, day and night, is on his projects; and even while eating his thoughts dwell on his inventions. His table conversation consists of occasional ejaculations regarding some new point in whatever project he may have in hand. He is at home in his laboratory, which is very large and complete in all of its appointments. He has a number of assistants, who are competent and quick to carry out his wishes, and they are often engaged on several widely different subjects at the same time. The experimental apparatus which is completed during the day is often tried at night when all is quiet and no visitors are present.

Notwithstanding his great mental labor, he avers that his health is good, and that as his occupation is pleasurable it does not tire him.

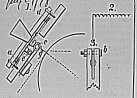
His residence and laboratory at Menlo Park are beautifully situated upon the brow of a hill that overlooks a picturesque valley. The beautiful landscape and the mountain air—Nature's best restoratives for the brain-weary—he has without the seeking.

Mr. Edison may well pride himself as to his position in the world of science, standing, as he does, first among the inventors of the day; and having, by his own energy and persistence, secured an income that enables him to carry forward on a grand scale such experiments as his prolific mind may suggest.

We publish in another column a detailed account of Mr. Edison's researches in telephony.

THE PHONOGRAPH AND ITS INVENTOR, MR. THOMAS A. EDISON.

(28) F. M., writes: "The parts of my phonograph are made as follows: The hollow brass cone is 3 c. cig. inches, with ¼ inch steel spindle 16 inches long, cooling at any brass foundry about $0.50 [illegible] inch twenty threads to an inch on spindle, and many on cones, but not on any. See Fig. 1. One of the



supports of spindle is sawed apart and drawn together by a bolt, A, causing the thread inside to cut its own way (not in the journal, as shown in Fig. 1. The base upon which the whole rests is 1 foot square and 3 inches thick, to give more hold to the spindle and stability to the whole. The disk, c (see Fig. 1), is made of beech, or other close grain wood, and is clamped between flesh (or rings, of which are 2 inches in diameter. This disk must be turned true from time to time on account of its getting warped by the moisture of the voice. It gives much better results than the more scholastic form-tips. A very essential part is the proper dampening of disk by pieces of rubber tubing and round rubber of the same material. It is also of great importance to have the needle chisel-shaped, and set at an angle of 45° in the hexagonal the cone. The smallest dancing needle is the best working. The reproducing funnel is 14 feet long and 3 inches wide at the top and ¼ inch at the bottom. It improves the working of the hole for speaking in top 2d is small, and also the paper between disk and top 2d is not in contain very much air.

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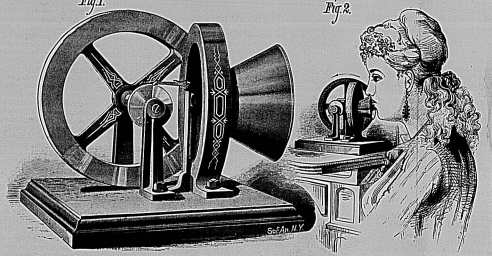
EDISON'S PHONOMOTER.

It is admitted that there is power in the human voice, but hitherto this power has been applied indirectly to produce mechanical results.

Mr. Edison in his telephone and phonograph experiments discovered that the vibrations of the vocal cords were capable of producing considerable dynamic effect. Acting on this hint he began experiments on a phonometer, or instrument for measuring the mechanical force of sound waves produced by the human voice. In the course of these experiments he constructed the machine shown in the engraving, which exhibits the dynamic force of the voice.

Fig. 1.

Fig. 2.



EDISON'S PHONOMOTER.

The machine has a diaphragm and mouth piece similar to a phonograph. A spring which is secured to the bed piece rests on a piece of rubber tubing placed against the diaphragm. This spring carries a pawl that acts on a ratchet or roughened wheel on the fly wheel shaft. A sound made in the mouth piece creates vibrations in the diaphragm which are sufficient to propel the fly wheel with considerable velocity. It requires a surprising amount of pressure on the fly wheel shaft to stop the machine while a continuous sound is made in the mouth piece.

Mr. Edison says he will have no difficulty in making the machine bore a hole through a board; but we consider such an application of the machine of very little utility, as we are familiar with voices that can accomplish the feat without the mechanical appliance.

Le mégaphone. — D'après le *New-York Herald*, le professeur Edison vient de construire un nouvel appareil qui ne le cède en rien au téléphone, ni au microphone.

Cet appareil, qu'il désigne sous le nom de mégaphone, recueille à une grande distance les vibrations sonores les plus faibles et les renforce de manière à les rendre facilement perceptibles. Voici du reste un passage de l'article du *New-York Herald*, dont un des rédacteurs a assisté aux expériences décrites.

« Malgré la dépense d'intelligence que nécessitent les nombreuses merveilles en cours de construction dans son

laboratoire, le professeur continue chaque jour à perfectionner son mégaphone. Hier il le plaça devant son laboratoire, et donna les tubes de cautchouc à notre rédacteur pour qu'il pût constater lui-même l'étrange pouvoir de l'appareil.

Ensuite il s'éloigna à travers champs d'environ un mille (1,609 mètres), et se plaçant sur le sommet d'une colline il murmura : « Entendez-vous ceci ? » Les mots arrivèrent distinctement, quoiqu'une brise assez forte se fît sentir en ce moment. Lorsqu'il partit de ton ordinaire, les mots étaient entendus aussi distinctement que si la distance entre lui et son auditeur n'était été que d'un pied au lieu d'un mille.

July 7.8

as 16 to the inch, and the form of the thread should be square.

The shaft, A, is journaled in wooden standards, C, which are 1x1½ in. in transverse section. The distance from the base piece to the center of the shaft is 2½ inches. The base piece is 7x11½ inches face and 1 inch thick.

The standards may be screwed, or secured to the base by two common wood-screws, as shown. The clearance between the standards is twice the length of the cylinder, or 8 inches. A steel plate, a, is let to the bearing of the screw threads in the shaft, a, and is secured to the side of the standard, which is slightly beveled to conform to the pitch of the screw.

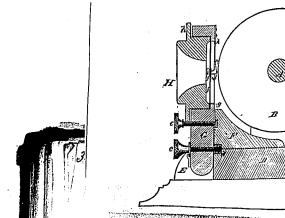


Fig. 2.

Under the cylinder and centrally between the standards a block, D, which is 3x3½ inches and 1 inch thick, is firmly secured to the base piece. The opposite edges of this block are covered by the cross pieces, E, and in the middle of the block a cap, F, is secured which is of the form shown in the engraving and 1 inch thick.

The screw, b, which are provided with lock nuts, b', pass through the front ends of the cross pieces, E, into metallic rings inserted in the edges of the diaphragm support, G, and form its pivots. This support is held in position by the screw, c, which passes through it and rests against a metallic button, which is inserted in the cap piece, F.

The diaphragm support, G, is 2½ inch thick and 3 inches

HOW TO BUILD A WORKING PHONOGRAPH.

WITH DRAWINGS MADE TO A SCALE OF HALF SIZE.

Now that Edison has invented the Phonograph, it is easy enough to make one, and every one wonders that it had not

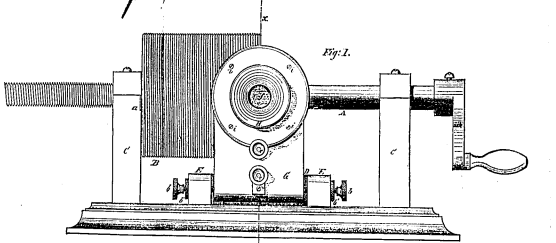


Fig. 1.

WORKING DRAWINGS FOR A PHONOGRAPH.—SCALE, HALF SIZE.

been done before. The Phonograph, truly wonderful as it is, is exceedingly simple and may be made at a slight expense.

The accompanying engravings represent two forms of a small phonograph which will work admirably, and do all that any of the large machines will do. In the illustrations, which are half size. Fig. 1 is a front elevation. Fig. 2 is a vertical section on line x x in Fig. 1. Fig. 3 is a plan view of a modified form of phonograph. Fig. 4 is a transverse section on line y y in Fig. 3. Fig. 5 is an end elevation, Fig. 6 a face view of the diaphragm, and Fig. 7 shows details of the screw cutting.

The shaft, A, is of iron, 1 and 2, 5/16 inch in diameter, 10½ inches long, and has on one end a 2 inch crank, and is threaded for five inches from the other end. The iron cylinder, B, which is 4 inches long and 4 inches in diameter, is bored axially, and secured to the shaft 3 inches from the threaded end, and has a screw cut upon it of the same pitch as that upon the shaft. The pitch of the thread should be 16 to the inch, and the form of the thread should be square.

The shaft, A, is journaled in wooden standards, C, which are 1x1½ in. in transverse section. The distance from the base piece to the center of the shaft is 2½ inches. The base piece is 7x11½ inches face and 1 inch thick.

The standards may be screwed, or secured to the base by two common wood-screws, as shown. The clearance between the standards is twice the length of the cylinder, or 8 inches. A steel plate, a, is let to the bearing of the screw threads in the shaft, a, and is secured to the side of the standard, which is slightly beveled to conform to the pitch of the screw.

Fig. 2.

Under the cylinder and centrally between the standards a block, D, which is 3x3½ inches and 1 inch thick, is firmly secured to the base piece. The opposite edges of this block are covered by the cross pieces, E, and in the middle of the block a cap, F, is secured which is of the form shown in the engraving and 1 inch thick.

The screw, b, which are provided with lock nuts, b', pass through the front ends of the cross pieces, E, into metallic rings inserted in the edges of the diaphragm support, G, and form its pivots. This support is held in position by the screw, c, which passes through it and rests against a metallic button, which is inserted in the cap piece, F.

The diaphragm support, G, is 2½ inch thick and 3 inches

Fig. 1.

WORKING DRAWINGS FOR A PHONOGRAPH.—SCALE, HALF SIZE.

wide, and is bored out to receive the diaphragm, f, and mouthpiece, H. The opening in the support, G, is of two diameters; the larger one, which receives the mouthpiece and diaphragm, is 2⅝ inches in diameter, and the smaller one nearly 2 inches, leaving a flange, g, which is 3-16 in. wide and ⅝ in. thick, and leaving 2 inches of the diaphragm exposed.

The mouthpiece, H, has an annular bearing surface which corresponds in width to the flange, g. The smaller part of the opening through the mouthpiece is 2½ in. in diameter.

The mouthpiece has a flange, h, for receiving screws, i, by which it is secured to the diaphragm support.

The diaphragm, f, is clamped between two rings of blotting paper, and is damped by two or three pieces, f', of elastic rubber placed between it and the inner surface of the mouthpiece, H.

A delicate wooden spring, k, having the head or mallet, e, is secured by screws to the diaphragm support, G, and the

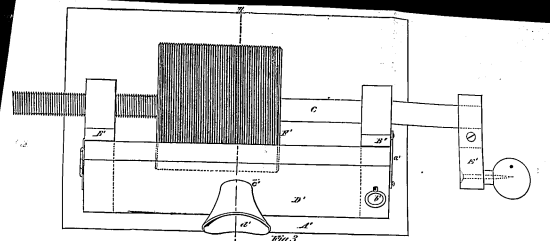


Fig. 3.

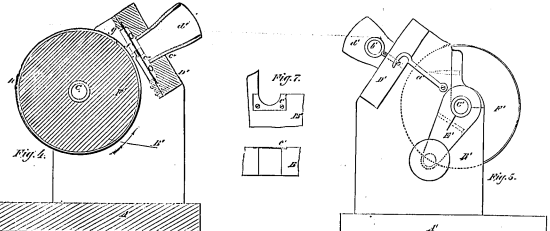


Fig. 4.

Fig. 7.

Fig. 5.

WORKING DRAWINGS FOR A PHONOGRAPH.—SCALE, HALF SIZE.

bevel, l, rests upon a thin piece, m, of elastic rubber, which is placed upon the center of the diaphragm.

The best material for the diaphragm is thin ferrotype plates, procurable at the photographer's. The head, l, is filed to a sensitive mouth, n, which projects about 1-16 in. and is quite sharp. The point, however, should be slightly round and shaped somewhat like the point of a leather awl, with the edge arranged parallel with the axis of the cylinder. The point of the point must be very slight indeed, and the mouth must always be kept in good condition. If the needle is too sharp it will cut and scrape the tinfoil. If too dull, the articulation will be muffled. The needle may at any time be sharpened by drawing it from the handle instrument by using a small abrasive slip. Before placing the tinfoil on the cylinder the needle must be adjusted by the

Fig. 6.

screws, k, so that it will strike exactly in the center of the space between the screw threads.

The tinfoil used with the instrument should be rather more than 2 inches square feet to the pound—and it should be cut into pieces 2 inches square.

The foil is mounted out on a glass plate and wrapped smoothly around the cylinder, and one end, after being greased or coated with a little shellac varnish, is lapped over the other end and the joint is carefully smoothed.

It is obvious that the cylinder, when tinfoiled, must be lapped depends upon the direction in which the cylinder is turned. While the cylinder may be turned either way, it is found preferable to turn it in a right-handed direction, and the foil accordingly should be lapped from right to left.

Having placed the tinfoil, the diaphragm is adjusted by means of the screws e e, so that the needle point will make a slight groove in the tinfoil, as the cylinder is turned. After this adjustment the screw e need never be changed.

Now, by speaking rather loudly in the mouthpiece, and at the same time turning the cylinder, the speech will be recorded upon the tinfoil. After loosening the screw c and the cylinder may be turned back to the point of starting. The needle may again be brought into contact with the foil by turning up the screw c, when, by turning the cylinder forward, the speech or other sounds will be reproduced.

It is found advantageous to speak to the instrument through a short tapering tube, the smaller end of which is ½ inch in diameter and the larger end 1¼ inch in diameter. The tube should be about 4 inches long.

When the instrument is made to speak a coiled paper resonator, 16 or 18 inches long and 3 or 4 inches diameter at the larger end and ½ in. diameter at the smaller end, should be inserted in the mouthpiece, as it greatly reinforces the sound.

Figs. 1 and 2, inclusive, represent a phonograph for which the standards may be purchased for $2.50. In this instrument the base piece is 7x11½ inches and 1 inch thick. The standards, B, are of the form shown in the engraving, and 1 inch thick. They support the shaft, C, which is 5/16 from the base, and cut all diagonally to receive the diaphragm support, D', which is hinged at one end and fastened by a hook, a', at the other end.

A screw eye, b', having its point filed off, is screwed through the free end of the diaphragm support and rests against the standard, B', and serves as an adjusting screw for regulating the needle. There is a ⅜ inch hole, c', exactly in the middle of the part, D', for securing the mouthpiece, d, and in the under side of the part, D', concentric with the hole, c', there is a shallow circular recess, e', which is 2 inches in diameter.

The shaft, C', is made of a piece of mandrel drawn brass tubing, 10½ inches long and ⅜ inch external diameter. It needs no turning, and it may be threaded by any steam or gas fitter. The length of the threaded portion should be the same as in the phonograph described above, but the lead may be somewhat coarser, say 14 or even 12 to the inch. The nut is made with a steel plate, e', screwed to the standard as in the other case.

The crank, F', is of wood, and is split from the shaft toward the handle and clamped tightly on the shaft by the screw shown in dotted lines.

The cylinder, B', of this machine is made of piece of pasteboard, and is turned off in the frames.

The method of making the cylinder is as follows: Drill two holes through the shaft at right angles to each other and insert two short pins, which will hold the cylinder in place after it is cut.

Strike two concentric circles on a piece of pasteboard, one 3½ inch and the other 4½ inches diameter. Put 7 inches of the smooth end of the shaft through the 3½ inch hole, and support the pasteboard in the middle of the shaft in vertical and at right angles to the pasteboard. Take a piece of sheet, smooth paper, 4 inches wide and 18 or 20 inches long, and form it into a cylinder 4½ inches diameter, and fasten the overlapping ends by means of pins or a string, and set it upon the 4½ inch circle on the pasteboard. Secure it in place with a little plaster of Paris.

Take a bucket viewed about 1 quart of water. Sprinkle into it 4 lbs. of very fine plaster of Paris, allow it to settle, pour off the surplus water, stir the latter quickly, but be careful that it does not become filled with air bubbles; pour the plaster into the paper cylinder, and allow it to set; when it becomes hard and before it dries, remove the paper mould, and place the shaft, C', in the bores in the standards and secure the box caps by a screw as shown in the end elevation (Fig. 5).

Fit a plug to the circumferences hole, c', and drive through it a turning chisel. Block up the free end of the part, D', and turn the shaft.

The cylinder revolves under the chisel, and is at the same time moved lengthwise by the screw. The machine is thus quickly converted into a lathe. By gradually lowering the chisel the cylinder is reduced to a uniform size both ways, and the cylinder will be reduced in diameter as much as may be necessary.

When it is 4⅛ inches in diameter, it is removed from the frames and dried in a warm (not hot) oven. When dry, and while it is warm, it is coated with paraffine, which is allowed to soak in.

When it becomes cool it is placed in the frame, and a V-shaped thread-cutting tool is substituted for the turning chisel, and the thread is cut in the surface of the cylinder by running the cylinder to revolve under the cutting tool as in the case of turning.

The thread-cutting tool must take very light chips, otherwise the cylinder will be rough.

The V-shaped grooves need not be deep, and the top of the thread should be wider than the groove. The diaphragm, f, is clamped between paper rings, over the recess, e', by means of a thin board, g, having a circular aperture which corresponds in diameter with the recess, e'.

The diaphragm is damped with short pieces of rubber tubing, and the needle is inserted in the same manner as in the machine shown in Figs. 1 and 2.

The mouthpiece is of porcelain, such as used for speaking tubes.

The tinfoil is wrapped around the cylinder and lapped as shown at A.

The arrow indicates the direction in which the cylinder must be turned.

A NEW ACOUSTICAL APPLIANCE.—The traffic over the elevated railway which disfigures New York is attended by great noise, which seriously interferes with business and comfort. A remedy for this is being sought, and the assistance of Mr. Edison, inventor of the phonograph and other electrical appliances, has been secured, and at present he is making investigation with a view of putting an end to the disturbance. He stated the other day that he had not yet found out all the sources of the noise produced by the trains, and until he had fully determined what the causes of the noise were, he could not act upon suggestions. He has, however, experiments, which would enable him to find out the noise, by which he can determine the character of the sound waves, and then get at the causes of the offensive roar. This instrument Mr. Edison described. It consists in part of a funnel to collect and condense the sound vibrations. At the small end of the funnel is a diaphragm which is made to vibrate by the sound. A cylinder similar to that used in the phonograph is placed near the diaphragm. About the cylinder is wrapped a piece of paper, which has been blackened by being held over the flame of burning charcoal. A straw is fastened to the funnel diaphragm in such a manner that the point falls on the blackened paper. As the cylinder is turned, the sound vibrations are traced by the straw on the paper in such a manner that they are plainly visible. The instrument is called the "phonautograph." By its use seconds of sound vibrations for any desired length of time can be easily made. These records, Mr. Edison believes, will enable him to determine the causes of the peculiar roar produced by the trains of the Metropolitan Road. He intends to use the phonautograph both in the cars and on the ground under the track. *N.Y. Sun 5/5/78*

THE PHONOGRAPH.—We hope to give an account of Messrs. Preece and Stroh's researches in vowel sounds in our next. *L.E. 7/5*

By V. DVORAK

[Translated from Annalen der Physik und Chemie, Band III., No. 3, Gustav Agren, November 18, 1877. With a note by Alfred M. Mayer.—*American Journal of Science and Arts.*]

(1.) *Acoustic repulsion of resonators which are open at one end only.*—In a previous article "On Acoustic Attraction and Repulsion," I have conclusively proved by theoretic considerations, as well as by experiments, that the average pressure at the node in a column of air vibrating in stationary waves cannot be equal to zero as long as the amplitude of vibration is not infinitely small.

In a resonator open at one end, as for example a cylinder, we find a node at the closed end. In the interior of the cylinder near the closed end there exists a greater pressure than on the outer surface of this end, which is touched by the outside air, as can be easily shown by means of a sensitive manometer.

To obtain resonance the opening of the cylinder is turned toward the source of the sound, and the cylinder is then repelled by the excess of pressure within. Resonators not having a cylindrical form, but open at one end, are also subject to such repulsion. In my previous communication I have indicated means for observing the acoustic repulsion of resonators. As the method described there is not very sensitive, I have replaced it by the following. The resonators here employed are usually made of India rubber, moreover well known glass and tops the shape of the cylinder with a little paper tube, *A A* as one end, Fig. 1, *a*. This little tube may also be omitted as in Fig. 1, *B*; in that case

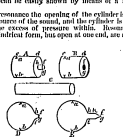


FIG. 1.

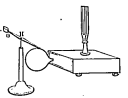


FIG. 2.

the resonator is tuned by increasing or diminishing the little opening, *f g*. Even a cylindrical tube open at one end, Fig. 2 *C*, may serve our purpose as a resonator. Spherical resonators of glass, Fig. 1, *D*, which a practical glass blower can make as light as paper resonators, are excellent. The note of the resonators is determined by gently blowing over the opening or by tapping.

The resonator is fastened with sealing wax to the end of a light wooden rod, the other extremity of which is provided with a counterpoise of lead, *G*, Fig. 2. The center of the rod has a glass cup, *H*, which rests on a needle point.

The best source of sound is a resonant box of a tuning fork, Fig. 2. The repulsion is so great that it is apparent even with an ordinary brass Helmholtz resonator, weighing, with the lead counterpoise, 142 grammes.* With every tuning fork we must first ascertain whether the air in the resonating box vibrates with sufficient energy, because this is not always the case even with accurately tuned forks. As the elasticity of the different boards which form the elastic system of the box is not equal, their vibrations may hinder the formation of the node at the bottom of the box; in this case the air on the bottom of the box will vibrate less than the air. We can easily ascertain this fact by successively applying the foot to the note of the fork and then observing whether the note is considerably weakened by partially covering the opening. If it is not, then the air in the box has but little vibration even if the base of the fork is powerful. I have, for example, two boxes with excellent tuning forks by König (of 256 vibrations per second), in which the air would in no way vibrate powerfully. The strength of the vibration of the air was considerably affected by the degree of tightness with which the fork was screwed to the top of the box. The air is always vibrated powerfully with a bow, and two bits of rubber tubing must lie on the bottom of the box. I generally use the fork A, of 435 vibrations per second, by König. Repulsion is then plainly visible with glass resonator at a distance of ten centimeters from the opening of the box. With a large C fork of König (of 128 vibrations), which sounds for more than ten minutes, it was apparent at a distance of twenty centimeters.

The resonators may be tested either by the re-enforcement of the sound produced with a tuning fork, or by the weakening of the sound on approaching them to the opening of the box.† It is not possible to obtain the repulsion of resonators from the prongs of a tuning fork alone, as their aerial oscillations are too weak. (Compare Dvorˇ, *ebdb*., p. 42.) I formerly tried in vain to obtain acoustic repulsion from vibrating bodies without the aid of resonance. I suspended small resonators, like that of a glass tube vibrating longitudinally and open at both ends, to a rock to increase the vibrating surface. The open end of the resonator was probably too near the end of the fork, and thus prevented a lowering of the tone and acoustic attraction instead of repulsion. Attraction is probably present in all cases and can manifest itself only when not counteracted by greater repulsion.‡ Later I obtained repulsion very easily in a longitudinally vibrating glass tube 127 centimeters long and 27 millimeters in diameter, on the end of which was a cork 46 millimeters in diameter. One of the resonators used was spherical, Fig. 1, B, and another cylindrical, C.

I also obtained powerful repulsion with a circular disk 21 centimeters in diameter and two millimeters thick, made by König. The plate was fastened in the center in a vertical position and made to vibrate in six segments, producing a tone of 208 vibrations. The resonator was made of stiff paper of the form of B, Fig. 1; *a* equal 80 millimeters, *c d* 140 millimeters, *f g* equal 17 millimeters, and its opening was placed in front of the center of a vibrating segment, or ventre.

(2.) *The Acoustic Mill.*—A continuous rotation is easily obtained on the principles of the acoustic repulsion of resonators by fastening four very light paper or glass resonators upon two wooden rods, *n, n', o, o'*, Fig. 3, crossing at right angles, and balanced on a glass cup; all the openings of the resonators

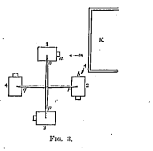


FIG. 3.

turn fronting one side in the direction of tangents. The whole apparatus is placed before the opening, *K*, of the resonating box and fork, in the manner indicated in Fig. 3. The open end, *a*, of resonator 1 is repelled from *K*; the closed end, *B*, of resonator 2 is attracted, but in general this attraction does not increase the rapidity of rotation, because it counteracts rotation the moment the resonator 2 has changed its position about 45°. It is therefore not possible to obtain continuous rotation by means of acoustic attraction, as I have shown by numerous experiments.‡ The resonance 1 continues to move by reason of its inertia and resonator 2 takes its place, being in turn repelled, and so on.

A very rapid rotation is obtained by using a large Kundt's tube and placing a small acoustic mill before its open end.

The glass tube (Kundt's), which vibrates longitudinally and produces the tone, is fastened in a heavy table, and protrudes only a short distance through the cork into the glass tube, placed upon a separate table so that its open end projects somewhat beyond the edge of the latter. The length of the rod was 127 centimeters, the diameter twenty-seven milli-

meters; the half wave length of its note, $\frac{2}{4}$, equals ten and

one-half centimeters. The length of the tube was 45 centimeters; the length of the vibrating column of air, corrected

for the open end, was $3\frac{2}{4} + \frac{1}{4}$, the inner diameter was five centimeters.

(4.) *The Acoustic Torsion Balance.*—If we hang by a silken thread, not provided with a resonator, like the beam of a Coulomb's torsion-balance, in a case having an opening in the side turned toward the resonator, we can demonstrate the intensity of notes having an equal number of vibrations by means of the repulsion of the resonating jar. For further experiments are necessary to test the practicability of this method.

The sound proceeded from an open pipe, having the note A (of 435 vibrations). To prevent the retreat of air which passed through the pipe into the resonating the resonator attached to the balance, we insert not the pipe exactly in the middle of its ends, and bind a thick membrane soaked with glycerine. To prevent the air, issuing from the mouth of the pipe, from impinging on the resonator, a board box is used, which surrounds the mouth of the pipe on all sides. This box is open on the side opposite the resonator so as not to impair the tone. The pipe is sounded by means of a Kinkle's acoustic bellows with a uniform blast of air. The distance

* This is perhaps connected with a connection of the aerial vibrations with the electric current. The ebb tide of the sound vibrations disappears in support to work.

† These experiments were also described in a previous communication, in the apparatus represented, Fig. 3, repulsion is easily over-rated into attraction by disturbing the opening of the resonator with wax, and so throwing it out of tune.

‡ Instead of resonator, No. 3, I used vertical pasteboard tubes, varying in length and inclination, allowing any position, notwithstanding the fact that there was a pasty string acoustic attraction for each separate

of the resonator from the mouth of the pipe must be at least two or three centimeters, to avoid a change of pitch.

(5.) *Production of Currents by Sound.*—It may easily be proved by simple theoretic considerations that the mean pressure on the walls of a column of air is greater than at its center, and that it steadily diminishes in passing from the node to the center, provided that the amplitude of vibration is not infinitely small.

It would seem that this difference of pressure would be neutralized by the passage of the air from the node to the center. There would then be produced a mean pressure in the whole column, which would be greater, however, than that of air at rest. Consequently air would issue from the opening of the vessel in which it forms stationary waves. I have not succeeded so far in making the whole process clear, or in realizing the perfect balance of pressure-laws place. The manometer gives evidence of a slight excess of pressure even at the center, but this excess increases as we pass to the node. All my previous experiments show a continuous current of air from the node to the center, and in a direction contrary to that of the principal current, so that the whole air is in the tube in circulation. The cross-section of the tube of equal current is nearly as great as that of the tube, while that of the secondary current is a very narrow ring.

The excess of pressure as shown by a manometer at the node is always less than the theoretical pressure, because in the latter the air is not supposed to issue from the node and to equalize the pressure. Of course the excess of pressure at the center is not equal to zero, as theory requires. Probably the friction of the walls has much to do with these phenomena. It may be expected from what has been said that the air will issue from the vessel in which it vibrates in standing waves. The manometer shows in the first place that the excess of pressure is not equal to zero in the place of the standing wave, and further because a portion of the air immediately in front of the sounding particles of this stationary wave rushes, and because there is always a small excess of pressure even in the vessel in ordinary waves. There is no doubt that a partial equalization of pressure takes place at the opening; experiments show, furthermore, that there is a continuous exit of air which, as in Kundt's tube, is probably neutralized by a secondary and contrary current.

The air-current can easily be proved, as follows: A sphaerulating flask, the resonator is placed before the resonant face of a vibrations are given to the fork, when the smoke will be seen to rush from the resonator.

The current of air proceeding from a resonator is well shown by means of a Chladni plate, by means of hydrogen, which accumulates upon the vortex in little heaps when a plate is sounded. If now we place the opening of a bottle, or bottles of 4 resonator, B, over such a heap, the hydrogen will be immediately blown about in a circle and may be scattered in any direction by giving suitable inclination in the resonator. A glass plate held over a heap of lycopodium produces the opposite effect by causing it to coagulate.

I have succeeded in producing comparatively strong currents of air in still another manner, but I have not yet found an explanation of these complicated phenomena.

A cone made of stiff paper was held with its large end opposite the opening of a large Kundt's tube. The size of this cone may vary, but itseffect is greatest when it vibrates to the same note as the Kundt's tube, and when a resonator is at both ends; the diameters of its open ends are thirty-seven and seven millimeters, and its length ninety millimeters.

When the Kundt's tube begins to sound lustily a current of air issues from the narrow end of the cone with such violence that it easily blows out the flame of a candle at a

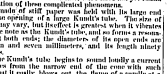


FIG. 4.

distance of twenty centimeters. This current reduces through the cone with a peculiar noise and is easily felt with the finger.

The cone may be replaced by a cylinder having the width of the Kundt's tube, open at the end turned toward the latter, and closed all but a small hole at the end, but the current issues less briskly; nevertheless it will move a small wheel with vertical paper vanes, Fig. 4.

In the experiments with the tuning forks, it is essential that the cone should vibrate to the same note as the fork, otherwise the current is too weak. For the fork A (of 435 vibrations), the openings of the cone have diameters of 82 and 7 millimeters, and the length 373 millimeters. The opening at the apex of the cone must be very small to obtain an appreciable current.

On conclusion of this investigation, Dr. R. Klinkg kindly communicated to me that Mr. Alfred Mayer in New York [Hoboken] had previously succeeded in producing continuous rotation by means of sound. The communication was as follows: "Professor A. M. Mayer showed me a very similar experiment last summer (1870). He suspended by a thread two large well-tuned flasks attached to a rod, and caused the whole apparatus to revolve by means of a tuning fork. I informed him in consequence that you had previously demonstrated the phenomena of repulsion in resonators, for he was not acquainted with your paper* on acoustic attraction and repulsion."

NOTE BY PROFESSOR ALFRED M. MAYER.

My connection with the discovery of the Sound-Mill is as follows:

In January, 1870, I made the discovery—first one not to a theoretic deductions—that there was more pressure on the inner surface of the bottom of a resounding cavity than on the outer surface of the bottom which touches the air. This I subsequently proved the truth of this conclusion by experiments on suspended resonators, and by observations on the motions of precipitated silica powder and films of soap-bubbles placed at various points in resonators of different

* Read before the R. Acad. Sci., Vienna, in 1873.

forms. My first publication of these results was on May 23d, 1870, on which day I read a paper on this discovery before the New York Academy of Sciences, and exhibited before the members an apparatus formed of a tuning-fork, a box of wood, with a resonator attached to sounding an organ-pipe, of Professor Dvorik's paper. In tune with these resonators, or a fork on its resonant box, in tune with these resonators, or a fork on its resonant box, in tune with these resonators, and they were successively repelled. At the same meeting a continuous rotation was exhibited. At the same meeting this experiment was preceded by those in the Scientific American, etc., in connection.

On the 8th of July, 1870, there appeared in the Scientific American a report of this meeting of the Academy, in which my experiments in Acoustic Repulsion are thus referred to:

"In the next place, Professor Mayer exhibited an apparatus constructed by him to produce motion by means of sound pulses. Four glass resonators on cross-arms were suspended by means of a string. On sounding an organ-pipe, in tune with the resonators, and bringing it oppositethe mouth of one of them, the resonator was repelled and the apparatus commenced to rotate. This experiment was the more striking, from the fact that, as far from any current of air proceeding out of the mouth of the organ-pipe, the air is actually sucked in, as may be rendered visible by means of smoke from a cigar. The smoke is carried up the pipe even when the latter is closed at the top with cotton wool so as to smother it of sound. On substituting flasks of cardboard for the resonator, they were thrown up to the mouth of the organ-pipe with considerable force. When two miles powder was placed in the resonators, it was thrown into violent motion on sounding the pipe."

In the same month, July, 1870, Dr. Rudolph Konig visited me, and I exhibited the same experiments before him.

The discovery of the acoustic repulsion of resonators and the invention of the sound-mill were made entirely naturally by Professor Dvorik and myself. It is another instance of mind—even so far distant as Agram and Hoboken—acting in the same path of research by the natural growth of science.

Dimensions of the resonators and reaction wheels used in millimeters: (1.) Fork C, of 128 vibrations. Glass resonator of form E, Fig. 1, a. 6, equals 90; b, f, 25; b, k, 20; k, f, 30; f, g. 8. Its weight, together with its leaded counterpoise, was 72 grammes.

(2.) Fork A, 435 (vibrations per second). (a.) The glass resonator used in the experiments represented in Fig. 2, and to show the currents of air by means of smoke, was of the form D, Fig. 1. a. d equals 58; b, f, 22; f, g. 10. (b.) The glass resonators of the acoustic mill were of the form D, a d equals 31; b, f, 12; f, g. 5. The length of the arms from the middle of the glass cups to the middles of the resonator was 52 millimeters. The weight of whole wheel was 23 grammes. (c.) Paper resonators of the acoustic mill, Fig. 3, were of the form A, E, a. d; a. e; d. m; d. y; e. n; y. z; 8 millimeters. The length of the arms was 65; the weight of the wheel 9 grammes.

(3.) Kundt's tube, $\frac{2}{4}$ equals 105 millimeters. The glass resonators of the acoustic mill were of the form D, Fig. 1, a d equals 51; b, f, 21; f, g. 7; length of the arms, 30 millimeters.

It is a striking fact that very small resonators may give very deep notes; with fork C a wooden glass resonator of the form H, Fig. 1, in which a. b equals 21; b, f, 11; and f, g. 4 millimeters. The volume was about 1/1000 of that of the resonator box of the fork, to which the resonator was tuned. Notwithstanding its smallness it showed acoustic repulsion.

[1871.]—Phonograph.—After the number of failures that have been recorded it is quite refreshing to hear of your success. Adjustment of the points, without looking at them, is simply a matter of practice. My method is to screw up the nut slowly until one hand, while with the other I turn the cylinder, I can hear the point just touch the groove of a turn; I can tell by the sound of the scratch when the adjustment is right. Of course it is easy to add regulating stops, but they will be found to require frequent alteration, as the instrument is very sensitive to change of temperature and moisture.—Sheldon Bidwell.
Ph. vol. —, page —, calc.

The Phenograph.—In his study of the phonograph record, Mr. Edison finds that he can recognize certain known sounds from their indentations when there sounds are made by the same kind of voice. In spite of the irregularity existing in the points of the same sounds uttered by different persons, or by the same person under different conditions, he claims that the record of any one sound can be distinguished from any other sound. Between the records of vowel sounds very little difference could be detected. For some vowels the indentations were deeper at one end than at the other; giving to the characters the shape of eggs, pears, and Indian clubs. This is usually the case with the vowel E. The deepest indentations are made by consonant sounds—on account of the explosive force with which they are uttered; P, especially being distinguished by the pit which begins the imprint.

New Phonographic Experiments.

Our [illegible] observations on the waveforms of articulate sounds may be made by Edison's phonograph. We have submitted the indentations of the [illegible], which had received the impressions of different sounds, to microscopic examinations, but the insignificance produced in them are on such a very minute scale, that even the microscope does not plainly reveal the differences, without peculiar preparation.

Prof. Fleeming Jenkin, assisted by Mr. J. A. Ewing, has obtained a large series of necklaces upon lamp-black paper, by which the waveforms of different sounds have been shown. Some of these results Prof. Jenkin has laid before the Royal Society of Edinburgh, Scotland. The vowel sounds in the phonograph are found not to depend on the speed with which the cylinder of the phonograph is turned, the distinct vowel being heard however much the pitch of the note may be altered by more rapid or slower turning of the instrument. He found that the phonograph would be produced to produce the French a, always converting it into the sound of oe. On the black-board Prof. Jenkin has exerted some of the commonest forms assumed by the sound-waves, one of the most interesting being that of the letter r. In the case of the broad sound of a, it was shown that while with most ordinary voices the wave took the form which might be described as having two humps, a rich bass voice had been found to give a wave-form much more intricate, showing four distinct humps in each re-current period of vibration. It was found that the phonograph gave vowel sounds as well when the cylinder was turned backward reversed; and, encouraged by this, the consonants were experimented upon, giving the same result. Even with a consonant at the beginning and end of a syllable, as, for instance, *bed*, it was rather unexpectedly found that the word would be correctly repeated either way, showing the identity of the sound.

Prof. Jenkin gave some amusement by describing the effect of reading words backward, stating that with careful observation every sound could be detected, for example, "association," which, when the cylinder was reversed, could be distinctly heard as "noos-hel-ass-see." Mr. Ewing—which he said Mr. Ewing could in "Edinburgh"—which he said Mr. Ewing could pronounce backwards, though he could not—the different sounds could also be distinguished. Words and sentences which, when pronounced backward or forward sound the same, were tried. Thus was tried the well-known sentence, "Madam, I'm Adam," with which Adam is traditionally alleged to have saluted Eve; and "Madam, I'm Adam," although spelled the same both ways, did not sound the same in the phonograph, the diphthongal sound of the "I'm" giving a sound like "aym."

It is obvious from Prof. Jenkin's experiments that some interesting points in acoustics may yet be settled by means of this extraordinary instrument.

[31116]—Phonograph.—I grind my points on an oil-stone to an angle of 45° or 60°, and then polish by rubbing with a bloodstone. I have even a phonograph with a ruby or sapphire point; I forget which. The ruby is the best, as it is harder than the other materials, and so polishes more easily and quickly. Indiarubber tissue under the tinfoil reduces the scraping sound, but it also diminishes the power of the instrument very considerably. On the whole it is best to use the tinfoil without backing. The highly polished points and smooth tinfoil respond lightly upon the cylinder with a practically scraping sound—a very subtle, and does not interfere at all with the performance of the instrument. With a single diaphragm and in the manner described, for me a few weeks was the acting circuit to find where, on the tinfoil, I could get the loudest sound. Speaking is the best; I still prefer two diaphragms for general use. Try steeper tinfoil. See that the point on it at spring turns slightly forwards, and do not make it or furrows too deep.—SHELFORD BIDWELL.

THE PHONOGRAPH AND VOWEL SOUNDS.

III.

WE now pass to the general conclusions which may be drawn from our experiments. In the first place it seems clear that vowels do not depend on pitch alone or on the simple grouping of partial tones independently of absolute pitch. Before the constituents of a vowel can be assigned, the pitch of the prime must be named. But on the other hand the pitch of the most prominent partial of the group is not alone sufficient to allow us to name the vowel in which it appears: to do this we also require to be told the relation of the constituent partials to one another.

The sound *ā* consists mainly of one tone generally lying in the region above *c*.

The sound *ā* requires at least two partials; when there are only two important ones these lie in the region between *g* and *f'*; a region covering nearly two octaves. Indeed the upper limit may extend above *f'* with a tenor or woman's voice. Other partials than the prime are reinforced by the mouth-cavity over all this region. This great range is obviously a distinguishing mark of *ā* as compared with *ō*, perhaps *the* distinguishing mark; for when *ō* and *ū* are sung at various pitches, the most prominent partial, first of one letter and then of the other, is highest, and the most prominent partial of both sounds may be on *f*5, the characteristic tone of *ā*. An *ō* sung on *f*5 may even have the true *f*5 more strongly present in it than an *ō* of the same pitch. When *ō* was sung by voice 1 on *f*5 the prominent partial was the second, when *ō* was sung at the same pitch by the same voice the second partial was still the most prominent. Thus for voice 1 the distinction between *ā* and *ō* rests on the fact that in the pitch of strongest reinforcement, that is the fact that the prime was larger for *ō* than for *ā*. When *ō* was sung at *f*5 the prominent partial was the prime; when it sang *ā* the prominent partial was the second, the prime being also strong. Thus, for voice 1, the distinction lay in the fact that the prime was much smaller for *ā* than for *ō*. It is obvious here that the ear cannot have been guided by the absolute pitch of the reinforcement to the distinction between *ā* and *ō*. At this pitch the distinction lies in the fact that *ā* contains two strong partials (the prime and second), whereas *ō* contains only one (the prime or the second). The argument is not weakened by saying that the *ā* of one voice was not the same as the *ā* of the other. Identically the same it cannot have been; nevertheless, on higher or lower notes the two voices agreed as to the composition of *ō*, and generically the vowels were certainly the

[Continued from p. 397.

same. There remains the fact that speakers and hearers were unconscious of any general change in the vowel *ā* when the pitch of the strongly-reinforced partial changed by a whole octave.

On the other hand, it is equally clear the voice, in singing a given vowel at various pitches, does not simply produce a certain constant group of relative partial tones. Possibly, indeed, the ear might recognise a single tone, especially if very feebly sec supported by higher harmonics, as a kind of *ā* out side the region within which the human voice forms *ā* in that way. Thus Helmholtz, in his *Tonempfindungen*, says that the single tone 6*c*, when sounded alone, gave a very dull *ō*, much duller than could be produced by the voice. It would be rash to assert before the prime where voice 1 proved to make *ō* by reinforcing the octave. Quite similarly it is easy to see that the group consisting of a prime and its octave might be recognised as *ō* even when produced below the limits within which the human voice does produce this simple form up in singing *ō*. Our own impression as to the re-ult of running the phonograph down is to speaking them when it is spoken to, supports this view, but we do not desire to lose any inference on that. Certainly *ō* and *ū* are sounded in this manner in not the human *ō*.

Moreover, we find a very decided re-semblance in the relative constitution of *ō* at a low pitch and *o*' or *ū* at higher pitches, *ō* in the neighbourhood of *f*5, and *ū* in the neighbourhood of *f*, and *ō*, *ū* are practically similarly constituted. Our experiments on *o*' and *ū* are not sufficiently extended to allow any very general conclusions to be drawn, but they are sufficient to show that between certain vowels the main distinction must lie in the absolute pitch of the reinforced group of partial tones.

We may thus bring back to our original statement that in distinguishing vowels the ear is aided by two factors, one depending on the harmony or group of partials, and the other on the absolute pitch of the constituents. It seems not a little dissimilar in their relative and absolute composition as those represented by the curves of Fig. 1.

We are forced to the conclusion already adopted by Helmholtz and Donders that the ear recognises the kind of cavity by which the reinforcement is produced; that although the sounds which I call *ā* and *ō* are both vowels, and are both recognised as generically represented by the curves of Fig. 1.

We are forced to the conclusion already adopted by Helmholtz and Donders that the ear recognises the kind of cavity by which the reinforcement is produced; that although the sounds which I call a practically vowel. But we have to consider what light the experiments throw on the kinds of cavity that are required for certain vowels. The cavities are clearly distinguished in virtue of two distinct properties: first, the pitch of their maximum reinforcement which they are capable of producing. This latter property has, we believe, been hitherto much neglected.

Prof. Cleve Brown's experiments prove that a *constant* cavity is capable of producing the constant vowel *ā* over a large range of voices singing *ā* appear to exhibit differences with various human which new partials are sometimes introduced somewhat abruptly; tend for the sound *ā* it seems certain that the cavity is tuned, that is to say, that the pitch of its proper tone is nearly the same when the vowel is sung on different pitches. The remarkably strong *fourth* partial in all the duplex *ā*'s of Table VI. may be noticed as favouring the view that in each of these examples the end cavity had been adjusted so as to be in unison with the second partial. We may describe the *ā* cavity as an adjustable cavity with a very limited range of resonance, whose effect is to reinforce strongly only one partial lying above *a*. It is possible that this cavity may keep itself constant throughout the very limited range of pitch employed in ordinary speech, but when that range is increased as in singing, a certain tuning seems indispensable.

If we assume that the *ō* cavity is absolutely constant, we must describe it as a cavity capable of reinforcing more or less strongly tones lying anywhere between *g* and *f*'. This cavity

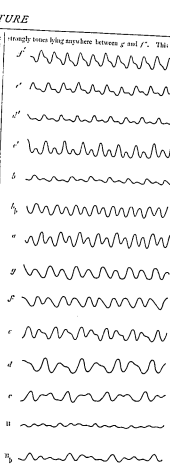


FIG. 1.—*Wave-forms of ō Sung by the same Voice at Various Pitches.*

[1] We reproduce this week the figure which accompanied Prof. Jenkin and Ewing's first paper, on "The Wave-Form of *Ō*," p. 310. It shows the delicate forms of the curves with greater exactness, and will enable the reader to understand more clearly the value of the conclusions come to by the authors.—ED.

LE MÉGAPHONE

Nous avons reçu de New-York le dessin du *Mégaphone*[1] pris sur l'instrument établi par le professeur Edison, à Menlo-Park. L'appareil possède, paraît-on, une puissance vraiment admirable. On est parvenu à converser à une distance de 1 à 2 milles, en causant dans le porte-voix, sur un ton ordinaire. La construction du mégaphone est aussi simple que ses effets sont merveilleux. Il est formé de deux simples entonnoirs de carton — ceux d'Edison ont 2 mètres de long et 1 m. de diamètre à leur plus large extrémité — terminés chacun par un tube de caoutchouc dont le bout se met dans l'oreille. Entre ces deux entonnoirs se trouve un porte-voix de construction semblable aux porte-voix ordinaires, si ce n'est le pavillon qui est beaucoup plus ouvert. Le plus petit

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chuchotement est entendu au moyen de l'appareil à quatre cents mètres de distance.

Malheureusement, cet instrument ne sera d'aucune utilité pour les personnes affligées de surdité; ses dimensions l'empêchant assurément de devenir jamais un « instrument très-portatif et susceptible d'être placé sur les grands ou dans la poche. »

[1] V. *Monde de la Science et de l'Industrie*, page 103.

LE MÉGAPHONE

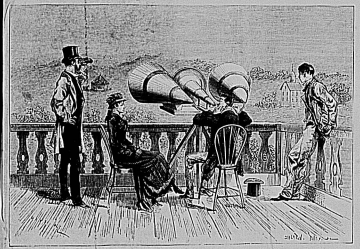
THE PHONOGRAPH.—The Abbé Cerbenal, of the Belsunce School, Marseilles, has been experimenting with the phonograph, and concludes that the recording and reproducing diaphragms should be distinct, the stiff, hard foil, the latter a delicate membrane like that of the ear. The foil could be made from a copper and corroded afterwards by acid so as to obtain a hard metal cast; but this is necessarily a defective process. The Abbé therefore employs albumen spread upon paper or other base, instead of the wax applied to the hardened. The soft albumen record is afterwards whose dims vary in depth with the intensity of the sounds he suggests the use of Bavaria wheat instead of a vibrating plate.

LE MÉGAPHONE DE M. EDISON

Le porte-voix qui, pendant deux siècles au moins, a été usité pour transmettre des sons à une grande distance, est très-employé sur mer; il est aussi sur terre pour faire entendre des sons destinés à dominer tout autre bruit. Il est à peu près certain que le porte-voix est d'origine nautique et qu'on en doit l'invention à Samuel Marland en l'année 1670.

Kircher, dans son *Ars magnæ et umbræ* et dans *Phonurgia*, mentionne une espèce de porte-voix, construit dans des dimensions gigantesques et désigné sous le nom de cor ou cerne d'Alexandre. D'après Kircher, cet instrument permettait à Alexandre le Grand d'appeler ses soldats à la distance de dix milles. Le diamètre du cercle devait être de 8 pieds et Kircher conjecture que l'instrument était monté sur trois solives.

Au siècle dernier, un professeur allemand, nommé Huth, fit un modèle de cor et trouva qu'il remplissait l'office d'un puissant porte-voix; mais nous doutons fort que les sons, passant par cet instrument, aient pu être portés à des distances réellement considérables.



Le Mégaphone de M. Edison.

Le cornet acoustique qui est la contre-partie du porte-voix, a été fabriqué dans différentes formes durant les deux derniers siècles; mais aucune des formes aujourd'hui existantes ne l'emporte sur un tube simplement conique évasé et ayant un orifice pareil à celui d'une cloche.

Le professeur Edison, dans ses recherches sur le son, a fait des expériences nombreuses et intéressantes; l'une des plus curieuses consiste dans le fait d'une conversation soutenue à 1 mille et demi ou 2 milles (2 ou 3 kilomètres) de distance sans autre appareil qu'un petit nombre de cornets en carton. Ces cornets constituent le *mégaphone*, instrument merveilleux tout à la fois par sa simplicité et par les effets qu'il produit.

Notre gravure représente l'instrument tel qu'il est installé sur le balcon du laboratoire du professeur Edison, à 1 mille et demi (plus de 2400 mètres) de distance; à l'endroit indiqué par les deux cavaliers sur notre dessin, se trouve un instrument tout à fait semblable à celui qui est représenté au premier plan.

Les deux plus grands cornets ont 6 pieds 8 pouces de long et 27 pouces 1/2 de diamètre à leur extrémité la plus large. Chacun de ces entonnoirs est muni d'un tube acoustique flexible, dont l'extrémité aboutit à l'oreille. Au milieu, le porte-voix ne diffère pas essentiellement du type ordinaire des instruments de ce genre. Il est un peu plus long et son orifice en forme de cloche est plus évasé. Avec cet instrument, on peut aisément converser à la distance de 1 mille 1/2 à 2 milles (de 2400 à 3200

THE PHONOGRAPH AND THE TELEPHONE.—In a communication to the *Comptes Rendus* M. Bouillaud discusses the question whether the phonograph repeats words on a principle similar to that on which differ notably from those which have been uttered, which is not the case with words repeated by an echo. Touching on the telephone, he expresses doubts as to the part played by the electro-magnetic machine.

M. Bouillaud, the eminent French savant who lately pronounced the phonograph a ventriloquial fraud and had his doubts set at rest for at the séance of October 7th, Count du Moncel again exhibited the "singing condenser" and the phonograph before the entire Academy, bearing it in the members to make the experiments themselves.

THE PHONOGRAPH will henceforth be sold in America to all purchasers, without any royalty to the Phonograph Company, for 100 dols. (£20 or 500 dols. (£16), according to the finish of the instrument.

1878.] THE LOGOGRAPH. 65

experiment might be tried of an analogous kind, by moving the hydrogen with a brush, or other mechanical means, to see if it has the same effect as the gases. I am sure you will all agree that we should return our thanks to Mr. Edmunds for his kindness in showing us this battery.

A vote of thanks was unanimously accorded to Mr. Edmunds.

Mr. W. H. Barlow, F.R.S., V.P. Inst. C.E., then gave a description of the Logograph. He said—The small instrument I have to show you is not altogether a new one. It is scientifically getting rather aged—about four years old. This instrument, I may confess at once, owes its origin to an attempt to make something which would do short handwriting instead of employing the services of the gentleman who sits there. We have failed in doing that, but it has certainly served some purpose. It has served the purpose of illustrating certain features connected with the articulations of the human voice. Everybody knows that, in speaking, the air contained in the lungs is sent forth from the mouth in spurts of different magnitude and with different degrees of velocity and intensity. I may say that forty years ago I first thought of this when I saw an old Turk smoking his pipe. The Turks, as you know, inhale the smoke into the lungs, and, as they speak, you can see all the action of the air coming from the mouth. I was also informed of the extraordinary sensitiveness of some of the instruments used for registering indicator diagrams of the steam engine at very high velocities, and it occurred to me to put these two things together and form a delicate apparatus, and so obtain indicator diagrams showing the relative powers of the different *syllables* uttered by the human voice.

The instrument I formed was that now before you. It consists of a small speaking tube, the end of which is enlarged to a disc of about 2½ inches diameter. That end is covered with a piece of thin india-rubber, taken from a toy balloon. That membrane being stretched with a certain degree of tension, a light aluminium arm is made to press against it, the end of the aluminium arm holding a small sable brush containing colour; the speaking part of the instrument is, to a certain extent, similar to the telephone; the

THE PHONOGRAPH AND THE TELEPHONE.—In a communication to the *Comptes Rendus* M. Bouillaud discusses the question whether the phonograph repeats words on a principle similar to that of the echo. He asserts that, as regards force, tone, speed and quality, the words of phonographic origin differ notably from those which have been uttered, which is not the case with words repeated by an echo. Touching on the telephone, he expresses doubts as to the part played in the electro-magnetic machine.

M. BOUILLAUD, the eminent French [illegible] pronounced the phonograph a remarkable [illegible] the microphone an accepted humbug [illegible] had his doubts set at rest, for at the soirée of the 7th, Count du Moncel again exhibited his [illegible] condenser" and the phonograph before the Academy, leaving it to the members to make experiments themselves. *Engineering*, 7 Feb.

THE PHONOGRAPH will henceforth be sold to all purchasers, without any royalty to the Company, for 100 dollars (£25) or 200 dols. (£50) according to the finish of the instrument. *Nature*

other part of the instrument causes a ribbon of paper to pass under that brush, and then speaking into the instrument you get a diagram of the utterances that are made.

[Mr. Barlow illustrated this—the mechanical action of the instrument being similar to that of the tape-printing telegraph—and passed the ribbon on for the inspection of the meeting.]

You see there (Mr. Barlow continued) the action produced by the sounds I have just given. I may mention some facts that I have obtained as to the absolute quantity of air consumed by this process. The horizontal movement is about half an inch for some of the letters, and the whole diagram is a very large and conspicuous one. I found on an average of experiments the quantity of air consumed for each syllable, or rather the average quantity of air for each syllable, is 1¼ cubic inch. It varies very much in different syllables. The quantity of air consumed was ascertained by taking a balloon of the cubical area of 513 cubic inches, and I found it took an average of 359 syllables to fill it. That brings it to an average of 1¼ cubic inch for each syllable. I also found the capacity of the ordinary breath is about 40 cubic inches, and that by taking an extreme breath you may bring up the quantity to 80 or 90 inches. I also found that you can speak against a pressure equal to that of two inches of water, but against a pressure of four inches it seems impossible to speak at all.

Having made these experiments, which resulted in showing the peculiarities of articulation, and how the different letters were formed, and what happened to them, it occurred that the marker I was using became fixed to the disc. That arose from having used goldbeaters' skin, which caused the attachment of one to the other. I found the consequence was to produce a vibration from the vowel sounds. [Mr. Barlow directed attention to a diagram on the wall illustrating

the vibratory action of vowel sounds as distinguished from the pneumatic action of consonants, and went on to remark.] These larger lines represent the consonant actions. You observe that following them is a fine vibration, and that vibration is the vowel sound, or rather I believe there is a certain organ which vibrates whenever the vowel sound is uttered. I think it is a kind of drone which is present whenever the vowel sound is uttered. A whisper is sufficient to make known the vowel sound intended, whereas whispering will make no vibrating action. The form of the diagrams produced leads to a good many curious questions, as to the action of vowels and consonants and compound letters, things which will combine and those which will not, and I have no doubt those who know something about the anatomy of the throat and the laws of sound will be able to get more out of this instrument than I have succeeded in getting.

The CHAIRMAN asked whether, in repeating the same words over and over again, the signs recorded are constant.

Mr. BARLOW: They are constant, subject to very minute variations that arise in this kind of thing. It is almost impossible to speak the same words exactly in the same manner each time. This instrument is purely phonetic, and however minutely your articulation differs at one time from another that difference is registered.

Illustrations were given of the diagram produced by the trilling the letter "r," also by repeating the same words two or three times.

The CHAIRMAN said he was struck with the great extent of the movement of this instrument. The movement was quite half an inch in some of the longer terms. It seemed to be necessary to place the mouth close to the tube.

Mr. BARLOW explained that it was necessary to do so in order that the full effect of the air might be brought into operation.

The CHAIRMAN: In other kinds of instruments of this description you do not place your mouth so close to the tube, but depend more upon the vibratory action of the air.

The thanks of the meeting were then unanimously accorded to

THE PHONOGRAPH AND THE TELEPHONE.—In a communication to the *Comptes Rendus* M. Bouilland discusses the question whether the phonograph repeats words on a principle similar to that of the echo. He asserts that, as regards force, tone, speed and quality, the words of phonographic origin differ notably from those which have been uttered, which is not the case with words repeated by an echo. Touching on the telephone, he [illegible] especially in the case of [illegible]

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THE PHONOGRAPH will henceforth be sol
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Company, for 100 dols. 150 or 200 dols. (
ing to the finish of the instrument. Nov

Mr. Barlow for his kindness in exhibiting his most interesting invention.

The CHAIRMAN then called upon Mr. W. H. Preece to give his promised description of

"THE PHONOGRAPH."

Mr. PREECE said: The instrument which has just been described to you by Mr. Barlow is a very fitting prelude to this wonderful instrument that has just come to us from across the Atlantic. The phonograph of Mr. Edison is an instrument which is constructed for the production or rather reproduction of sound by mechanical means. It differs from the telephone in this—that the telephone is an instrument that produces sounds at distant places by the aid of electricity; but in the first principles of the two instruments we have the same identical object, viz.: that by producing vibrations by the voice upon a disc placed in a certain position we are able to produce effects which reproduce those sounds.

Now, in order to make this plain to you, I have again called in the kind aid of Mr. Edmunds to produce before you the experiments which I had the pleasure of bringing before the Royal Institution. I have here what is called a Reiss' transmitter. At the end of this nickel-plated brass tube is a diaphragm of india-rubber, and whenever I speak into that tube the india-rubber disc vibrates. You can hear it vibrate by the two plates at the contact points coming into contact. Whenever those two plates come into contact with each other they complete the circuit of a battery which passes through the primary coil of an induction coil, and the secondary circuit of that coil passes through a vacuum tube. This vacuum tube rotates by means of a common electro-magnetic mill worked by three Groves' cells. If the lights are put down we shall see the sparks that pass through the vacuum tube, and as different notes are sounded into this transmitter these different notes will be reproduced in different figures.

You will observe that every note has its distinct figure.

THE PHONOGRAPH AND THE TELEPHONE.—In a communication to the *Comptes Rendus* M. Bouillaud discusses the question whether the phonograph repeats words on a principle similar to that of the telephone. He asserts that, as regards force, time, speed and quality, the words of phonographic origin differ entirely from those which have been uttered, which is not the case with words repeated by an echo. Touching on the telephone, [illegible] magnetic machine.

M. BOUILLAUD, the eminent [illegible] pronounced the phonograph a ventrilo the microphone a nocturnal bombsh had his doubts as to real, for at the ad 9th, Count du Moncel again exhibite condenser" and the phonograph bel Academy, leaving it to the member experiments themselves. *Engi*

THE PHONOGRAPH will henceforth be to all purchasers, without any royalty b Company, for 100 dols. (£5) or 200 dol ing to the finish of the instrument. *Sc*

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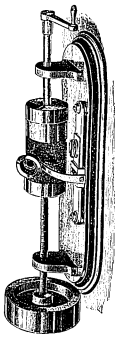

FIG. 1.

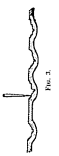

FIG. 2.

FIG. 3.

Now the evidence we have there is, that, whenever this disc is placed in front of the mouth, the sonorous vibrations issuing from the mouth, or from a musical instrument, make in that instrument a different figure.

Now in the phonograph we have a precisely similar disc—a disc identical in form and in character with the disc used in the now well-known telephone; and at the back of the disc there is a steel point which, by means of a spring, gently presses against a piece of tinfoil. Here is one of the pieces of tinfoil that is used. This tinfoil is placed around the circumference of a long cylinder, which cylinder has a thread upon it—a spiral thread—and the length in this case of this thread is about 42 feet. Now this cylinder is rotated in this particular instrument by a handle, and in order to give the cylinder a uniform rotation at the extreme end of the axle carrying the cylinder is a heavy fly-wheel. I may tell you this instrument is only the second which Mr. Edison, that wonderful genius on the other side of the Atlantic, has made. (See fig. 1.) It was brought over from America by my friend Mr. Puskas, who has brought it here, and who, as he understands the working of it better than I do, will show it you in actual operation. Now here we have all the simple conditions of a phonograph. We have a disc vibrating in response to the tones of the voice. We have a sheet of tinfoil, a yielding substance, which receives the impressions, and being highly non-elastic it retains those impressions, so that when you take up the sheet of tinfoil you will find, as far as the eye is concerned, little indentations, little rapid dots in telegraphic language, but really, as far as the eye can see, nothing but a series of these dots. (Fig. 2.) However, there is no doubt that these dots on the tinfoil follow exactly all the conditions of the sonorous vibrations expressed by the voice. Now, while I am speaking to you, vibrations enter the ear in the form of words, which strike the tympanum of the ear—an instrument identical with the mouthpiece of the phonograph. The tympanum of the ear vibrates responsively to the tones produced, which in the phonograph is imitated by the steel point at the back of the disc upon this tinfoil, so that if we take a succession of tinfoils we shall have a succession of undulations similar to

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THE PHONOGRAPH will henceforth be [illegible] to all purchasers, without any royalty [illegible] Company, for 100 dols. (£21) or 200 dol[illegible] ing to the finish of the instrument.

those of Mr. Barlow, only they are more minute. The marks on the paper of Mr. Barlow are very large; but these illustrations upon the tinfoil only vary a small fraction of an inch. (For magnified section, see fig. 3.)*

This impresses upon the tinfoil the marks as you see. The number of these waves or vibrations determining the note given out by the voice, the depth of the vibrations giving the loudness of the tones, and their form giving you the quality of the notes produced —whether it be the deep bass of a man's voice or the soprano of a woman's voice—whether it is a trumpet or a whistle,—every single sound imparted to that disc imparts a curve on the tinfoil, and that curve is the exact representation of the sounds. The result is, after having spoken into the cylinder you have the foil on the cylinder indented with these waves, and all you have to do to reproduce those effects is to cause those indentations on the tinfoil to go over the same course again; but in the second result, instead of being produced by the point of the disc these curves impart motion to the point, and the point imparts motion to the disc that previously vibrated; and if the motion be the same and at the same rate, and if the point goes over the same ground, tumbling into these indentations and gently riding over the hedges and ditches, the result is the disc is caused to vibrate exactly in the same way as it was caused to vibrate by the voice, and the consequence of this repetition of the vibrations is the reproduction of the same sounds.

Mr. Puskas will perhaps go to that instrument and say something to it.

[Mr. Puskas complied, and spoke as follows:—"The Phonograph presents its compliments to the company," which was repeated by the instrument with great distinctness.]

Now (continued Mr. Preece) this instrument which you have just heard is only the second of the kind ever made. We succeeded in England in getting some very careful written descriptions of it, and my friend Mr. Pidgeon, of Putney, a very able amateur mechanician, has, with the aid of his son, succeeded in producing a fac-simile of Mr. Edison's. The only difference between its construction and

* The Society is indebted to the courtesy of the Proprietors of "Engineering" for the engravings of the Phonograph.

THE PHONOGRAPH AND THE TELEPHONE.—In a communication to the *Comptes Rendus* M. Bouillaud discusses the question whether the phonograph repeats words on a principle similar to that of the echo. He asserts that, as regards force, tone, speed and quality, the words of phonographic origin differ notably from those which have been uttered, which is not the case with words repeated by an echo. Touching on the telephone, he

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THE PHONOGRAPH will henceforth be to all purchasers, without any royalty t[o] Company, for 100 dols. [illegible] or 200 dol[lars] ing to the finish of the instrument.

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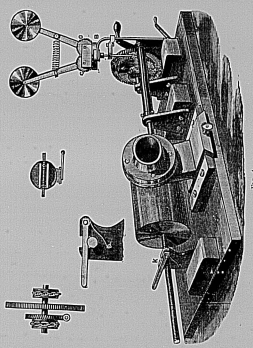

FIG. 4.

the one you have just seen is that the diaphragm into which the words are uttered is different from the one which reproduces the sounds. There are two diaphragms, and I am not sure that in abandoning his first plan Mr. Edison has made an improvement.

The great advantage, in my opinion, in having two diaphragms is that when you have a disc for receiving sonorous vibrations from the mouth you can have it set so as to be equally resilient to different voices. A strong voice or a weak voice can equally speak into it without affecting too actively the tinfoil; but that which is good for receiving sonorous vibrations is not equally good for imparting them. With a different diaphragm for receiving, it is a matter of indifference what loudness of sound is imparted. It will always reproduce the same sounds with the same amplitude. Hence you are able to make your sounding disc of lighter and more spring-like materials than your receiving disc, and you have no fear of damaging the tinfoil with loud words.

Now, Mr. Pidgeon has kindly brought his instrument here to-night. This is not to be regarded as a competitive exhibition. Here is the second instrument made by the inventor himself, and here also is the first that has been made by an amateur from a description of the inventor's own instrument. Mr. Pidgeon and his son will now exhibit that instrument to you. [Illustrated—several sentences were given and songs sung]. I am sure you will congratulate Mr. Pidgeon upon such a very excellent example of amateur mechanical skill. There is one defect in it which led Mr. Pidgeon rather to deprecate the singing of songs—that is, they come out rather out of tune. The reason is this—with the mechanical contrivance for rotation by hand it is almost impossible to produce that uniform motion which is necessary to reproduce notes in their exact pitch. Mr. Edison has endeavoured to get over that by the addition of a heavy fly-wheel; but in this instrument (pointing to another) that difficulty has been got over by the introduction of clockwork and a governor. (Fig. 4.)

Some three weeks or a month ago I had the honour of lecturing before the Royal Institution, and, the phonograph being then a greater novelty than it is now, I had been promised by Mr. Edison an instrument for exhibition, but, knowing that inventors cannot

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THE PHONOGRAPH will henceforth be to all purchasers, without any royalty t Company, for one dollr, (£5) or 200 dol ing to the finish of the instrument. 24

always fulfil their promises as to time, I thought the better plan would be to secure the services of one of our ablest mechanicians, Mr. Stroh, to undertake the manufacture of an instrument from Mr. Edison's description. He did so, and this instrument was exhibited at the Royal Institution. It reproduced sounds in a very admirable manner, but we found the same evil—the impossibility of reproducing the exact pitch of the notes, owing to the irregular motion of the apparatus when moved by hand. So Mr. Stroh has constructed for us the apparatus you see here. It is in principle the same, but he has applied to it a weight and an ingenious governor, which secures the uniform motion that we want. It is still, however, of course, Mr. Edison's instrument. We have the disc to speak to, the cylinder with its spiral thread, the tinfoil, and everything you have seen before, but we have, in addition, that uniform motion which I hope will enable us to reproduce musical notes in a way superior to what we have yet heard.

[Mr. Spagnoletti sang into the instrument a stanza of a popular song, which was reproduced by the phonograph, and on being encored was again distinctly reproduced by the instrument. Mr. Preece also sang with similar results.] Now, Gentlemen, while Mr. Stroh is putting in another sheet of tinfoil I may mention that this inventive genius, Mr. Edison, has devoted a great deal of time to the perfecting of this instrument. His later form, instead of having this foil spread on the cylinder has it spread upon a flat disc, and the disc rotates so as to bring the foil continuously underneath the point in the form of a spiral, so that instead of having these marks upon the circumference of the cylinder they would be recorded upon the spiral curve, and he has also applied mechanical power to secure uniformity of motion. I am told that in his new instrument he has produced sound sufficiently loud to be heard at a distance of 425 feet, and he has so improved the articulation that the dictated matter was repeated at Philadelphia twelve times without mistake. The articulation is perfect, and even whispering is repeated. The sounds can be reproduced not only once, but a great many times. Take one instance. I called on Mr. Puskas immediately on his arrival at the Langham Hotel. He turned the phonograph. It said, "How do you do? what

do you think of my phonograph?" These words had been imparted to it by Mr. Edison in New York before its departure for England; they had been reproduced several times *en route* for the gratification of the passengers on board the steamer, and were again made distinctly audible to me at the Langham Hotel a fortnight after they had been originally uttered. (Applause).

The instrument itself is so simple that the dullest comprehension cannot fail to understand it.

[Mr. Spagnoletti here sang into the instrument "God Save the Queen," which was distinctly reproduced.]

Mr. PREECE remarked that there was no reason why Mr. Spagnoletti's melody should not be kept for one hundred years, say, till 1978, when the sounds would be reproduced as "God Save the Queen, sung by Mr. Spagnoletti before the Society of Telegraph Engineers in England in 1878." (Laughter.) There is just one more effect I should like to produce, though it is almost a desecration to superpose a song upon what we have just heard; nevertheless it will be worth your while to hear the effect of sounds superposed on other sounds. [This was illustrated, the two different sounds being quite distinct though simultaneous.]—Before I sit down I beg to convey my best thanks to Mr. Puskas for the loan and exhibition of Mr. Edison's instrument; to Mr. Pidgeon for bringing his clever workmanship here; and to Mr. Stroh for the exhibition of the beautiful instrument he has been kind enough to bring here and manipulate to-night.

The CHAIRMAN: It is now just our usual time for adjourning, but I am sure you would not wish to separate without an expression of your thanks to the gentlemen who have occupied us with an entertainment so agreeable as we have experienced to-night, or without conveying to Mr. Edison at New York an expression of the great pleasure which the exhibition of his wonderful instrument has afforded us. I regard this invention as an epoch in the history of sciences, and we ought not to let this occasion pass without recording a vote of thanks in return for the great pleasure we have had this evening in hearing Mr. Edison's instrument, and I hope that vote will be communicated to him by telegraph.

Carried by acclamation.

THE PHONOGRAPH AND THE TELEPHONE.—In a communication to the *Comptes Rendus* M. Bouillaud discusses the question whether the phonograph repeats words on a principle similar to that of the telm. He asserts that, as regards force, intonation, and in many the words of phonographic origin differ notably from those which have been uttered, which is not the case with words uttered by an echo. Touching on the telephone, h magnetic machine.

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Mr. WEAVER said he would undertake to telegraph the communication to Mr. Edison, an offer which was gladly accepted by the meeting. A cordial vote of thanks was also passed to Mr. Puskas, Mr. Falgeon, and Mr. Stroh, for the exhibition of their respective apparatus, and to Mr. Preece for his lucid description of them.

It was announced that Mr. Conrad W. Cooke had been transferred from the class of Associates to that of Members.

The Meeting then adjourned.

LE PHONOGRAPHE D'EDISON.

Après bien des expériences et des recherches, l'inventeur de cet instrument est parvenu à perfectionner sa forme au moyen à obtenir une articulation parfaite de l'enregistrer, de façon qu'elle se conserve et de reproduire les sons phonétiquement après un certain temps.

L'appareil perfectionné inscrit, non-seulement le langage et le chant, mais il répète aussi les sons des instruments de musique, le chant des oiseaux, et, les cris de tous les animaux. Il enregistre tout les sons possibles et les répète après un intervalle, avec les mêmes intentions que lorsqu'ils furent émis.

L'appareil qui produit des résultats aussi extraordinaires, est simple, en principe, quoiqu'il consiste réellement de deux instruments.

D'abord il y a le phonographe proprement dit, ou appareil à noter les sons; ensuite le mécanisme pour les reproduire, que l'inventeur appelle le "phonet." Dans le premier, les ondes sonores viennent frapper une plaque ou un diaphragme métallique placée au fond d'une chambre, pourvue d'un orifice ou embouchure. Cette plaque vibrante porte une aiguillette ou pointeau qui répond aux vibrations que reçoit la plaque et les inscrit par son série d'empreintes sur une substance convenable. Celles-ci porte donc une ligne de dépressions diverses qui forment les archives des ondes sonores, et conséquemment des sons qui ont été reçus sur la plaque du phonographe. Cette surface est ce qu'on appelle un phonogramme. Sa base est habituellement en fer blanc, ou ce qui vaut mieux une feuille de cuivre placée sur une feuille de papier, et étendue sur une surface à rainures. Ou moyen de l'électro-typie on peut alors produire une matrice ou copie en relief en fer; celle-ci peut être convertie en acier et trempée; ensuite on peut fondre des planques en des répétitions exactes du phonogramme qu'on peut multiplier à l'infini. On peut aussi obtenir des reproductions en plâtre au moyen de la pression.

Le "Phonet," ou appareil pour reproduire les sons, ressemble beaucoup au phonographe, ayant une plaque vibrante et un poinçon, mais il agit naturellement en sens inverse. Son fonctionnement, comme celui du phonographe, est simple. Le poinçon du "phonet," est ajusté de façon à tomber dans la ligne de dépressions du phonogramme, et comme celui-ci se meut dans une direction horizontale, le pointe passe dans la dentelure et tmmanet à la plaque à chaque variation de surface, des vibrations en rapport direct avec la profondeur de l'empreinte.

La plaque du "Phonet," reçoit donc les mêmes vibrations que le phonographe avait communiquées à son propre. Il s'ensuit une succession rapide d'ondes sonores qui, en passant à travers une chambre ou un entonnoir, reproduisent les sons qui avaient primitivement influencé le phonographe. Si on place un entonnoir en papier ou autre matière résonnante devant la plaque vibrante, les sons seront plus retentissants et plus clairs. L'instrument est composé d'un cylindre sur lequel la feuille de métal qui forme le phonogramme est enroulée. Pour tenir le papier métallique en place, le bords ou lisières en sont passés dans deux minuces. Le cylindre marche au moyen d'un mécanisme d'horlogo, ou par toute autre force motrice. Le mouvement longitudinal est obtenu par le moyen d'une vis. Le poinçon à la même forme que celui du phonographe, mais il est plus petit afin d'arriver au fond des dépressions sans en toucher les bords. Il est fixé sur un levier placé au-dessus de la plaque du "Phonet," et se repose sur le cylindre; son poids et celui du levier sont suffisants pour obtenir la pression nécessaire sur le phonogramme.

La Fig. 1 montre une section du phonographe et une élévation de la section du mécanisme pour roumettre la feuille métallique, enlevée à l'action du poinçon; la Fig. 2 est un plan du phonographe; *a* est le cylindre couvert à l'action du poinçon; *b* la plaque vibrante; *c* le poinçon. Il y a une ouverture formant l'entonnoir dans la chambre, et par laquelle les vibrations d'air arrivent à la plaque. Celle-ci est fixée au chassis par les bords, laissant un espace pour lui permettre de vibrer librement. Le poinçon qui est en diamant, ou autre substance résistante, est rendu sur un ressort tubulin *e*. Entre celui-ci et la plaque il y a un morceau de caoutchouc tubulaire pour amortir le coup, et empêcher les fausses vibrations. Le poinçon agit avec beaucoup plus de justesse par ce moyen, que lorsqu'il est fixé directement sur la plaque vibrante.

Le phonographe est placé sur un bras de levier *i*, sur un pivot *f* à la vis *g*, de façon qu'il peut être mû horizontalement ou verticalement, pour une raison que nous indiquerons plus loin.

On comprend maintenant que si une personne parle près de l'embouchure ou tube d'admission du phonographe, les ondes sonores se porteront sur la plaque, et la feront vibrer; le poinçon aura également agité, et si on approche une feuille de métal près de l'extrémité du poinçon, et qu'on lui imprime un mouvement horizontal, et qu'on imprime en mouvement au poinçon, le résultat sera une série de marques formant un registre de vibrations sonores.

La manière de placer la feuille qui doit recevoir l'empreinte et de lui imprimer le mouvement est comme suit :—*a* est un disque fixé sur l'arbre *d* et tournera avec lui. *f* est un chassis fixé sur le disque au moyen d'une charnière. Il y a deux rainures hélicoïdales 3, 4, dans la surface du disque et aussi les chevilles 2, 2, qui correspondent avec des orifices dans le chassis. La feuille de métal qui doit recevoir l'impression est de la même forme et de la même grandeur que le disque et ce-ci-dessus *f*; elle est percée de trous qui correspondent avec la position des chevilles 2, 2. Lorsque la feuille est placée sur le disque, on amène le chassis dessus pour la tenir en place. On peut pratiquer dans la feuille de métal une ouverture ovale, ou un peu plus grande qui reçoive occupé par la spirale 3. Les bords extérieurs de la

EDISON'S PHONOGRAPH.

Extensive experiment and research has enabled the inventor of this instrument so far to improve its construction as to give thereby very perfect articulation, to produce mechanically a record of the sons in a convenient form for preservation, and from this record to reproduce the sounds phonetically after any reasonable length of time. By this means, not only the various sounds made by the human voice in speaking and singing, but those made by various musical instruments, birds and other animals, or indeed any sound whatever, can, from a set of permanent characters, be, as it were, read off by machinery, and at any desired moment be uttered, as if by their original agent or producer.

The instrument which is capable of accomplishing these astonishing results is comparatively simple in principle, and consists essentially of two distinct instruments. First, the "Phonograph," proper, or sound-recording apparatus; and second, the mechanism for reproducing the sounds, which the inventor calls the "Phonet," in the first of these, the sound-vibrations or undulations produced in the atmosphere are brought to bear upon a metallic plate or diaphragm, placed at the back of a chamber provided with an opening, or mouthpiece. Attached to or otherwise placed in connection with this vibrating plate is a small point, which, moving in unison with the vibrations thus imparted to the plate, produces upon the surface of a suitable material that is moved along mechanically in contact with it, a series of minute impressions or indentations. The line of marks or depressions thus produced forms a permanent record of the sound-waves, and consequently of the sounds themselves, which acted on the diaphragm or phonograph-plate.

From this indented surface, or "Phonogram," as it is called, which usually consists of a strip or sheet of tinfoil, or, what is better, thin copper sometimes, a sheet of paper and stretched upon a grooved surface, a matrix or copy in relief may be made of iron by electrotype deposit, which may be converted into steel, hardened, and used for impressing sheets or rollers of metal, thereby enabling the original sound-record to be multiplied indefinitely. A plaster cast can be used for producing a copy by pressure.

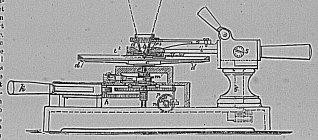


FIG. 1.

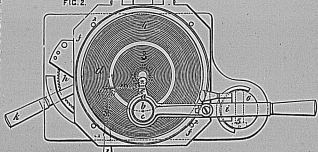


FIG. 2.

The "Phonet," or apparatus for reconverting or translating the marks produced by the phonograph (or a reproduction of them) into the corresponding and original sound-vibrations is somewhat similar in construction to the Phonograph, being provided with a vibrating diaphragm and point, but its action is, of course, reversed. The manner in which it performs its office is, like that of the latter instrument, comparatively simple. The point connected with the diaphragm is so adjusted as to fall into the line of indentations in the foil, and, as the latter is moved along beneath and in contact with it, the point passes from one indentation to another, and receives a movement corresponding to the depth of the indentations, transmitting this movement to the diaphragm, and the latter is thus thrown into a state of vibration corresponding exactly with that of the diaphragm which operated the indenting-point of the phonograph, the effect of this movement as to produce a rapid succession of air-waves, which, passing through a chamber or funnel, give rise to exactly similar sounds as those which had been originally communicated to the phonograph-plate. A funnel of paper or other resonant substance is placed in front of the diaphragm to render the sounds louder and more distinct. The instrument essentially consists of a cylinder or barrel, around which the sheet or strip of foil forming the phonogram is wrapped, the edges being held firmly by being passed into a slit. This cylinder is then rotated by clock-work or other suitable mechanism, and at the same time is moved lengthwise by the action of a screw. The vibrating point, which corresponds in shape to that of the Phonograph, but is slightly smaller, so as to follow the bottom of the depressions in the foil, without coming in contact with the sides, is attached to an arm or lever, placed above the vertical axis of the Phonet, so as to rest upon the cylinder, the weight and leverage of the arm producing the necessary pressure upon the phonogram.

Fig. 1 shows a section of the Phonograph and a sectional elevation of the mechanism for presenting the surface to be indented and Fig. 2 is a plan of the same; *a* is the body portion of the diaphragm, and *c* the indenting point. The latter is a small conical projection forming the mouth-piece, into which a person speaks, or through which opening the sound vibrations pass to act upon the diaphragm. The diaphragm—which is made of thin sheet of iron, is secured at its edges to the body, being *b* spaces between them in order to allow the diaphragm to vibrate freely. The indenting point, which consists of a diamond or other very hard substance, is mounted upon a small elastic spring arm *e*, inserted between this spring and the diaphragm a short piece of india-rubber tube is placed, to act as a damper for preventing false vibrations. By this arrangement the action is rendered much more perfect than when the point is fixed directly on the diaphragm.

The phonograph-point is mounted upon a lever arm *i* pivoted at *f* to the vertical stud *h*, so that the phonograph may be raised or lowered vertically, or moved horizontally.

It will now be understood, that if a person speaks with his mouth near the mouth-piece of the phonograph, the sound-vibrations will act upon the diaphragm and vibrate it, and will communicate to the indenting-point a similar movement, and that if a piece of metal foil or other material susceptible of being indented is placed beneath or behind the indenting-point, and caused to move regularly, the material will be indented, and form a perfect record of the sound-vibrations.

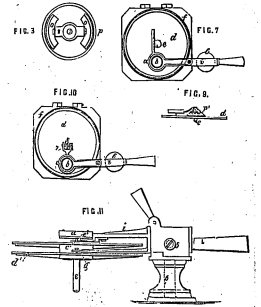
The means for sustaining the sheet to be indented, and the mechanism for moving the same, consists of the following:—*a* is disc or plate secured to and turning with the shaft *d*, and hinged to this disc is a ring-frame *f*; this disc *d* has two spiral grooves 3, 4, in its surface, and also two pins 2, 2, upon the surface of the disc, and holes at corresponding places in the

feuille sont doublés de carton au moyen de colle forte ou de gomme. Nous avons dit que la surface du disque d portait deux rainures hélicoïdales 3 et 4; la rainure 3 guide une cheville placée sur un bras g sur le phonographe et 4 guide le poignon c. Le disque et la feuille sont mis en mouvement et la rainure 3 fait occuper au poignon une position directement au dessus de la spirale 4, et l'empreinte sur la feuille de métal suivra la direction de cette dernière comme on voit dans la Fig. 2.

La deuxième sur la feuille du métal forme un registre exact des vibrations d'air reçues par la plaque. Cette feuille de métal inscrite est le phonogramme, et c'est par elle qu'on reproduit les sons. Le phonographe est emporté par l'action de la spirale 3, et se meut sur la tige verticale 6. Et en dépeignant l'extrémité des leviers f, le phonographe prend une position qui permet d'ouvrir le châssis f, et alors on peut enlever la feuille de métal du dessus le disque.

L'arbre e tourne au moyen d'un poids ou d'un ressort et de l'engrenage qui se trouve au point h, et on remonte le ressort par le mouvement alternatif de levier k et de l'action d'une roue dentée, et d'un linguet de construction ordinaire; l'axe un levier qui a une rainure à son extrémité extérieure pour recevoir le levier m, fixé au moyen d'une cheville. L'autre bout du levier m communique avec la bride d'accouplement m', et, en faisant fonctionner le levier l, l'arbre e est mis en communication ou détaché du l'engrenage h. Ainsi on peut arrêter le disque d, ou le mettre en mouvement sans déranger la force motrice.

Pour assurer l'uniformité du mouvement de l'arbre e, et surtout pour empêcher qu'il ne marche trop vite, il faut placer un régulateur ou pointe s, et ceci peut se faire comme dans les Figs. 1, 2 et 4, on peut voir des blocs de métal o, aux extrémités de bras à ressorts pertants de la traverse d'un arbre qui dérive son mouvement du point A. Ces blocs sont placés dans l'intérieur d'un cylindre immobile p, et lorsque la rapidité est trop grande, ils viennent en contact avec la surface intérieure du cylindre et la friction qui en résulte ralentit le mouvement. Dans la Fig. 6 ces bras sont attachés à un prisme. Il est bon de couvrir les surfaces qui sont les plus près du cylindre p avec du feutre ou autre étoffe qui leur permette de glisser sur la surface du cylindre tout en produisant une friction moyenne selon l'action centrifuge.



On peut remplacer la spirale 3 par un des expédients représentés dans les Figs. 6, 7, 8, 9 et 10.

Dans les Figs. 6 et 7 l'arbre e passe au dessus de la surface du disque d. Il y a une sorte d'arbre qui agit sur une embouchure fixée dans le phonographe, et à chaque révolution de l'arbre, la excentricités et excentriques exécutés aux points où la dent vient en action. Dans ces machines il faut former les spirales selon le mouvement du phonographe.

Dans la Fig. 8 une vis sans fin sur l'arbre e, agissant sur un pignon fait tourner l'arbre e', et les vis sans fin à l'autre bout de l'arbre e', agissant sur les dents qui sont autour de la base du levier f, sur la tige 6, fait avancer le phonographe graduellement. Ici, la spirale 3 est remplacée par une identique avec celle de la figure d.

Dans la Fig. 9 l'arbre e porte une fusée au point p', et une entaillure d'un bras de levier, qui est attaché au phonographe, se trouve rapportée contre cette fusée dont les spirales emportent le phonographe par degrés, et la ligne inscrite forme la même courbe que la spirale 3.

Dans la Fig. 10 les dents d'un pignon à vis fixé sur l'arbre e, agissent sur une came 7, et en forme la spirale 3.

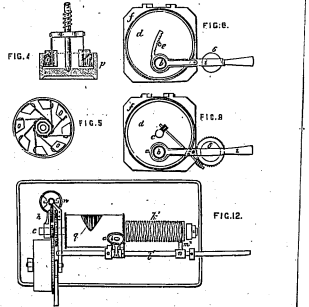
Dans la Fig. 11 la rainure hélicoïdale 3 pour la cheville g est sur un disque d' sur l'arbre e, mais elle occupe la même position relative sur ce disque d', que la rainure 4 occupe sur le disque d. Ainsi le mouvement du phonographe lui est imprimé de la rainure sur le disque d', par l'action des bras g and 6, sur le pivot vertical 6.

Au lieu de placer la feuille métallique sur le disque d, on peut en entourer un cylindre c, Fig. 12. Ce cylindre est sur un arbre e', soumis à l'action de l'engrenage h' ; l'arbre porte vis à double pas qui correspond avec une double rainure hélicoïdale dans la surface du cylindre c. Le phonographe est attaché à un arbre pivoté f', logé au moyen d'un levier pouvant alternatif au moyen de la vis k', qui agit sur le bras m', fixé sur l'arbre f'. A mesure que le phonographe marche dans une direction, les empreintes sont faites selon une spirale sur la plaque métallique sur le cylindre c. Lorsque le bras m' arrive à l'extrémité de la vis, le

ring-frame; the sheet to be indented is of a size and shape to correspond with that of the disc d and the frame f, and said sheet has holes in it, corresponding to the position of the pins 2, 2, and these holes form register-marks in placing or replacing the sheet upon the disc d, and after the sheet is so placed the ring frame f is brought down upon the sheet and holds it firmly in place. There may be a central opening in the indented sheet of a size slightly larger than the space occupied by the spiral 3, and the outer edges of the sheet are stiffened by a ring of thick paper or pasteboard caused to adhere by glue or other adhesive material. The surface of the disc d is made with two spiral grooves 3 and 4 as aforesaid; the groove 3 is a guide for a pin that is upon an arm g on the Phonograph, and the groove 4 is for the indenting-point c. As the disc and sheet are revolved, the groove 3 causes the indenting-point to occupy a position immediately over the line of the spiral 4, and the indentations will be made upon the sheet of foil in a line corresponding to that of the spiral 4, shown in Fig. 2. The indentations made in the foil are a complete record of the sound-vibrations that act upon the diaphragm b, and from this indented sheet, or "phonogram," the sounds can be reproduced. The phonograph is carried outwardly by the spiral 3, and in so doing the parts swing upon the vertical stud 6. *By depressing* the outer end of the lever f, the phonograph is raised, so that it can be swung aside from the disc d, to allow of the ring frame f being thrown back, and the "phonogram" removed from the disc.

The shaft e is revolved by a weight or spring, and gearing at h, and the spring is wound up by moving the lever k back and forth, which acts upon a ratchet and pawl of ordinary construction; l is a lever provided at its outer end with an inclined groove, in which is a pin on the lever m, and the other end of this lever m is connected with the coupler m', by moving the lever l one way or the other, the shaft e will be connected to or disconnected from the gearing h, and hence the disc d may be stopped or started without interfering with the motor.

As it is necessary that the shaft e should be revolved with uniformity, it is necessary to provide a governor 8; s, to prevent the apparatus receiving too rapidity; and this may be made as in Figs. 1, 2, and 4, in which there are metal blocks o at the ends of springs-arms from a cross-head on a shaft driven by the gearing h, these blocks swinging radially, and acting against the interior of a stationary cylinder p if the speed becomes too great, thereby checking the speed by the friction of the blocks against the cylinder. These spring-arms may be screwed at one end to a pivotable block, as shown in Fig. 5. It is preferable to cover the surfaces of the blocks o next the cylinder p with felt, or similar material, that will slide upon the interior surface of the cylinder p, but produce more or less friction, according to the centrifugal action.



The guide-spiral 3 may be dispensed with, and either of the devices shown in Figs. 6, 7, 8 [illegible]

In Figs. 6 and 7 the shaft e passes above the surface of the disc d. In the former case there is upon the shaft, contiguous to a rack-bar extending from the phonograph, hence each revolution of the shaft, the rack-bar and the phonograph will be moved the space of one tooth, consequently the lines of indentations will be parallel and concentric to the shaft e, excepting at the places where the teeth acts to move the rack-bar and the phonograph outward or inward. In this case the spiral grooves are cut to correspond to the feed.

In Fig. 8 a worm upon the shaft e acts upon a worm-pinion to revolve the shaft e', and the worm at the other end of this shaft e' acts upon teeth around the base of the lever l on the stud 6. By this device the phonograph will be moved outward gradually, and the line of indentations will be in a spiral corresponding to the continuous spiral groove 3 in the plate d.

In Fig. 9 the shaft e is made with a fusee at p', and one end of a swinging arm connected to the phonograph takes against the same. The spirals of the fusee gradually more as the disc and shaft are revolved, and the spiral-line of indentations will be similar to that made by the spiral 3.

In Fig. 10 the shaft e is provided with a screw-pinion meshing with teeth upon a cam-wheel 7. This gives the same movement to the phonograph as the spiral groove 3.

In Fig. 11 the guide-groove 3 for the arm g is upon a disc d' upon the shaft e, but the groove 3 occupies the same relative position upon the disc d' as the groove 4 does upon the disc d, so that the phonograph is moved outwardly by the groove of the disc d', swinging both the arms g and f upon the vertical pivot 6.

Instead of the sheet of metal foil being upon the disc d, it may be wrapped upon a cylinder c, Fig. 12. In this case the cylinder is upon a shaft e' revolved by the gearing at h', and upon said shaft there is a right and left hand screw at k', and there is a corresponding double-spiral groove in the surface of the cylinder c. The phonograph is carried by a swing arm on a pivoted shaft f', and said shaft is moved endwise back and forth by the screw k', acting upon the arm m' that is secured to the shaft f'. As the phonograph is moved in one direction, the line of indentations is made spirally in the foil on the cylinder c, and when the arm m' reaches

feuille sont doublés de carton au moyen de colle forte ou de gomme. Nous avons dit que la surface du disque d portait deux rainures hélicoïdales 3 et 4 ; la rainure 3 guide une chevillette placée sur un bras g sur le phonographe et il guide le poinçon c. Le disque et la feuille sont mis en mouvement et la rainure 3 fait occuper au poinçon une position directement au dessus de la spirale 4, et l'empreinte sur la feuille de métal suivra la direction de cette dernière comme on voit dans la Fig. 2.

La douzaine sur la feuille de métal forme un registre exact des vibrations d'air reçues par le phone. Cette feuille de métal inscrite est le phonogramme, et c'est par elle qu'on reproduit les sons. Le phonographe est emporté par l'action de la spirale 3, et se meut sur la tige verticale 6. Si on dispense l'extrémité des leviers i, le phonographe prend une position qui permet d'ouvrir le châssis f, et alors on peut enlever la feuille de métal du dessus le disque.

L'arbre e tourne au moyen d'un pédale ou d'un ressort et de l'engrenage qui se trouve au point A, et on remonte le ressort par le mouvement alternatif du levier a et de l'action d'une roue dentée, et d'un linguet de construction ordinaire ; l est un levier qui a une rainure k aux extrémité extérieure pour recevoir le levier m, fixé au moyen d'une cheville. L'autre bout du levier m communique avec la bride d'accouplement m', et on faisant mouvoir le levier l, l'arbre e est mis en communication ou détaché de l'engrenage A. Ainsi on peut arrêter le disque d, ou le mettre en mouvement sans déranger la force motrice.

Pour assurer l'uniformité du mouvement de l'arbre e, et surtout pour empêcher qu'il ne marche trop vite, il faut placer un régulateur au point n, et ceci peut se faire comme dans les Figs. 1, 2 et 4, on peut voir des blocs de métal o, aux extrémités de bras k remués parallèles de la traverse d'un arbre qui dérive son mouvement du point A. Ces blocs sont placés dans l'intérieur d'un cylindre immobile p, et lorsque la rapidité est trop grande, ils viennent en contact avec la surface intérieure du cylindre et la friction qui en résulte mettent le mouvement. Dans la Fig. 6 ces bras sont attachés à un pignon. Il est bon de couvrir les surfaces qui sont les plus près du cylindre p avec du feutre ou autre étoffe qui leur permette de glisser sur la surface du cylindre tout en produisant une friction moyenne selon l'action centrifuge.

FIG. 3

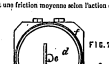


FIG. 7

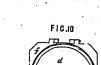


FIG. 10

FIG. 9.

FIG. 11

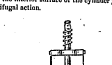


FIG. 4

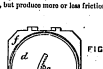


FIG. 6.

FIG. 5

FIG. 8

FIG. 12.

On peut remplacer la spirale 3 par un des expédients représentés dans les Figs. 6, 7, 8 et 9.

Dans les Figs. 6 et 7 l'arbre e passe au dessous de la surface du disque d. Il y a une dent sur l'arbre qui agit sur une crémaillère fixée dans le phonographe, et à chaque révolution de l'arbre, la crémaillière et le phonographe font un pas en avant ; les figures des dentelures seront semblables et concentriques excepté aux points où la dent vient en action. Dans ces machines il faut former les spirales selon le mouvement du phonographe.

Dans la Fig. 8 une vis sans fin sur l'arbre e, agissent sur un pignon fait tourner l'arbre e', où la vis sans fin k fixée au bout de l'arbre e', agissent sur les dents qui sont autour de la base du levier i, sur la tige h, fait avancer le phonographe graduellement. Ici, la spirale des empreintes sera identique avec celle de la plaque d.

Dans la Fig. 9 l'arbre e porte une tête ou pointe p', et une entretoise d'un bras de levier qui est attaché au phonographe, se trouve rapportée contre cette tête dont les spirales empreintes le phonographe par disque, et la ligne inscrite forme la même courbe que la spirale 3.

Dans la Fig. 10 les dents d'un pignon à vis fixé sur l'arbre e, agissent sur une roue 7, et qui forme la spirale 3.

Dans la Fig. 11 la même hélicoïdale 3 pour la chevillette g est sur un disque d' sur l'arbre f, mais elle occupe la même position relative sur ce disque d', que la rainure 4 occupe sur le disque d. Ainsi le mouvement du phonographe lui est imprimé de la rainure sur le disque d', par l'action des bras g and i, sur le pivot vertical 6.

Au lieu de placer la feuille métallique sur le disque d, on peut en entourer un cylindre p, Figs. 12. Ce cylindre est sur un arbre e', semble à l'action de l'engrenage A' ; l'arbre porte un vis à double pas qui correspond avec une double rainure hélicoïdale dans la surface du cylindre p. Le phonographe est attaché à un arbre glissant f', lequel se meut par frottement alternatif au moyen de la vis de k', qui agit sur le bras m', fixé sur l'arbre l'. A mesure que le phonographe marche deçà une direction, les empreintes sont faites selon une spirale sur la plaque métallique sur le cylindre p. Lorsque le bras m' arrive à l'extrémité de la vis, [illegible] et [illegible] la main spirally in the foil on the cylinder p, and when the arm m' reaches

ring-frame ; the sheet to be indented is of a size and shape to correspond with that of the disc d and the frame f, and said sheet has holes in it, corresponding to the position of the pins 2, 2, and these holes form register-marks in placing or replacing the sheet upon the disc d, and after the sheet is so placed the ring frame f is brought down upon the sheet and holds it firmly in place. There may be a central opening in the indented sheet of a size slightly larger than the space occupied by the spiral 3, and the outer edges of the sheet are stiffened by a ring of thick paper or pasteboard caused to adhere by glue or other adhesive material. The surface of the disc d is made with two spiral grooves 3 and 4 as aforesaid; the groove 3 is a guide for a pin that is upon an arm g on the Phonograph, and the groove 4 is for the indenting-point c. As the disc and sheet are revolved, the groove 3 causes the indenting-point to occupy a position immediately over the line of the spiral 4, and the indentations will be made upon the sheet of foil in a line corresponding to that of the spiral 4, shown in Fig. 2. The indentations made in the foil are a complete record of the sound-vibrations that acted upon the diaphragm b, and from this indented sheet, or "phonogram," the sounds can be reproduced. The phonograph is carried outwardly by the spiral 3, and in so doing the parts swing upon the vertical stud 6. By depressing the outer end of the lever i, the phonograph is raised, so that it can be swung aside from the disc d, to allow of the ring frame f being thrown back, and the "phonogram" removed from the disc.

The shaft e is revolved by a weight or spring, and gearing at A, and the spring is wound up by moving the lever k back and forth, which acts upon a ratchet and pawl of ordinary construction; l is a lever provided at its outer end with an inclined groove, in which is a pin on the lever m, and the other end of this lever m is connected with the coupler m', by moving the lever l one way or the other, the shaft e will be connected to or disconnected from the gearing A, and hence the disc d may be stopped or started without interfering with the motor.

As it is necessary that the shaft e should be revolved with uniformity, it is necessary to provide a governor at n, to prevent the apparatus revolving too rapidly; and this may be made as in Figs. 1, 3, and 4, in which there are metal blocks o at the ends of spring-arms from a cross-head on a shaft driven by the gearing A, these blocks swinging radially, and acting against the interior of a stationary cylinder p if the speed becomes too great, thereby checking the speed by the friction of the blocks against the cylinder. These spring-arms may be received at one end to a prismatic block, as shown in Fig. 5. It is preferable to cover the surface of the blocks o next the cylinder p with felt, or similar material, that will slide upon the interior surface of the cylinder p, but produce more or less friction, according to the centrifugal action.

The guide-spiral 3 may be dispensed with, and either of the devices shown in Figs. 6, 7, 8 and 9, could be [illegible]

In Figs. 6 and 7 the arbor e passes below the surface of the disc d, and has a [illegible] upon the shaft, contiguous to a rack-bar extending from the phonograph, hence each revolution of the shaft, the rack-bar and the phonograph will be moved the space of one tooth, consequently the lines of indentations will be parallel and concentric to the shaft e, excepting at the places when the teeth acts to move the rack-bar and the phonograph outward or inward. In this case the spiral grooves are cut in correspond to the feed.

In Fig. 8 a worm upon the shaft e acts upon a worm-pinion to revolve the shaft e', and the worm at the other end of this shaft e' acts upon teeth around the base of the lever i on the stud 6. By this device the phonograph will be moved outward gradually, and the line of indentations will be in a spiral corresponding to the continuous spiral groove in the plate d.

In Fig. 9 the shaft e is made with a fosse at p', and one end of a swinging arm m' is connected to the phonograph, and is taken against the same. The spirals of the fosse gradually move as the disc and shaft are revolved, and the spiral-line of indentations will be similar to that made by the spiral 3.

In Fig. 10 the shaft e is provided with a screw-pinion meshing with teeth upon a cam-wheel 7. This gives the same movement to the phonograph as the spiral groove 3.

In Fig. 11 the guide-groove 3 for the arm and pin g is upon a disc d', upon the shaft e, but the groove 3 occupies the same relative position upon the disc d' as the groove 4 does upon the disc d, so that the phonograph is moved outwardly by the groove of the disc d', swinging both the arms g and i upon the vertical pivot 6.

Instead of the sheet of metal foil being upon the disc d, it may be wrapped upon a cylinder p, as in Fig. 12. In this case the cylinder is upon a shaft e' revolved by the gearing A', and upon said shaft there is a right and left hand screw at k', and there is a similar double spiral groove in the surface of the cylinder p. The phonograph is carried by a slotted shaft f', and said shaft is traversed endwise back and forth by the screw k' acting upon a [illegible] that is secured to the shaft f'. As the phonograph is moved in one direction, the [illegible] is made spirally in the foil on the cylinder p, and when the arm m' reaches

celle dont le pas est dans le sens inverse, renverse son mouvement, et la phonographe produit une seconde spirale d'empreintes qui croise la première. Cette machine est fort utile lorsque la surface du cylindre est formée de métal galvanisé ou d'une autre matière fondamentale du phonogramme, et que l'on désire que les mots ou les sons ne soient réproduits autoestinguement, et à des intervalles marqués.

Il est préférable d'employer une mince plaque de métal a^3, comme dans les Figs. 13 et 14, dont une des extrémités est sur un pivot; la plaque étant placée dans une rainure longitudinale tracée sur la surface du cylindre g. Ce système maintient la plaque dans sa position. La surface supérieure de la plaque métallique a^3 est de niveau avec la surface du cylindre, et cette plaque porte des rainures qui correspondent avec celles du cylindre aux passant interrompues la marche du poinçon. On peut encore employer un fil à chaque extrémité du diamètre du cylindre et le tenir en place au moyen de tous qu'on peut élever ou abaisser par une came. L'expérience démontre que l'oreille en aimé par une interruption d'un huitième de pouce (0m,254).

Les appareils 1 et 14 sont semblables au No. 12, la seule différence étant que le phonographe est immobile tandis que le cylindre a un mouvement horizontal. La vis de l'arbre e^2 n'a qu'à un pas; il faut donc remettre le cylindre à sa place à la main, si on désire reproduire des sons du phonogramme, ou si on veut continuer le travail du phonographe, après qu'une nouvelle feuille métallique a remplacé celle qui vient d'être terminée. Ceci se fait aisément en levant la lame a^2, et détachant au dent de la vis k^1. L'arbre e^2 et le cylindre sont alors désengagés et peuvent se mouvoir d'un côté à l'autre.

Dans la Fig. 15 le phonographe accomplit le mouvement horizontal au lieu du cylindre g, mais comme l'arbre e^2 ne porte qu'un pas de vis, il faut remettre le phonographe à sa place après avoir désintégré le lame O^1, de la vis k^1.

Dans les Figs. 12 et 15 le phonographe peut tourner sur l'arbre l^1, pour détacher le poinçon du cylindre y afin de placer une nouvelle feuille métallique sur ce cylindre. Quand le phonographe reprend sa position on l'ajuste au moyen de la vis k.

Dans les Figs. 13 et 14 le mouvement du phonographe est horizontal au lieu d'être vertical, et l'appareil tourne sur le pivot q. La vis d'ajustage S est aussi en usage.

Si on désire opérer la répétition des sons dans l'instrument qui les a reçus, on n'a qu'à faire traverser le ligne des empreintes par le poinçon c, et ajuster un entonnoir selon les figures pointillées, qu'on voit dans la Fig. 1, pour donner de la pureté et de la force aux sons.

FIG. 13.

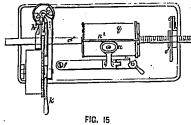
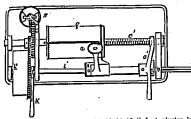


FIG. 15



Dans les appareils 1, 2, 6, 7, 8, 9, 10, 11, 13, 14, 15, il faut ajuster le "Phonet" à la main comme nous avons déjà expliqué, afin que le poinçon c soit placé au commencement de la spirale d'enregistrement. Le poinçon c passe d'une empreinte à une autre, par un mouvement horizontal comme dans les Figs. 12 et 16, ou en fait passer la feuille métallique par le même mouvement sous le poinçon, comme dans les Figs. 1, 2, 6, 7, 8, 9, 10, 11, 13, 14.

Au lieu de la feuille métallique on peut faire usage de papier ou d'autres matières après leur avoir donné une couche de paraffine ou d'un autre hydro-carbone, de cire, de gomme ou de laque. On peut faire passer une feuille d'une de ces substances dans un bain de paraffine chauffée, et ensuite entre deux rouleaux; puis on place un papier métallique excessivement mince sur la surface obtenue, et on fait passer cette double feuille au laminoir. Si on se sert de la feuille ainsi préparée on obtient une empreinte très-nette où l'extrémité du poinçon n'est pas chargé d'huile.

Dans la Fig. 16 le poinçon c est attaché à un bras à ressort c^4, de même que dans les Figs. 1 et 2, mais il y a des longueurs de tube en caoutchouc c^5 de chaque côté de la plaque des vibrations à, pour amortir le coup et empêcher les vibrations fausses.

Dans la Fig. 17, le caoutchouc de la plaque agit contre le bout extérieur du bras c^4 pour augmenter la force du coup et diminuer la profondeur des empreintes, ce qui permet d'employer une substance plus résistante que le fer blanc.

No. 18 est une modification de l'appareil que nous venons de décrire, la pression s'appliquo ici entre le poinçon et le support du bras, de façon à augmenter la force du coup.

La Fig. 19 montre le bras c^4 en forme de levier à ressort.

La Fig. 20 représente le poinçon placé sur le milieu d'une tige à ressort fixée au deux extrémités. La tige communique avec la plaque par une corde ou autre attache.

Dans la Fig. 21 la plaque b est de forme concave au lieu d'être plate.

Dans la Fig. 22 le poinçon est fixé sur un ressort qui fait partie de la plaque vibrante.

La Fig. 23 montre un disque sur le ressort c^4 qui est placé sur le poinçon. La surface de ce disque touche presque celle de la plaque. Ce disque est agité par l'air au moment de la vibration de la plaque, car il en est de même que les deux vibrent ensemble, et que l'air ne peut passer entre eux et s'échapper aussi rapidement qu'ont lieu les vibrations.

La Fig. 24 montre une plaque dont les vibrations sont produites par l'électro-magnétisme. Dans cet exemple la plaque est en fer, et la puissance de l'aimant varie selon la force du courant électrique passant par son hélice. Cette variation est le résultat de l'action du son sur une plaque vibrante en rapport électro-magnétique.

FIG. 14.

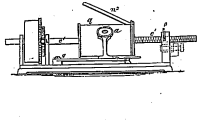


FIG. 16.

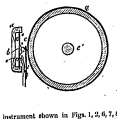


FIG. 17.

FIG. 18.

In the instrument shown in Figs. 1, 2, 6, 7, 8, 9, 10, 11, 13, 14, and 15, the phonet require to be positioned by hand, as before explained, in order that the point c may be placed at the beginning of the spiral line of indentations. The point c is caused to pass from one indentation to the next, either by the foil being moved beneath the point, as in Figs. 1, 2, 6, 7, 8, 9, 10, 11, 13, and 14, or by the point moving over the foil, as in Figs. 12 and 15.

Paper or other materials may be used instead of metal, the same being coated with paraffine or other hydrocarbons, waxes, gums, or lacs, and the sheet so prepared may itself be indented, as the material, say paper, may be made to pass through a bath of hot paraffine and thence through rollers, which give it a beautiful smooth surface. The indentation can now be made without any fear of the point sticking.

In Fig. 18, the indenting-point c is upon a spring arm c^4, as in Figs. 1 and 2, but there are short sections of rubber tube c^5 at each side of the diaphragm b to dampen the diaphragm and prevent false vibrations.

In Fig. 17, the rubber of the diaphragm acts against the outer end of the arm c^4, to increase the force and lessen the depth of indentations in the foil, and thus allow of the record being made in less yielding material than the foil.

Fig. 18 shows a modification of the last-mentioned device, the pressure being applied to the arm c^4 between the indenting-point and the support for the arm, so as to increase the depth of the indentations.

Fig. 19 shows the arm c^4 made as a lever with a spring.

Fig. 20 shows the indenting-point upon the centre of a spring bar that is firmly held at each end; the bar is connected at its centre to the diaphragm b by string or otherwise.

Fig. 21 represents the diaphragm b as of concave form instead of flat.

Fig. 22 shows the indenting-point upon a spring secured to the diaphragm.

Fig. 23 shows a disc upon the spring c^4 of the indenting point; this disc is placed quite close to the diaphragm, and is moved by the air as the diaphragm is vibrated, the disc being so close to the diaphragm that the two will vibrate together, as air cannot pass between or so close to the diaphragm that the two will vibrate together, as air cannot pass between or escape so rapidly as the vibrations take place.

Fig. 24 shows the diaphragm vibrated by electro-magnetism; in this case the diaphragm is an iron of iron, and the power of the electro-magnet will be varied by a rise and fall of the electric current passing through the helix of the electro-magnet; this rise and fall of electric tension is to be produced by the action of sound upon a diaphragm and its connections.

Dans la Fig. 25, on voit la mâchoire de faire vibrer le ressort et le poinçon par l'action directe d'un électro-aimant, sans l'intermédiaire d'une plaque, le courant électrique dans l'hélice étant varié par des vibrations sonores sur une plaque.

Dans la Fig. 26, la lame à ressort a^2, est attachée à une des extrémités d'un aimant permanent et magnétise le poinçon représenté en a^3. La feuille métallique doit être en fer. Quand le poinçon passe au dessus d'une empreinte, l'attraction est moindre que lorsqu'il passe sur surface unie, l'attraction est plus claire et plus nette, et on obtient par la grincement, causé par le frottement, du poinçon sur la feuille, attendu qu'il ne la touche pas, ces vibrations étant dûes au magnétisme.

Dans la Fig. 27, on voit deux épaisseurs en rapport avec le cylindre g; dans cet appareil le "phonet" et le "phonographe" sont séparés. Le phonographe manque de la membrane vanelle, mais la plaque "phonet" est mise en vibration par le mouvement alternatif vertical du levier e^1. Le mouvement est donné à la plaque par un levier, et le grincement sur la feuille métallique est réduit au minimum.

La Fig. 28, représente une disposition au moyen de laquelle, quatre personnes peuvent parler en même temps, le régulateur, contiendra les quatre émissions de voix en lignes parallèles, et elles seront reproduites comme venant d'une seule personne.

La Fig. 29, montre un seul phonographe, capable de recevoir les voix de trois personnes discutant ensemble. Les sons des trois voix arrivent à la plaque au moyen de tubes flexibles. Le registre se montre en quinze lignes, mais le "phonet" reproduira les trois voix.

Dans la Fig. 30, la feuille métallique est placée sur un cylindre creux, dont l'extrémité à la forme conique. Les impressions se font de la manière usuelle, mais le poinçon passe complet, tenant au travers de la feuille. Un tuou en gutta-percha est placé de façon à être toujours en face de la ligne de la dentelure; elle est en communication avec un réservoir d'air ou d'un autre fluide comprimé; chaque fois qu'une empreinte vient en face de la boue, une légère bouffée d'air passe dans le cylindre, et en entend un ne claquement. On peut faire la boue sur un ressort pour le maintenir, en face de la ligne des dentelures;

Dans la Fig. 31, il y a une grande chambre entre la plaque vibrante et l'embouchure; cet arrangement est utile, lorsque le son à remplacer vient d'une distance de quelques pieds.

La Fig. 32, montre un cylindre au moyen duquel on peut se dispenser du poinçon. Le phonographe y a la forme d'un cône. La plaque vibrante est à sa base. Une petite ouverture est percée au sommet, devant lequel passe la feuille métallique qui est placée sur le cylindre; il faut que cette feuille soit excessivement mince, afin d'être sensible à l'action des ondes sonores, concentrées par le cône.

Le Fig. 33, fait voir un "phonet," dans lequel le phonographe est inscrit sur une feuille métallique circulaire en sens fin, on peut employer comme jouet par ce qu'il est possible en outre soubriens, qui relates à l'amen. — Cette feuille peut être en acier.

La Fig. 34, qui vue vue, en perspective, qui montre un double "phonet," portant une ligne selon action, lesquels l'autre fait la même. Il faut que les billes soient en matière opposée; alors, le disque continuant sa marche dans la même direction, force un des "phonets" à vibrer en centre, puis l'autre vient en communication et en reproduira. — On peut en faire un jouet.

La Fig. 35, représente un "phonet" dans lequel le phonographe est remplacé par un jouet. — découvre, en d'une aiguille quelconque de sons, est remise sur une boîte, et se déroulant graduellement, phonographe, ainsi déroulé, fait agir le "phonet" en question. — Application facile. — Le

Dans la Fig. 36, on voit un phonographe ou "phonet," semblable à celui de la Fig. 15. Le cylindre g tourne sur son axe sans mouvement alternatif; mais le phonographe en a. Il est pourvu de quatre ressorts, a^1, a^2, a^3, a^4, et chacun d'eux est muni d'un style qui les fait agir à tour de rôle à peu près comme dans le système Wheatstone. Le style a^1 est en contact avec le cylindre, et pousse sous le ressort directeur inférieur a^2, lorsque la vis porte le bras et la phonographe vers la droite. Le ressort que ce bras est poussé sous le directeur a^2, et se dirige de la vis, et le bras est ainsi poussé sous le directeur a^3, à mesure que le mouvement en va le phonographe, et le bras est poussé sous le directeur a^4, à mesure que le mouvement se continue. Le style a^1 est ainsi ramené à son commencement du trajet. A ce point, le bras est ramené à son commencement du trajet. A ce point, le bras est poussé sous le directeur a^1, et tombe dans le jeu de la vis, celle-ci en tournant emporte le bras, et le ramène sous le directeur comme auparavant.

La Fig. 37, représente le phonographe ou le "phonet" placé sur un bras à pivot, qu'on peut placer à angle droit, sur la ligne de mouvement du phonographe. On peut obtenir des empreintes, selon une direction longitudinale ou en travers courbes, ou en lignes brisées. Le phonographe dans la Fig. 38, est semblable à celui de la Fig. 31, excepté que la chambre acoustique a une forme différente.

Dans la Fig. 39, il y a une embouchure en caoutchouc qui s'adapte à la bouche de la personne qui parle, et la plaque de vibration reçoit les ondes sonores, dans toute leur intégrité.

Dans la Fig. 40, est voit l'embouchure du phonographe avec caoutchouc et boîte irrégulières.

Dans la Fig. 41, cette embouchure est percée de plusieurs trous.

Fig. 25 shows the method of vibrating the indenting spring and point by the direct action of an electro-magnet, without the use of a diaphragm, the electric tension in the helix being varied by sound-vibrations upon a diaphragm.

Fig. 26 shows the spring arm a^2 connected to one end of a permanent magnet, so as to highly magnetize the reproducing point; in this case the foil should be of iron. When the point passes an indentation, there will be less attraction than when passing no indentation; this will give good articulation, free from the scraping noise of the point on the foil, for in this case it does not touch the foil, but is worked by magnetic attraction.

Fig. 27 represents two instruments in connection with the cylinder g; in this case the phonet and the phonograph are separate. The phonograph recevies in the usual manner, but the phonet has the diaphragm set in motion by the rise and fall of the lever e^1. In this arrangement, the diaphragm is moved by leverage and slight tension, and the scraping noise is reduced, as the foil is drawn along beneath the point e.

Fig. 28 shows an arrangement whereby four persons may speak simultaneously and have records made in separate parallel lines upon one cylinder, and the phonogram will reproduce the sounds the same as though it contained the record of but one voice.

Fig. 29 shows a single phonograph adapted to receive the voices of three persons, as in singing; the sounds made by the three voices are conveyed through flexible or other tubes to the diaphragm, and will be recorded in a single line of indentations, but, when reproduced by the phonet, the sounds uttered will correspond to the three voices.

In Fig. 30, the foil is sustained upon a hollow cylinder with a funnel-shaped end. The record is made upon the foil in the usual manner by the phonograph, excepting that holes are made entirely through the foil. A nozzle with a small opening is placed so that it will always be opposite the line of perforations as the cylinder is revolved. This nozzle is connected to a source of compressed air or other fluid, and every time a perforation comes opposite the nozzle, a puff of air passes into the cylinder, and a sound is produced upon the principle of the siren. The nozzle may be placed on a spring to keep the end of the nozzle in contact with the line of perforations.

Fig. 31 shows the phonograph as made with a large chamber between the diaphragm and the mouth-piece; this is especially useful in collecting sound when the person speaking or the sound to be recorded is made several feet from the instrument.

Fig. 32 shows a device whereby the diaphragm and cylinder may be dispensed with in the phonograph. The funnel forming the phonograph is made with a diaphragm at the larger end or mouth-piece, and a very small hole at the point of the funnel and adjacent to the foil on the cylinder g; this foil should be very thin, so that the indentations will be made by the direct action of the air-waves concentrated, by the funnel without the interposition of the indenting point.

Fig. 33 shows a phonet in which the phonogram or sound-record has been made upon an endless belt; this is a convenient arrangement for toys, as the same may be made to imitate the bark of a dog or other noise made by an animal; and this belt may be of metal or other material, and be made to run for a long period of time.

Fig. 34 is a perspective view showing a double phonet, there being a spiral line of indentations on each side of the revolving disc d, one phonet coming into action as the other finishes; in the same direction, forces the phonet from the centre outwards, so that the one finishing is connected and moved back to the centre, the other, continuing to revolve.

Fig. 35 represents a phonet in which the phonogram containing a series of indentations, spaced, circular, or otherwise, is wound upon the second roller by any suitable mechanism, and as the phonogram is thus moved, it actuates the phonet, a, b, c.

Fig. 36 shows a phonograph or phonet similar to that shown in Fig. 12; the cylinder g is set forth over the cylinder. In this instance the arm a^1, and the phonograph or phonet is movable back and passes beneath the springs a^2, a^3, a^4, a^5, and as the arm a^1 is retarded, beyond the screw b^2, and brought towards the right; as the arm a^1 moves, when the screw is carrying the arm and phonograph back to the starting point, the arm a^1 passes beneath the spring a^4, when the screw b^2 moves the shaft, phonograph, and arm, along to the place at beginning; at which place the arm a^1 drops off the end of the indented guide a^4 into the thread of the screw, and as this revolves it carries the arm along the indented guide a^4 into the thread of the screw, and at this point the phonograph or phonet again passes beneath the spring a^4 as before, and the screw or at right angles to the line of movement of the phonograph with the style, and the same line of indentations may be transferred to the wax or other material or phonogram. In of a circle.

Fig. 37 shows a phonograph similar to that shown in Fig. 15, except that the arm to which is of a different shape.

Fig. 38 shows a mouth-piece with an orifice of one inch diameter at the mouth or the place the person speaking, so that all sound waves will be confined to the chamber and diaphragm.

Fig. 40 shows the mouth-piece of the phonograph made with a flexible rubber bell or bulge.

Fig. 41 shows the mouth-piece perforated with holes.

Dans la Fig. 42, l'embouchure n'a qu'une ouverture à bords irréguliers pour renforcer les intonations sifflantes, et produire un phonogramme plus parfait.

L'embouchure 43 est en mica, avec garniture de bois.

Dans la Fig. 44, la plaque est en tissu métallique doublé de papier, au moyen d'un ciment convenable. Un cercle de papier sert à renforcer les bords du tissu.

La Fig. 45, représente une plaque en parchemin, dans le cadre b^4, tendue par des cordes et des chevilles à vis. Les cordes sont de différentes longueurs et sont soumises à des degrés différents de tension, pour renforcer ou affaiblir certains sons.

La Fig. 46, montre une embouchure pour le "phonet," imitant la forme de la bouche humaine.

Dans la Fig. 47, la chambre et la plaque sont de forme triangulaire.

La Fig. 48, représente trois cylindres creux unis d'un phonographe ou d'un "phonet," pour reproduire des trios de voix ou d'instruments.

La Fig. 49, "est un "phonet" de forme globulaire, avec ouverture en pavillon, possédant deux plaques de vibration 15 16, dont les plans coupent celui du tube à angle droit, de façon à former une chambre à air. Il y a une troisième chambre f, qui reçoit sa vibration du polygone reproducteur e, et qui, en relation l'un de la chambre, fait vibrer les plaques 15 et 16; celles-ci produisent des ondes et les sons, se confondant, sortent des deux pavillons, avec augmentation de volume et de sonorité.

La Fig. 50, représente une disposition, au moyen de laquelle on peut faire des empreintes profondes dans la feuille métallique. On emploie deux plaques, la première b^5, reçoit les ondes sonores; en même temps, elle entraîne une soupape b^6 placée dans un conduit qui communique avec un réservoir d'air ou d'un fluide comprimé; cette soupape, agissant sous l'influence des vibrations de la plaque b^5, y met à plus ou moins d'air s'arriver à la plaque b^4. Les deux plaques, accomplissent donc le même nombre de vibrations dans le même espace de temps, mais celles de b^4 étant renforcées par celles de b^5, les empreintes seront plus profondes dans la feuille métallique.

Les Figs. 51 et 52, représentent une disposition pour augmenter le volume et la sonorité des sons, reproduit par le "phonet." Les vibrations de la plaque b^4, sont transmises à la plaque b^5, au moyen d'un tube, indiqué par les lignes ponctillées dans la Fig. 51; celle-ci contrôle la soupape b^6, d'un conduit qui communique avec un réservoir d'air ou d'autre fluide comprimé. A mesure que l'air s'échappe il passe dans le pavillon du tube et produit des sons claires et distincts, reproduits des sons obtenus par l'un des "phonets" que nous avons déjà décrits.

On peut employer cet appareil, pour renforcer l'émission de voix qui a servi à faire vibrer la plaque b^4, qui a son tour a reglé les ondes sonores s'échappant de la valve b^6, et passant dans le pavillon.

La Fig. 53, représente l'instrument enfermés dans une chambre. Par ce moyen, presque toutes les vibrations atteignent la plaque du vibration.

Les chaînes 54 et 55, montrent clairement les mouvements des libres, en parlant, pouvant être reproduits. Un levier, communiquant avec la plaque, porte le polygone e. Fig. 55, la personne qui parle, prend l'extrémité de ce levier dans la bouche, et le mouvement simple des libres règle la dentelure de la feuille de métal.

Dans la Fig. 54, nous présentons un appareil semblable.

En, le "phonet" placé dans une boîte, communique avec un manche au moyen de levier et, quand on fait agir l'appareil, les libres se mettent en mouvement, et en semblant de vie et d'intention remarquable à rien, tout le temps que les vibrations sont transmises du phonographe au "phonet."

Les Figs. 56, représente un jouet, nommé "phonet," la bande métallique 56, est fixée d'un bout, sur un cylindre sur lequel elle est enroulée. En tirant la bande, elle se déroule, et son mode d'application s'enroule sur l'autre des cylindres, et en laisse aller la bande, l'élastique fait tourner le cylindre, et les sons se reproduisent dans le "phonet," au moyen du phonogramme, qui agit sur un polygone et sur une plaque a. On règle le mouvement de l'arbre par l'écrou b, le filet de la pignon 58.

Dans la Fig. 57, le cylindre qui porte la bande, est pourvu de chevilles qui passent dans des trous sur les côtés du phonogramme; ce qui donne un mouvement très-régulier.

Dans la Fig. 58, le cylindre est à roberts sur diriger la feuille métallique.

Fig. 42 shows but one opening in the mouth-piece; the edges of this are irregular. These irregular edges reinforce the hissing sounds, and cause a more perfect phonogram to be produced.

Fig. 43 represents a mouth-piece of mica, with a central opening protected at its edge by a wooden ring.

In Fig. 44, the diaphragm b is of wire gauze with a backing of paper connected to it by any suitable cement, and there is a ring of stiff paper at the edges of the gauze disc to strengthen it.

Fig. 45 represents a diaphragm b of parchment or similar material stretched tightly within the frame b^4 by cords and screws. The cords may be of different lengths and tension, and exposed to and relieve certain sounds.

Fig. 46 shows a mouth-piece for the phonet made in imitation of the human mouth.

Fig. 47 represents the body portion of the phonograph or phonet made triangular, and the diaphragm is of corresponding shape.

Fig. 48 represents three cylinders, each provided with a phonograph or phonet; this is useful in recalling and reproducing three-part singing or music.

Fig. 49 represents a phonet made as a tube, with flaring or trumpet-shaped ends, and with two diaphragms 15, 16, placed crosswise of the tube so as to form an air chamber. There is a third diaphragm f, which is vibrated by the movement of the reproducing-point e, and this diaphragm gives motion to the air in the chamber, and vibrates the diaphragms 15, 16, which latter produce air-waves, and the sounds issuing from the two trumpet-shaped ends will blend and increase the volume of sound.

Fig. 50 represents a device whereby deep indentations are made in the metal foil. Two diaphragms are employed, the first, b^5, is vibrated by the sound vibrations, and controls a valve b^6 in a tube connected with a source of compressed air; this valve b allows more or less air to pass to the diaphragm b, according to the vibration of the diaphragm b^5, hence the diaphragm b will vibrate in harmony with the diaphragm b^5, but it will be acted upon by greater force, and consequently the indentation will be deeper in the foil than if the diaphragm b was acted upon simply by the sound-vibrations of the voice.

Figs. 51 and 52 represent a device that may be used with a phonet to increase the loudness of the sounds reproduced. The sound-vibrations from the phonet are conducted by a tube shown by dotted lines in Fig. 51, to the diaphragm b^5 that controls a valve b^6 in a tube connected with a reservoir of air or other fluid under pressure, and the air as it escapes by the control with a reservoir of air or other fluid under pressure, and the air as it escapes by the control valve passes into the trumpet-shaped end of the tube, and produces sounds that are very loud and clear, and are a reproduction of the sounds resulting from the use of one of the phonets before described.

This same apparatus may be used to reproduce with louder attainment a person's voice, the sound from the voice being used to vibrate the diaphragm b^4, and thereby regulate the air-wave escaping from the valve b^6 into the trumpet.

Fig. 53 shows the speaker's head within a box or case; in this instance nearly all the sound-vibrations are upon the diaphragm.

Figs. 54 and 55 illustrate how the movements of the lips in speaking may be recorded and reproduced. In this instance, a lever applied to the diaphragm carries the indenting-point e.

Fig. 55, and the end of this lever is placed in the mouth of the speaker, and the movement of the lips produces the indentations in the foil.

A similar apparatus shown in Fig. 54 within a case is connected to the movable lips of a figure which can be given motion upon the lever, reproduce accurately all the movements made music, while being examined upon the lever, reproduce accurately all the movements made music, while being examined upon the lever, reproduce accurately all the movements made by the figure during vibrations. By this means, a remarkable semblance of vitality is obtained while the sound-vibrations are given by the phonograph to the phonet.

Fig. 56 represents a toy phonet in which the phonogram-strip 56 is secured at one end to a cylinder upon which it is wound. By pulling upon the strip it is unwound, and a rubber cord cylinder upon which it is wound. By pulling upon the strip it is unwound, and a rubber cord applied to the shaft of the cylinder. When the band is removed from the indented 57 it wound upon the shaft and winds up the phonogram upon the cylinder, and the strip, the rubber cord rotates the shaft and winds up the phonogram upon the cylinder, and the strip, the rubber cord rotates the shaft and winds up the phonogram upon the cylinder, and sounds are reproduced in the phonet by the phonogram acting upon a point and diaphragm a. The movement of the shaft is regulated by the fan, vane, and pinion 58.

In Fig. 57, the cylinder for moving the phonogram-strip is shown as provided with pins that enter holes in the edges of the strip; this causes the strip to be fed along very regularly.

In Fig. 58, the cylinder with pins is shown as made with bands to set as guides for the strip.

Le Fig. 59 montre un moyen d'agrandir les empreintes. Cet instrument porte deux cylindres dont l'un a^1, marche plus rapidement que l'autre a^2, un levier 40 sur un pivot 41, porte un pointeau 42 pour chaque cylindre. Une des pointes suit la ligne des empreintes sur le cylindre a^1, et l'autre en fait de même sur le cylindre a^2. Comme celui-ci tourne plus vite, les impressions sont plus longues, et aussi plus profondes, comme ce pointeau est à l'extrémité du levier.

Dans la Fig. 60, un des cylindres 42 est en métal trempé, et la dentelure est en relief. Il est placé de façon à pouvoir graver la phonogramme sur la surface d'un cylindre 43 en métal doux. On emploie une vis, ou parfois d'autres moyens, pour obtenir la pression nécessaire.

La Fig. 61 représente un rouleau 42 en métal dur, avec la dentelure en relief, disposé de façon à faire denteler le phonogramme dans le rouleau 43, de métal doux, lequel est pressé contre le rouleau 42 avec l'aide d'une vis ou par tout autre moyen.

Le cylindre portant une matière hélicoïdale sur sa surface, peut être fabriqué en plaquant le moule qu'on voit dans la Fig. 62 autour d'un rouleau ou autre, et en remplissant l'espace entre le rouleau et le moule de plâtre, ou avec une matière convenable. Le moule est en métal et porte un filet en spirale. Il est composé de deux pièces reliées entre elles par une charnière, afin qu'on puisse le détacher facilement, lorsque le plâtre est sec. Que ce soit pour amusement ou comme étude, le phonographe peut devenir d'un usage très-étendu. Le cylindre rotatoire que nous présentons dans la 63e figure, porte des rangs d'un, pointes représentant les lettres de l'alphabet. Il a en outre un rang de clefs qui portent les lettres correspondantes; on peut employer ce cylindre pour enseigner l'alphabet, des phrases, des discours. On peut tout apprendre du "phonet" sans se servir de la vue.

On peut appliquer des cylindres et des roues à phonogrammes aux horloges et elles disent l'heure à haute voix et donnent d'autres signaux. Au moyen de phonogrammes et de "phonets" d'un mécanisme simple, on peut construire des jouets qui reproduisent fidèlement du rire, le chant des oiseaux, le miaulement du chat, le hennissement du cheval, le ronflement du lion, et tous les autres cris des animaux. On peut obtenir la répétition de tous les sons par un moyen automatique qui remonte le poignet au commencement de chaque phrase.

Le régulateur 64 dans la Fig. 64 est le poids d'un pendule attaché à l'extrémité inférieure d'une tige ayant un joint universel 65, et le bout supérieur est attaché à une manivelle 66 qui reçoit son mouvement de l'engrenage. Avec augmentation de rapidité le poids décrit un cercle d'un plus grand diamètre et alors la résistance devient plus grande.

On peut remplacer le joint par un ressort, Fig. 65.

Dans la Fig. 66 on peut voir un aimant 67 sur la manivelle qui sert à faire tourner les pendules par l'attraction qu'il exerce sur une armature à l'extrémité supérieure de la tige, ce qui évite la friction qui provient du contact des tiges du pendule sur le manivelle.

Dans la Fig. 67 la plaque 6 communique avec deux soupapes dans un conduit 68 lequel a trois lumières. L'une correspond avec un réservoir d'air comprimé, les deux autres 70 et 71 sont en communication avec une chambre 72 sur les côtés opposés d'une plaque de membre à faire vibrer celle-ci en harmonie avec la plaque b^4, et produire un son d'un plus grand volume.

FIG. 56 FIG. 57 FIG. 58 FIG. 59

FIG. 60 FIG. 61 FIG. 62

FIG. 63 FIG. 64

FIG. 65

FIG. 67 FIG. 66

Fig. 59 shows a re-indenting device for amplifying or increasing the size of the indentations. There are two rollers, one of which a^1 travels faster than the other a^2, and there is a lever 40 pivoted at 41, and provided with a point 42 for each cylinder. One point follows the indentations in the cylinder a^1, and the other rests upon a^2, and as this travels the fastest, the indentations made thereon will be longer and also deeper, by the point being at the outer end of the lever.

In Fig. 60, one roller 42 of the pair is made of hardened metal with the sound-record in relief. This is obtained by electrotype or other process from an iron foil or other metal phonogram, and this roller is used to indent strips or sheets of foil or rollers to produce copies that can be used with the phonet.

Fig. 61 represents a roller 42 of hardened metal with the record in relief, and arranged so as to knurl or indent the phonogram in a roller 43 of soft metal that is to be pressed against the roller 42 by a screw or other suitable means.

The cylinder having a spiral grooves in its surface may be made by placing the mould shown in Fig. 62 around a cylinder or shaft, and filling the space between the cylinder and mould with plaster of Paris or other suitable material. The mould is of metal with a screw or spiral rib projecting therefrom, and it is made in two parts, and hinged, so that it can easily be removed when the plaster of Paris is dry.

For amusement or instruction, the Phonograph is capable of extended use; for instance, a revolving cylinder, see Fig. 63, containing rows of indentations representing the letters of the alphabet, and provided with keys containing corresponding letters, can be used in teaching the alphabet, and sentences, speeches, and other matter can be spoken by the Phonet, and repeated by the learner without the eyesight being called into use.

Clocks may be provided with phonogram cylinders or wheels, to call off the hours, to give alarms, &c.

By means of phonograms, and phonets connected with simple mechanism, toy animals may be constructed capable of reproducing a bird's song, a cock's crow, a dog's bark, a cat's mew, a horse's neigh, a lion's roar, or any other sound. The repetition of such sounds can be produced by the phonet-cylinder being moved automatically, so as to bring the point to the commencement of the phonogram.

The governor to regulate the speed of the instrument may be made of a pendulum weight 64, see Fig. 64, hung at the lower end of a rod that is provided with a universal joint at 65, and the upper end of the rod is moved around by a crank 66 that is revolved by the train of gearing. As the speed increases, the weight will describe a circle of larger diameter, and thereby increase the resistance.

The universal joint may be displaced by a spring wire, Fig. 65, that allows of the movement.

A magnet 67 upon the crank arm 66, Fig. 66, may be used to revolve the pendulum by attracting an armature at the upper end of the pendulum-rod, and thereby avoid the friction resulting from the contact of the surfaces of the pendulum-rod with the crank.

In Fig. 67, the diaphragm b is represented as connected to a pair of delicate piston-valve, within a tube 68 that has three ports; one, 69, is connected to a reservoir of compressed air the others, 70 and 71, are connected to a chamber 72 at opposite sides of a diaphragm, so as to vibrate the latter in harmony with the diaphragm. Then there will be greater amplitude given to the same by the pressure of the air, and by a connection to the phonet-diaphragm b^4, the sound produced will be greatly increased.

REVUE COMMERCIALE.

Des nouvelles que nous recevons tendent à prouver que, quoique la position commerciale s'améliore, il y a des entraves décourageantes. La faillite d'une bonne affaire quelquefois comme la Cornish Bank, ajoutée aux désastres financiers qui l'ont précédé influe beaucoup sur les cours des marchés.

Il y a un autre élément auquel on a récemment eu recours qui nuit considérablement à la spéculation saine. Nous voulons parler de rumeurs sans fondement, mais qui circulent partout, des crises commerciales prochaines et également des complications politiques. Nous pourrions obtenir d'autres informations à ce sujet, mais jusqu'ici il est certain que les nouvelles que l'on colporte si activement ne sont que des alarmes pour favoriser les fabriques accommodantes. Il est à déplorer que pendant la crise commerciale actuelle, des spéculations aient principes profitent en augmentant la méfiance.

A mesure que les comptes rendus de l'année passée se complètent, on voit dans certains cas que l'état des affaires n'a pas été aussi insalubre qu'on l'a annoncé tant de fois. La quantité totale de coton en magasin a été réduit à 62,000 tonnes contre 63,621 tonnes de l'année passée. Les stocks de fer sont très-grands, et on y fait encore que peu d'affaires, mais les acheteurs ne seront pas toujours inactifs.

Il y a longtemps qu'on a commencé une année en faisant des réductions de salaires dans tant d'industries, on peut dire qu'il y a une réduction générale, mais ceux qui sont les plus atteints sont les ouvriers des usines de fer. Dans les industries plus légères telles que la coutellerie, la taillie des limes, la fabrique des outils tranchants et autres, la situation des ouvriers est affectée par les petites journées que leur font faire les patrons. Il reconnu d'y avoir des mal entendus dans les diverses branches de l'industrie métallurgique, parce que les manufacturiers veulent remettre la journée à dix heures de travail comme autrefois, ou ont au moins de faire plus d'heures pour le même salaire. Il semble de l'intérêt de tous d'arriver à un compromis, car pendant la crise actuelle il est nécessaire que les ouvriers fassent quelques concessions.

Dans le cas de grèves ou de fermetures de fabriques on a recours à la main d'œuvre étrangère, et à des frais inutiles, qu'il vaut mieux éviter en contribuant dans la situation difficile dans laquelle nous nous trouvons. La grève des employés de chemin de fer du Midland est un autre exemple de ces disputes regrettables, qui dans l'intérêt de tous il est mieux vaux éviter en arrivant à un mieux, ce qui était des plus faciles, vu la peu d'importance des points, on aurait épargné ainsi bien des pertes ainsi que les désagréments aux transports de minéraux.

L'industrie de la construction des navires est très-active, et les ouvriers de l'industrie de construction de Cleveland, de Stockton et d'Hartlepool, n'éprouvent pas aux réductions de

TRADE REPORT.

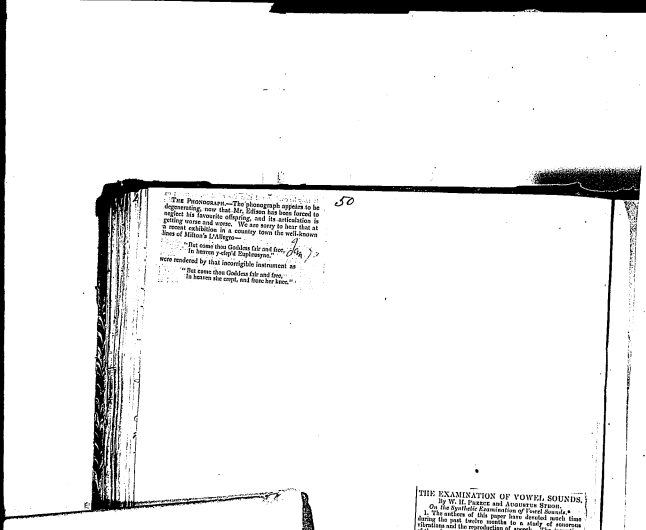
Advices received contain a considerable amount of material, all tending to prove that although in certain respects the trade prospect is improving, there are disturbing elements introduced which make the position a discouraging one. The failure of a good business like the Cornish Bank, regarded with the financial disasters which preceded it, weaken the markets immensely.

There is another element which lately has been introduced with most-effect on sound speculation. We allude to the unfounded, but widely-circulated, rumours of impending financial, or, in other cases, political difficulties. There may be further revelations of the kind, but certain it is that those now circulated so industriously are merely fictions invented for the sake of carrying on questionable transactions. It is to be deplored that in the present unsatisfactory condition of affairs, unprincipled speculators should be able to spread fresh mischief and make a profit by so doing.

As the returns for the past year gradually arrive at completion, it is seen that in some notable respects the condition of trade has been less inanimate than at time reported. The aggregate stock of copper is reduced to 62,000 tons, as against 63,621 tons twelve months previous. The stocks of pig iron are undoubtedly large, and the trade is still devoid of activity, but consumers are not likely to remain long inoperative. Probably, as soon as the evident prices have touched the lowest point, there will be a resumption of purchasing.

Seldom has a year opened with so many reductions in wages. It may almost be said that wages are being generally reduced, but the principal sufferers are still ironworkers.

In many of the lighter trades, such as cutlery, file cutting, edge tool makers, and kindred industries, the men suffer from the short time for which employers can find them work. The arrangements of disturbances in the engineering trade because employers deem it necessary to return to the ten hours system, or, at all events, to work extra time for the old rate of wages. It will be for more to the interest of all parties concerned if a compromise is arrived at, as the event of a general strike or lock-out, and a recourse to foreign labour importation to the amount, of needless expense and annoyance will be entailed which but letter be avoided. Another example of an unfortunate dispute which, for public convenience and the interest those interested, had far better have been avoided by means of a mutually agreeable arrangement, which, considering the small issue at stake, might surely have been arrived at within half the loss attendant on the strike and the delay to mineral traffic.



THE PHONOGRAPH.—The phonograph appears to be degenerating, now that Mr. Edison has been forced to neglect his favourite offspring, and its articulation is getting worse and worse. We are sorry to hear that at a recent exhibition in this country two the well-known lines of Milton's *L'Allegro*,

"But come thou Goddess fair and free,
In heaven ycleyd Euphrosyne,"

were rendered by that incorrigible instrument as

"But come thou Goddess fale and free,
In heaven ale cupd, and thurc her name."

THE EXAMINATION OF VOWEL SOUNDS.

By Professor W. HENRY and Augustus Stroh.

*On the Synthetic Examination of Vowel Sounds.**

1. The authors of this paper have described, more than three years ago, a method of analysing such thin curves as those of the phonograph, and of reconstructing them by the vibrating discs of the phonograph. This invention has proved a great stimulus to this study. Researches have been carried on in the same field, and many of the facts elicited by the authors have been anticipated by others who have been able to command more extensive study of the subject. Nevertheless, the method of inquiry, the apparatus employed, and the results elicited by the authors, appear to us to be sufficient novelty to justify their being brought before the Royal Society.

2. The curves traced by the vibrating discs of the phonograph are useful, whether examined synchronously or reproduced by a species of phonograph, were soon found to be insufficiently delicate to give the proper shades of sound, and to fail to indicate the true curve of the articulation in all cases. This is shown by the imperfect articulation still given by the phonograph itself; the merging of the sharp consonants into one another, and the absence of all the delicate and personal of the "noises" of speech. The phonograph is by no means very successful speaker, and it requires the aid of much imagination and considerable guessing to follow its representations of articulate speech. Its wonderful perfection, but it fails to reproduce many of the "noises" of which speech is so largely composed. The telephone is also deficient in this respect, though to a much less degree.

3. The first object of the authors was to find a disc which should vibrate to the least shades of successive vibrations, and which would be free from the peculiarities characteristic and "personal" portials which are nearly inseparable from all vibrating discs, and which interfere with the accurate, delicate, and indistinguishable experiments, on almost all known forms. After a long search, a stretched membrane of thin india rubber rendered rigid by a thin film of paper, was found to give the best effects. Such a disc was supplied to the telephone and the phonograph with fair success, and was attached as a receiver in Fig. 1 (see page 200) was then constructed to record its vibrations. To the centre of the membrane was attached a very similar to that in Fig. 1, which was placed to act as a receiver for the phonograph, was attached an extremely fine glass tube, and fixed acted as a pen. The ink employed was either ink, and lines drawn through the pen by the very slight friction exercised between the point and the paper. The paper p on which the curves were to be traced was then fixed bend frequently and for this purpose was attached to a small drawer under the pen by mechanism similar to that used in the Wheatstone automatic telegraph apparatus. A speed which could be carried at will from 1 in. to 60 in. per second.

4. In this way curves were obtained illustrating the successive vibrations due to the tones of speech, but their form was not so perfect as could have been wished, due to the imperfection of the disc, as well as, perhaps, to the friction of the pen failing to indicate the higher upper partials. Now at a slow speed, this instrument records the variations of air pressure perfectly, but at a rate at a sufficiently correct speed, and numerous vibrations. It thus combines the functions of Barlow's logic and of Leon Scott's phonautograph.

5. It is intended in this paper to confine our observations to these fundamental and normally sounds, a graphic representation of which, drawn by the new phonautograph, is exhibited.

6. Helmholtz's theory of vowel sounds is this. Vowels are compound musical tones, or resultant sounds, formed by the superposition of certain consecutive or simple tones called partials, the first partial, which determines the pitch of the whole, being the gravest, and the others the upper partials. The partials depend upon the reinforcements due to the cavity of the mouth, and the pitch corresponds to the cavity of the mouth, or on Q and depend therefore of the particular shape, or form, or arrangement of the particles about, but on both. The partials are consequently produced by resonance. It must recognise the kind of vowel sound, the reinforcements, and therefore it determines the different vowels. This theory has been partly confirmed by Mr. Hermann Klingling Jenkin and Ewing, by an analytical examination of phonographic tracings, fully described by them in a paper read before the Royal Society of Edinburgh.

7. The principal vowel sounds are:

A, as in	...	...	...	path
E	...	...	...	bay
I	...	...	...	fee
O	...	...	...	so
OO	...	...	...	soon
U	...	...	...	good

There are several others which are modifications of these five, such as in gull; a as in hall; ow as in how, &c. The diphthongs are:

I which is compounded of ah and o,			
A	...	...	o and oo.
O	...	...	oo and e.

8. The cavity of the mouth changes during the articulation of these diphthongs—it remains constant during the production of a vowel. It is thought that the inference of the first mentioned of these facts is allowed by the examination of the vowel curves, and that of the second, that in addition to the influence of the cavity of the mouth, reinforcements must be made for the increment of the pitch of the successive vibrations, as well as for the variation of air pressure at the commencement and completion of the vowel. Helmholtz has acknowledged the existence of these reinforcements in consonants and compound tones generally, but has not considered them in vowel sounds. The curves show what an essential feature they bear on vowel sounds.

9. Variance in which vowel sounds blend into each other is strikingly shown in the way in which different pronunciations of different words. Thus, what Londoners would call *cart* is Lancashire *aun calls sartiart*; a Londoner says *Marlborough*, a Yorkshireman says *Marrlebrer*, a Scotchman *Marlebrer*. Londoners often pronounced *Asher*, We need not, however, examine these variations in order to recover the existing blending of vowel sounds; it is found in inhabitants of the same district to a greater or less extent. Thus, for example, the word *Manchester*, *Lancheste* after *man Marlebrer*, *Manchester*, or *Marrchester*. In every case which the sound is considered, this change of vowel sound, due to dialect, is simply due to the shifting or lowering of the upper partials.

10. The order of the principal vowels, which is given above, does not follow any theoretical principle. It appears that a better order to follow would be one dependent on the pitch of the partials as given by Helmholtz.

1.	...	...	...	oo
2.	...	...	...	o } ah—(part).
3.	...	...	...	aw—(law).
4.	...	...	...	a } a—(hat).

All the subsidiary vowels, such as ow, ar, &, take up intermediate positions in this scale, so that, in fact, we may say that there is a vowel spectrum, in which the different sounds merge into each other by almost indistinguishable gradations, and hence, probably, the difficulties in distinguishing vowel sounds.

11. In the following investigation, a method opposite to that of Helmholtz has been pursued, and fixing has been adopted, i.e., the premises have been studied by the method of synthesis. It has been assumed that vowel sounds are compound of a prime sound and certain upper partials, and the number of these partials has, for convenience, been fixed at eight, although there are many more. Let these be here taken, as those were, the 10th, 12th, and 15th. Now, since each partial is represented by a simple harmonic curve, if we assume the pitch of a note to be constant, then it would be possible, by means of a tuning-fork, to sound a note and vary each partial in phase and in amplitude. For this purpose an instrument was constructed, which we call the "synthetic curve machine." It which a number of tuning-forks, A, B, C, D, E, F, G, H, &c. (Figs. 2 and 3, page 202) are mounted on a heavy cast-iron frame, A, B, C, &c., board, so that they will vibrate together and the numbers of their teeth are so calculated that distinct multiples of the speed of the wheel A will make two, C three, F four, H five, K six, G seven, H eight revolutions, and so on. The wheel A, as its peripheral axle, a small crank, by means of which the whole system of wheels can be rotated. On the same axle with A is fixed a wheel D, and on the wheel C, which, by means of a train of wheels, gives motion to a sliding table E. Each head of the pins on which the tuning-forks vibrate, has, in its centre, a small slit or hollow, in which rest the pointed ends of eight steel rods (one of which D only is represented in Fig. 6), held in position by eight springs k. To the rod on the wheel A is attached, over the forks, one end of a silken thread F, passing over its pulley, and the other end being attached to the rod on the wheel C, which also works C and D, E and F, G and H, and so on. The four rollers N are mounted on the lever V, which slightly inclined, so that the rollers N are pivoted at p, and by means of the silken lever P. This lever is pivoted at p, and by means of a silken thread to the lower end of the lever P is pivoted another lever W, which is better and a small counterbalancing suitable ink. On the table E is placed a glass pen G containing coloured glass, and a half sheet of paper or the sheet of the eight wheels has on the paper a very small circle, and the pen when the pulses of the rods F cause the curves. Whatever be the rate of speed, the tuning-forks will be in the same relative position, and the curves will be identical. If, however, two or more rods be placed on the faces of the wheels, then the pen will trace a curve compounded of the sum of the several simple curves. In order to increase or decrease the amplitude of the vibrations, each rod is placed further from, or nearer to the centre of the wheels. Difference of phase is obtained by shifting the position of the pulleys on the wheels, K, L, M, have been fitted, making in additional multiples, respectively, to one turn of the wheel A, and that they can be removed for the use of three smaller wheels, S, T, and U.

12. Besides assuming the pitch to be constant, it has been assumed that each series of the five partial, to naturalness, equal loudness of sound, must diminish somewhat in the following order. Thus the

First picture is	the amplitude of the prime.	
Second	"	"
Third	"	"
Fourth	"	"

The intermediate notes, such as the third and the fifth, increase in intermediate ratio.

13. The synthetic machine enables us to form synthetically all the curves produced by vowel tones, and to show how these tones are composed of their several partials.

14. Complex curves, such as those which can be produced by simple harmonic curves, and compound tones by the superposition of various orders of several simple tones.

The following figure (Fig. 5) shows the simple harmonic curves, a, b, c, d, and the resultant curves, e, f, g, h, which curves formed by different components. In this way curves have been reconstructed as shown in Fig. 6, representing the vowel sounds heard on Helmholtz's theory, as indicated by Mr. Ellis in a Lecture statement, at page 181 of his translation of Helmholtz's work.

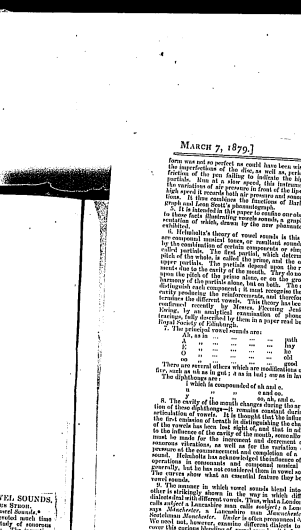


FIG. 5.

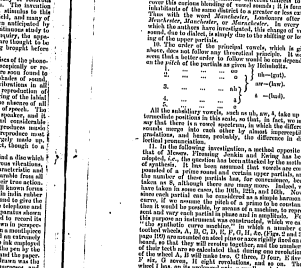


FIG. 6.

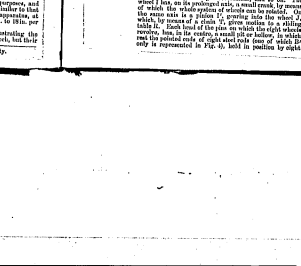


FIG. 7.

15. (It is worth remarking parenthetically, that one interesting fact arising from the operation of this machine was that curves could be so constructed as to give a stereoscopic effect. One curve was drawn simply, and the other drawn in the same line—at the proper distance from it to represent the eye—and each compound, by the addition of a partial of one amplitude. The result of the combination by the eye in a stereoscope of these two curves, was to produce a perspective effect. Thus, when certain curves were drawn which included a certain amount of such stereoscopic effects in a manner which would be out of place here. This has no bearing whatever on the present question, and is only adduced as a scientific toy arising out of the inquiry.)

16. Having thus studied the formation of vowel sounds, and having a means to reproduce the compound curves which gradually represent the articulations of speech, it remained to examine the latter themselves, the analysis of which is the object of the present paper. This we shall attempt in a future paper.

Since vowels are produced by a prime and its upper partials, and as the upper partials vibrate as rapidly in amplitude, the idea arose that these vowels might be produced by sounding a prime and one of its upper partials. This was done by means of an electro-magnet E, Fig. 1, page 202, which was made sensitive A with a microfile spring D, attached to it in such a way that the vibrations of the armature, by varying the length, could also be adjusted to any particular partial.

The result was certain was to roughly reproduce the principal vowel sounds, but the effect not being by any means satisfactory, but the effect not being by any means satisfactory, a machine was made on the principle of the synthetic curve machine, which would, by superposing curves on paper, reproduce eight partials by transferring the vibrations of the intermediate wheels to a vibrating tuning-fork, and the vibrations of eight wheels fixed on the same axis. The periphery of the wheels being cut into teeth of such a number as to correspond with the eight partials, in fact each wheel is simply harmonic curve, and the wheel represents one partial. The axis can be rotated at any speed. By depressing a key a vertical rod is brought into contact with the edge of each wheel, and a tuning-fork vibrates in accordance of those curves are transferred by this curve to an intermediate linking to a diaphragm of double, see Figs. 4 and 5, page 202, and by varying can be depressed variously by simultaneously by electricity, and the disc will vibrate to the resultant effect of all the curves. Two keys and chords can be sounded.

Here again, though the vowels were fairly reproduced, considerable difficulty arose in the superposition of numerous curves to be accurately drawn, and all the facts elicited by the examination of the curves, and all the facts above can be sounded by illustrations. Moreover, it forms the basis of a new musical instrument which has been constructed, and will be noticed.

With the hope of getting more perfect definition, another machine, with more ready means of varying the speed, and producing curves out in exact copy of the curves produced by the vibrations of tuning-forks. These curves are produced by vibrations of the receiving diaphragm of a phonograph, and readily traced on the surface of a cylinder of lampblack. The musically phonographic curves, Fig. 9, (see page 202), about 6 in. long, one end of which is attached to a fly-wheel, and the other end to a greased pulley G, round which a band or gut passes from a

driving wheel D, fitted with a crank handle E. On rotating the driving wheel, the long axle is caused to make about 60 revolutions per minute.

On the axle are placed, in such a manner that they can easily be removed and replaced by others, a number of brass wheels or discs a, a, a, &c., the peripheries of which have been cut by a machine especially constructed for that purpose into the different curves corresponding exactly to the curves obtained by the synthetic curve machine, and which is mounted on the same axle.

A diaphragm C with spring and frame H, similar to that in a phonograph, is so fixed that it can be shifted from one to another of the wheels, and the sound produced by the different curves can be readily compared with each other. A resilient vibrating reed is also fixed to the frame, by the curves can be readily compared with each other. By the help of curves related almost twice per second, and in the musical scale.

A number of combinations of curves have been cut on the phonograph cylinder, and the sounds produced by the vibrations of the brass discs, represented certain variations of the portials, or experimental determinations. These discs were then placed on the axle, and the sounds exactly resembling the vowel sounds of the human voice were easily recognised.

10. In this way it was found that from about *f* to *b* in

* Paper read before the Royal Society.

(2230) PHONOGRAPH AND PHONOPHONE.—The following item is clipped from the *Sunday Telegraph* of February 26th, about 3 years ago by Scott Tr.: "*The Times* of forty years months since," was the advice of Dr. Ellerby, lecturer before the Academy of Science at Union Hall. Now should there to the Indies proverb, and open first their eyes, then their ears, and last their mouths. If the mouth is duly inspected, its delicate functions during the day, it must be closed during the night. The lat- lows, wind-shoes, and mole-plugs that form the human voice must have their periods of rest, for sound is the result of motion. Wherever no produce sound we have silence. The old phe- nagaph, invented twenty years ago by Scott of London, and perfected by Koenig of Paris, was made on the principle of indentations of a needle on smoked paper. The new substitutes appearance of sound. One of them, being of wood like pipe, and is then charged with the melody of "My Grandfather's Clock," so that it clicked with such precision and deadened the de- sound with such distinctness of articulation, that the audience was highly amused." Will you please explain the mechanical operation, and oblige.—F. E. P., New York City. [?]

A NEW PHONOGRAPH.—Mr. Johnson, Mr. Edison's chief assistant at his Menlo Park laboratory, has been for some time engaged in improving the telephone and the phonograph. He has accomplished that no other one has ever yet been able to do—that is, the reproduction of the phonograph of words transmitted by telephone with such accuracy that they could be repeated by the speaking machine with sufficient distinctness to be understood. This was, of course, done by the employment of Edison's new electro-motor receiver, the only instrument as yet found that delicate enough and sufficient power for the purpose. Mr. Johnson has also nearly completed the invention of a new phonograph which he claims will be adapted to the practical use of business correspondence, and as proved by recording telephonic messages, greatly excels yesterday's experiment, will facilitate the use of the phonograph for business purposes.

A SIXPENNY PHONOGRAPH.

Whilst a great scientific discovery or invention is announced to the world, such, for example, as the telephone of Professor Graham Bell, the microphone of Professor Hughes, or the phonograph of Mr. Edison, it is pretty certain in a short time to be followed first by spurious and unauthorized imitations, which, if the invention be protected, are nothing more or less than direct infringements of the patent, and after that by highly interesting modifications of the ap- paratus either for the extension of the principle, developing further physical facts, or to analyze those already discovered; or else for the reduction of the instrument to its simplest possible form, so as to place in the hands of the teacher as well as in those of the million a scientific toy which can illus- trate and render familiar the principle which lies at the base of the more important and typical ap- pliances.

There are few who can have failed to see that both the telephone and the microphone have gone through both these stages; and the phonograph, after having been imitated by amateurs and copied, by unlicensed manufacturers, has led to the very beautiful analytical and synthetical apparatus of Mr. Stroh, and has quite recently reappeared as a curious and most interesting scientific toy, and one which we would hesitate to say could not be made applicable to some useful purposes.

The very simple apparatus which we illustrate below is a speaking phonograph that can be made and sold for sixpence or even less, and yet leave a profit to the manufacturer. It is the invention of M. Leontiegen, an inspector of telegraphs at Ahls, in the Department of Tarn, in the south of France, and has been brought to this country by M. Higelbaldet, whose name is well known in connexion with physical and electrical science.

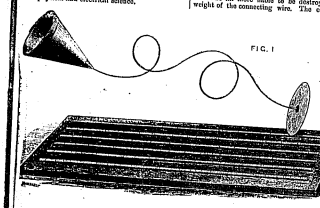


FIG. 1.

FIG. 2. FIG. 3.

The whole apparatus which is represented in Fig. 1 consists, first, of a button-cone of pasteboard about 1½ in. in diameter, whose apex is cemented in the centre of a circular metal pasteboard disc by means of a lead wire about 10 in. long; and, second, of a cardboard or tablet, on which is fixed one, or a larger number of short lengths of lead wire, each of which bears upon its upper surface a phonographic embossed record corresponding to a certain word or sentence, by which it was originally produced by a process to be described further on.

To those who are familiar with the construction of the phonograph in the form in which it was first shown in this country, and which was fully described in these columns some time in the year ago, it would appear necessary in order to reproduce the sounds recorded on the tablet, for the edge of the disc to be held in an annular frame so as to convert it into a diaphragm, and for its centre to be brought into vibra- tion by means of a point or style projecting from it and drawn over the undulatory surface of the record. But the method of using the apparatus is far simpler than that; all that is necessary is to hold the paper cone against the ear with one hand and with the other to take hold of the cardboard disc, drawing its edge along the record with a steady scraping motion, and the mechanical vibrations thus set up in the disc being communicated by the wire to the conical ear-piece which serves as a resonator and concentrator, produce in the organs of hearing the sensation of the articulate sound by which the mark- ings on the leaden record were originally produced. We should have thought that a sound thrown or a lighter wire would have formed a more efficient as well as a cheaper connexion for the purpose than the lead wire, but we are informed that M. Lambrigot has found the lead to answer the purpose better than anything else; it does not require to be kept stretched between the cone and the disc, and being of a very inelastic nature is does not spring about and produce disturbing sounds by clashing against itself or against neighbouring objects. Again, it would naturally be expected that the ear-piece would be more perfectly adapted to its purpose if it were in the form of that used in the ordinary thread telephone, that is to say if it consisted of a cylin- drical cardboard box closed at one end with a stretched paper diaphragm, to the centre of which the conical wire was attached, but simply as a fact, this would undoubtedly be a more complex form of construction than the cardboard cones, and would be for more liable to be destroyed by the weight of the connecting wire. The employment of cardboard as the material of which the principal parts of the apparatus are constructed is, in the case of the cone, for cheapness, and in that of the tablet partly for cheapness, but chiefly to protect the markings on the lead record from being destroyed, as they soon would be if a harder material than lead were employed.

The most interesting point connected with this very simple apparatus is the method by which the leaden records are produced, which is as follows: The top surface of a rectangular piece of glass, or other hard and rigid material, is thickly coated with shellac wax, which is then scraped into a convex form, as shown in the diagram Fig. 2, in which *a* represents the glass slab and *b* the convex casting of shellac. This bar is then fixed with a simple phonographic instrument, which, by means of a screw or other mechanical contrivance, traverses it at a suitably speed below a diaphragm. This diaphragm is rigidly held around its circum- ference by an annular framework (not shown in the diagram), and is in every respect exactly similar to the diaphragm of an ordinary phonograph. To the centre of this diaphragm is attached a thin flat piece, whose lower end is cut out to a concave curve to fit the convex surface of the shellac *b*. When all is properly adjusted, and the temperature is ar- ranged so as to give to the stearine surface the proper degree of hardness to insure the best results, the handle of the instrument is turned, and at the same time words are spoken against the diaphragm, which immediately set up in it vibrations, which are communicated to the plate or style. While this is moving up and down, following the vibrations of the diaphragm caused by the voice, the stearine coating of the bar *a b* is steadily drawn in the direction of the arrow below the vibrating bar, receiving from it a phonogram similar to that produced on the tin- foil of an ordinary phonograph.

The stearine bar is then coated with a fine surface of plumbago so as to give to it an electrically con- ducting surface, and it is then electro-plated with copper by the ordinary process. Out of the copper coating so formed the stearine is removed, and a rigid backing of lead or other metal having been run over the outside convex surface of the copper, a firm copper-lined matrix or mould is formed, the whole presenting the appearance shown in Fig. 3, and consisting of a rectangular block having in the centre of one of its sides a semi-cylindrical groove of copper which bears upon its surface certain raised striations corresponding to the depres- sions which were made by the diaphragm on the surface of the stearine. Into this groove is laid a piece of lead wire of about 3 or 4 millimetres in diameter, and the two being pressed into a press and squeezed together the surface of the lead wire receives a permanent impression which is an exact reproduction of the original impression made upon the stearine bar. One copper matrix is very large number of lead wire pressings may be made, and we are told that it has proved to be good for as many as 1,000 records, each containing the record of a short sentence, can be made and sold with a profit for one half-penny each.

It is an interesting fact that if a small stick of wood, such as the stem of a common match, be substituted for the disc shown in Fig. 1, and its end be drawn along the copper groove of one of the matrice moulds shown in Fig. 3, articulate speech is communicated equally well to the ear-piece, although the vi- bration of the point in the recesses of that of the disc, and this bears a very close analogy to the fact that in the ordinary Bell telephone a message is trans- mitted with equal distinctness whether the po- sition of the receiving instrument be reversed or not.

We have had an opportunity of testing this ele- little instrument, and the words come out of it in remarkable distinctness, though of course with a feeble power; and among the following words, of which we have heard it utter, some were decidedly clear: "Mon cher ami," "Louis Quatorze," "Victor Hugo," "La République," "Chemin de fer," "Banjore," "Lambrigot." "Microphone," "Phonograph," and "Electricité," and it is a curious fact that while the phonograph the words "Phonograph" and "Electricité" do you do?" come out with exceptional distinctness in this instrument the words "Banjore," "Lambrigot," the name of the inventor, "Lambrigot," are those of those we have heard.

It is only fair to Mr. Edison, the inventor of the phonograph itself, to point out that the process of producing a phonogram on a stearine surface, and afterwards reproducing it in copper by the aid of electrolysis, was suggested by Mr. Edison, but we do not understand that Mr. Lambrigot claims any novelty for that portion of the process, but more especially for having produced an instrument at the cost of a few pence, which demonstrates the action of the phonograph and illustrate some of the most beautiful phenomena con- nected with the science of acoustics. We congratulate M. Lambrigot on having produced a very beautiful methods by which he has brought it about, and we hope before long to see many use- ful little instruments very fruit their way in numbers to this country, for it is by the cheap and simplest apparatus that some the greatest discoveries of sciences are made to contribute to the intimate north in phenomena, but because popular instruments, accessible to the million, are the first tests for scientific investigation, starting them on a research which may lead to great findings, and out of the multitude of workers new inventions instigate, some discoveries of high certain to be made.

THE LONDON GAS COMPANY

is satisfactory to find that at least one of industry has escaped the depression most of the trades of this country. In every part of the country the present month investment shares of the shareholders of gas compa- of these we shall only call attention to the Gas-Light and Coke Company, the Chartered Gas Company, the Commercial, and Phœnix Gas Company, which stand next in impor- tance to the Gas-Light and Coke Company, that about two-thirds of the supply of Lon- don is given, perhaps a small ratio of the whole capital.

The accounts of the London Gas-Light Company showed an increase of rental notwithstanding the severe winter. After providing for the dividends on the preference shares there was a balance of profit for the half-year ending December, 1878, of 26,462*l.*, giving a dividend at the rate of 12 per cent. on the ordinary stock. As might be supposed, there was much little talk of the danger from explosion in the electric light. It appeared that the Board of this company had not been influenced by "electric scare," for out of a total of 500 miles of capital only about 14,000*l.* had changed hands during the year, and this chairman denied that there was any serious falling off in the consumption of gas, or any unless exceedingly favourable terms were offered. Mr. Robert Rawlinson, C.B., the well- known engineer of the Local Government Board, and a director of the company, stated that the electric light might be of service in exceptional cases, but was too costly. He exhibited the idea of

* See ENGINEERING, vol. xxv., page 186.

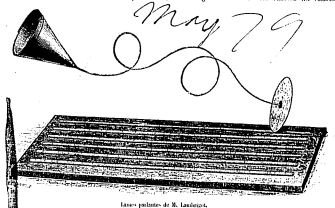
LES LAMES PARLANTES

DE M. LAMBIGOT.

Après avoir obtenu par le phonographe d'Edison une reproduction fidèle de toutes les vibrations délicates qui constituent le *son articulé* ou la parole, on s'est demandé s'il ne serait pas possible de multiplier indéfiniment le clichè obtenu comme l'imprimerie multiplie à l'infini le livre après une seule composition.

C'est ce problème qu'a résolu M. Lambigot par des procédés d'une simplicité remarquable dont nous allons faire connaître le principe.

Remplaçons la pointe du phonographe d'Edison par une petite lame d'acier en forme de cautcau et le cylindre tournant par un chariot sur lequel nous



Lames parlantes de M. Lambigot.

fixerons une laguette de verre portant une couche de stéarine sur une de ses faces.

En promenant un certain nombre de fois le chariot devant la plaque, la lame d'acier va racler la stéarine et en former une surface parfaitement unie.

Faisons passer une deuxième fois le chariot devant la plaque du phonographe avec une vitesse uniforme en parlant devant cette plaque, la lame d'acier, en suivant toutes les vibrations de la plaque, va venir strier la stéarine et former à sa surface une reproduction exacte des vibrations qui l'ont influencée. La stéarine, offrant une résistance moins grande que la feuille d'étain employée dans le phonographe, permet d'obtenir une reproduction plus fidèle des vibrations de la plaque.

La laguette de verre est enlevée du chariot,

le de plombagine du côté de la stéarine, et dans un bain galvanoplastique où elle se couvre d'une couche de cuivre sur la face où se trouve la stéarine. On obtient ainsi une matrice en cuivre reproduisant fidèlement toutes les vibrations tracées d'abord sur la stéarine.

En plaçant sur cette matrice en cuivre des petits fils de plomb de 1 millimètre 1/2 de diamètre, et en exerçant une pression convenable, on obtient sur le plomb une reproduction exacte du strioge de la stéarine; le cuivre étant plus dur que le plomb permet d'obtenir par pression un très grand nombre de lames avec un seul clichè en cuivre. En passant sur ces lames de plomb ainsi préparées un petit disque de carton, ce disque va suivre toutes les ondulations tracées sur les lames et vibrer de façon à reproduire très nettement les paroles inscrites par le phonographe enregistreur.

Pour rendre les sons plus perceptibles, M. Lambrigot attache un fil de plomb au centre du disque et fixe un cornet de carton à son autre extrémité, les vibrations se transmettent mol'écalrement par le fil de plomb et font vibrer le cornet qui concentre les vibrations sur l'oreille qu'on applique à son embouchure.

L'usure des lames étant insignifiante, on peut répéter plusieurs milliers de fois la phrase inscrite.

Ces lames permettent de répéter à plusieurs des expériences que l'on fait avec le phonographe; elles en jouissait le carton sur la lame à des vitesses différentes, on reproduit la phrase inscrite avec une voix de tonr ou une voix de basse à volonté. La vitesse moyenne est de 20 centimètres par seconde environ.

On peut concevoir un discours tout entier imprimé par le procédé Lambrigot sur un long fil de plomb qu'un mouvement d'horlogerie ferait dérouler régulièrement au-dessus du petit disque de papier

CHURCH ENTERTAINMENTS

That Instead of Sociables as usual, and dirt-dear paying bosses.

If Churches furnish elevating amusements they must be winning ones. Mind away from hurtful excitements. The Microphone, Phonograph and Telephone entertainment furnishes rare, refining pleasure. It will long be remembered by both young and old with pride as well as pleasure. The audiences has been great; in many cases netting handsome amounts to Churches and Societies. Everywhere where less novel and instructive entertainments have not paid expenses, intelligent people everywhere have rend so much about these wonderful inventions that they have been anxious for their development and hear an intelligent discourse on the principles of applying the whole subject [as well as some of the very wonderful future results]. The Telephone, with its instantaneous electricity of the evening, coupled with the great public interest in recent inventive development, makes the entertainment appropriate for any to-morrow of the year, and a paying one [necessarily].

Special arrangements can be made whereby the ladies can have at the close [on their own premises] a sociable with refreshments, if they may see fit. The Telephone can be postponed till first time and thereby a hungry audience held a half hour or more. Excellent results have been [in a few cases] obtained. Or, if desired, no-sociable arrangements can be made whereby a Concert ticket shall include, for instance, a dish of ice cream.

The new feature of

A Free Phonograph Matinee for Children,

in the afternoon, at close of day schools, assists greatly in drawing a large house in the evening. In matinees throughout the City of Philadelphia [in 78] delighted advocates, [with appetites aroused to [see the fullest extent in the evening,] and also furnishes a large number of active and effective those who they have heretofore ticket sellers from several different schools who work [in the evening] raising moneys for themselves.

The Matinee [when given *alone* results in a paying house for the evening, and has proved itself the best feature possible for selling to work up an evening financial interest.

An additional inducement to children to sell tickets before the Matinee, is, that all will sell the required number [as to as many be best in the locality,] can have *tickets their entrance ticket for evening*, a special one will be issued for the Matinee, [which will be good for that day only].

The invitation to the children to the free *Phonograph* Matinee [no other apparatus publicly used till evening] should be extended to the children through the public schools as early as possible, [several days before the concert day,] in order that the children may be talking the matter over at their homes, and thereby advertising the Concert.

THE PROGRAMME.

1st. Use of Speaking Telephones while the audience are assembling [testing speech, music, imitation, &c., over a long wire.]

2d. The Scientific Lecture, [about a half hour.]

3d. The Singing Telephone [heard throughout the largest room by all without effort.]

4th. The Phonograph [heard distinctly throughout the largest Churches or Opera Houses.]

5th. The Microphone.

6th. Examination and trial by the audience of Phonograph and apparatus, [when opportunity is given to all to ask questions.]

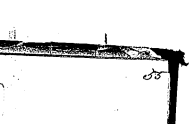
THE ENTERTAINMENT

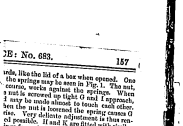
has been everywhere pronounced first class.

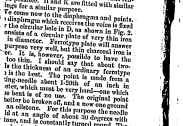
The Lecture itself alone furnishes a good evening's entertainment.

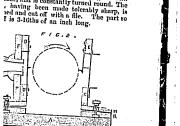
Everywhere it has been accorded the verdict of "superior," "an entertainment of rare success," "a rich treat," "more worth more than the cost of the ticket," "the most instructive [and] entertaining lecture to which we have ever listened," "Leading intellectual men in the City of Chicago, with the history of marvellous success, [the result of hard work] are introduced as a stimulus to worry about the future or poor, as well as a matter of existent pride at his steps attended achievements.

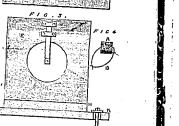
[OVER.]

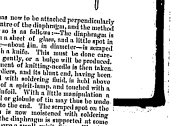


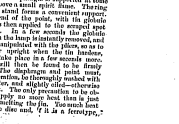


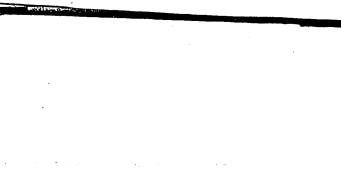












THE PHONOGRAPH

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among [up rods, [with [to

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fixé sur une caisse sonnante. On réaliserait ainsi un *lecteur automatique* et on justifierait en même temps l'expression populaire et imagée du *moulin à paroles*. Au point où en est la question, il y a peu à faire pour réaliser ce que nous venons de dire, et des perfectionnements ont déjà été apportés par l'auteur à l'appareil primitif.

En effet, dans une autre disposition, M. Lambrigot place ses lames sur une caisse résonnante et les phrases peuvent être perçues par plusieurs personnes à la fois, sans le secours du cornet, en passant simplement une carte à jouer à la surface des lames avec une vitesse convenable.

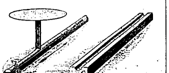

Fig. 2. Fig. 3.

Fig. 2. — Diagramme théorique montrant la disposition de la baguette de verre *a*, de la couche de stéarine *b* et du petit couteau fixé à la membrane vibrante du phonographe enregistreur.

Fig. 3. — Matrice en cuivre obtenue par dépôt galvanique, et servant à reproduire les petites lames de plomb.

Ces lames, qui peuvent être fabriquées à très bon marché, rendront de réels services pour l'étude des langues étrangères, car elles permettent de conserver indéfiniment et de se faire dire à loisir les mots dont la prononciation trop difficile nécessite de nombreuses répétitions. On arrivera à constituer ainsi un véritable *dictionnaire parlant*, problème dont la solution ne pouvait être espérée ni même prévue il y a quelques années.

E. Hospitalier,
Ingénieur des arts et manufactures.

CHRONIQUE

Boîte aux lettres de la Nature. — Nous appelons l'attention de nos lecteurs sur la *boîte aux lettres* que nous commençons à publier aujourd'hui à la page troisième de notre couverture, et qui, nous l'espérons, pourra leur être utiles, soit pour obtenir des renseignements, soit pour faire connaître des faits scientifiques ou discuter des questions intéressantes. Notre boîte aux lettres est désormais ouverte à nos lecteurs.

Congrès météorologique de Rome. Excursion au Vésuve. — M. Albert Tissandier, qui a représenté *la Nature* à cette intéressante réunion scientifique, nous écrit au sujet de l'excursion qui a été faite au Vésuve, le 24 avril, par les membres du Congrès. « Cette excursion, nous dit notre correspondant, a eu lieu sous les auspices du gouvernement italien. Ce matin, douze calèches étaient attelées; elles nous ont transportés à l'Observatoire Palmieri, où nous attendait un magnifique déjeuner. Après le repas,

nous avions les guid[…]
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Vésuve. Le principal[…]
le cratère au fond […]
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de soufre fondu qui[…]
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la science.

Exposition a[…]
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très nombreuse et[…]
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Il y a quelques[…]
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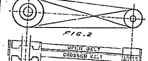
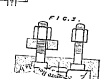
supported in straight or conical bearings, and with or without back gearing. A tail-pin is necessary to prevent back-lash or end-long play. A bolt secures this headstock to the lathe-bed. There is usually a cone of three or four pulleys on the shaft to vary the speed, and there must also be some contrivance for throwing the wheels of the back gearing out of gear. Each headstock has a steel centre fitting taper (1 in 16) in the headstocks. The end of the spindle nearest the rest is screwed for a face-plate, jaw, or bell (sometimes called a bottle) chuck to fit on. The speeds of lathes vary with the material to be cut, and some lathes, especially those for screw-cutting and brass-finishing, have a *driving apparatus* (Fig. 2) arranged to give two speeds to the lathe, and besides this many screw-cutters are arranged to be driven either by a crossed or open belt, so as to reverse the motion and send the saddle back without unlocking the nut at all. It is needless to say that this is a safeguard against locking on to the wrong thread of the leading screw. The back gearing gives a slower motion, and consequently increased power to a lathe. Most pulleys, particularly those running at a high speed, have their peripheries convex, to prevent the strap coming off. A common slide-rest is a rest arranged so as to give any desired motion (in a straight line and given horizontal





THE PHONOGRA[…]
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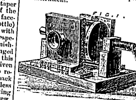
DESCRIPTION OF A PHONOGRAPH.

By Shelford Bidwell, M.A., LL.B.

Several articles on the phonograph have already appeared in the English Mechanic—I shall therefore assume that readers are acquainted with the nature and principle of the instrument.



The most important part of it is the cylinder. This, in my phonograph, is a hollow brass casting, 4½in. long and 4¼in. in diameter. It is mounted upon an iron spindle, ¾in. in diameter and 16in. long, at one end of which is a winch handle. Upon that part of the spindle which lies between the handle and the cylinder a screw is cut, having eight threads to the inch. The other end of the spindle is left plain. The cylinder having been turned perfectly true, a screw is cut upon its surface of exactly the same pitch as the screw upon the spindle—*i.e.*, eight threads to the inch. The depth of the spiral groove thus formed is 1-16in., and its breadth is 1-16in. It is better to cut it square, and not V-shaped. Two brass bearings for the spindle are made of the following dimensions—length, 2¼in.; thickness, 1⅛in.; height, 1¼in. One of these has an inside screw corresponding to the screw upon the spindle. Each bearing has two holes for screwing it to the support, as may be seen in Fig. 1, which is engraved from a photograph of the instrument.

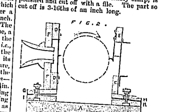
The cylinder, spindle, and bearings being completed, ten pieces of wood must be prepared as follows:—

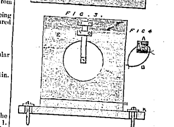
A is 12in. × 9½in. × 1⅛in.
B is 3in. × 3in. × 1⅛in.
C is similar to B.
D is 5¼in. × 5¼in. × ½in., and has a circular hole, 1¾in. in diameter, cut in its centre.
E is similar to D.
F is 5½in. × 5½in. × ½in., and has a hole, 1in. in diameter, in its centre.
G is 5½in. × 2¼in. × ½in.
H is similar to G.
I is 8in. × 2¼in. × ½in.
K is similar to I.

B and C are the upright supports for the bearings, one of them being shown in Fig. 1. The postion of the others is indicated by the letters corresponding to them in Figs. 2 and 3.

The uprights B and C are fixed near the ends of the baseboard, A, by means of 2¼in. screws. D and F are screwed together (see Fig. 1), and the two are then fixed perpendicularly upon G. G is joined to I by a pair of hinges. The two ends of I are screwed to the baseboard, but the holes in I are ⅛in. larger in diameter than the screws which pass through them. The heads of the screws are effectively enlarged by iron washers ¾in. in outside diameter. The object in this arrangement is to allow a certain amount of play in the board, I, for purposes of adjustment. When properly adjusted the screws may be tightened, and the board firmly fixed in position. E is attached perpendicularly to H, and made rigid with two small triangular pieces, which are not shown in any figure. H is hinged to K and K is fixed to the base in exactly the same manner as I. Through the middle of I is passed a brass screw-bolt, the square head of which is fixed in I. The screw goes through an elongated hole in G, and is fitted with a round milled brass nut. It is well to place a washer under the nut. Screw-bolts of this description are used for fixing the expanding bodies of ordinary photographic cameras, and may be had of any optician. H and K are fitted with a similar bolt. Two rather stiff pieces of steel spring are attached to the ends of I, and extend for a little distance underneath G. These springs tend to separate G and I, or rather to cause G to turn backwards, like the lid of a box when opened. One of the springs may be seen in Fig. 1. The nut, of course, works against the springs. When the nut is screwed up tight G and I approach, and may be made almost to touch each other. When the nut is loosened the spring causes G to rise. Very delicate adjustment is thus rendered possible. H and K are fitted with similar springs for a similar purpose.

We come now to the diaphragms and points. The diaphragm which receives the voice is fixed over the circular hole in D, as shown in Fig. 2. It consists of a circular plate of very thin iron 4in. in diameter. Ferrotype plate will answer the purpose very well, but thin charcoal iron is better. It is, however, possible to have the iron too thin. I should say that about two-thirds the thickness of an ordinary ferrotype plate is the best. The point is made from a knitting-needle about 1-20th of an inch in diameter, which must be very hard—one which can be bent is of no use. The original point had better be broken off, and a new one ground upon an oilstone. For this purpose the needle is held at an angle of about 30 degrees with the stone, and is constantly turned round. The point, having been made tolerably sharp, is polished and cut off with a file. The part so cut off is 3-16ths of an inch long.





This has now to be attached perpendicularly to the centre of the diaphragm, and the method of doing so is as follows:—The diaphragm is laid upon a sheet of glass, and a little spot in its centre—about ¼in. in diameter—is scraped clean with a knife. This must be done carefully and gently, or a bulge will be produced. The fragment of knitting-needle is then taken up with pliers, and its blunt end, having been moistened with soldering fluid, is held above the flame of a spirit-lamp, and touched with a piece of tinfoil. With a little manipulation a small bead or globule of tin may thus be made to adhere to the end. The scraped spot on the diaphragm is now moistened with soldering fluid, and the diaphragm is supported at some distance above a small spirit flame. The ring of a retort stand forms a convenient support. The butt end of the point, with tin globule attached, is then applied to the scraped spot with pliers. In a few seconds the globule melts, when the lamp is instantly removed, and the point manipulated with the pliers, so as to be perfectly upright when the tin hardens, which will take place in a few seconds more. The point will then be found to be firmly attached. The diaphragm and point must, after this operation, be thoroughly washed with soap and water, and slightly oiled—otherwise they will rust. The only precaution to be observed is to apply no more heat than is just necessary for melting the tin. Too much heat will warp the disc and, if it is a ferrotype,

LES LAMES PARLANTES

DE M. LARBIGUET.

Après avoir obtenu par une reproduction fidèle délicates qui constituent parole, on s'est demandé de multiplier indéfiniment l'imprimerie multiplie à l'infini à seule composition.

C'est ce problème qu'a ing des procédés d'une sin nous allons faire connaître ici.

Remplissons la pointe par une petite lame d'acier le cylindre tournant par

conduite de phonographe ; mise dans un bain gal reconvre d'une couche de trouve la stéarine. On cuivre reproduisant fidèlement traces. Enfin sur la stéa

En plaçant sur cette m fils de plomb de 1 millim exerçant une pression on plomb une reproduction stéarine; le cuivre étan permet d'obtenir par ren bre de lames avec un En passant sur ces lame un petit disque de carton les ondulations tracées reproduire très nettement par le phonographe sans

Pour rendre les sons

bilator the jaws. The soldering fluid consists of equal parts of hydrochloric acid and water, in which is dissolved as much zinc as possible. A pile of books will be found useful for steadying the arm while manipulating the point. The diaphragm is fixed in its place by means of a brass flange (like a concert flange), 5in. in outside diameter, with a 2½in. opening. Four flat-head, withdraw the point by hand, turn the handle backwards until the cylinder is in its original position, and screw up the record nut until the second point proves lightly but steadily upon the bottom of the furrow. Then put on the paper remainder, and turn the handle at the same speed as before. If the adjustments are perfect, the result will be fair-sounding.

I will conclude with a few general remarks and hints.

It will be observed that this instrument has two diaphragms, whereas Edison's latest have only one, which does both the receiving and the speaking. I have made many experiments with the object of dispensing with one of the diaphragms, but I have never, under any circumstances, obtained as good results with one as with two. Mr. Preece told the Physical Society that the employment of only one was a retrograde step. Reason and experience appear to me to concur in his opinion.

I do not believe that iron and parchment-paper are the best possible materials for the diaphragms, though they are better than any others which I have hitherto tried. The great fault in the iron appears to lie in its tendency to resonate (ring). A certain resonance is certain tuned sounds. I have tried to overcome this by coating the diaphragm with India rubber, but with no great success. I think, however, that a ring of indiarubber between the diaphragm and the flange has an undoubted effect in diminishing the misonance. Paper is also subject to independent vibrations of a similar nature. These may be diminished by coating a piece of soft indiarubber to a delicately spun it at a point about 1in. below the *lower strip of lamé*. I have also found it an advantage to wrap indiarubber round the top of the spring before screwing it on.

I believe that the mouthpiece of a telephone would give better results than that of a speaking tube. A long resonating mouthpiece like that which Edison first used is worse than useless.

The point on the steel spring should be made to turn very slightly upwards instead of being perpendicular. In the latter case it is liable to produce a squeak something like that of a slate-pencil when drawn upside down across a slate.

If the points are too sharp, they will cut and scrape the tinfoil ; if too blunt, the articulation will be muffled. After the points have increased the cylinder 200 or 300 times, they will require sharpening. This can be done with a small oil-stone, without removing them.

In conclusion, I may mention, for the encouragement of those who wish to make a phonograph, that the performance of the instrument here described is at least equal to that of any which has hitherto been exhibited in London.

THE ORGAN: A COMPREHENSIVE TREATISE ON ITS MANUFACTURE, PROCURAL, AND LODGMENT.*

By JOHN WARNER WALKER, M.A.,
Associate of the College of Organists, London.

PART I.—GENERAL TREATMENT IN MANUFACTURE.

I T will be seen that, in the features given, there is no provision for pneumatic or for Pedale to keep it distinct from the Manual four or five disturbing 16 intonation of the latter. The simple reason is, that such provision is found to be an indifferent infrastructure. The Pedal will thereafter Manual less in the proportion of 16 to 8 than any part of the Manual will disturb Pedale. *See* Sec. DETERMINATION OF NUMBERS or PARTS (22.)

8. *Tenor Organs.* (See Swell Organ, Stiehls.) It is a very great mistake to have the tenor on too heavy a wind ; the dignified stop

* All rights reserved.

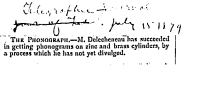
pointer is likely to suffer. In reality the earnest bath pellets and its Registers usually supplied, and large enough for the purified. A better proportion Reeds, particularly if there be good ; but it must be remembered here no means of reducing available to improve the tone at a supplementary of the Pedal to do despite the latter the Reeds of Great, unless there are in fact indeed in Engfor further in Acts. of THE BOROUGHMASS (25, c. lxxxii).

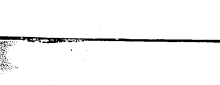
9. *Reeds.* These are the reeds receive the increased pressure they require a great addition such treatment; second, is pedestally liable to weaken notes, therefore the increase to that portion ; third, free separate Pallet for the Reed to be taken off the coupling of Pedale (for more fully in Section applies with more force other Manuals—scarcely at a Great (see 6 preceding). It is laid down that the applied wind-weight to Swell Reeds more to which the increase of legitimately applied, particularly as Solo Organ.

Remedy inferior is to heavier wind to the Pedal fairly whole tone is a Rule borne in mind here that numerous enough one or on the lighter wind, the Pedal prominent the other Organ.

With regard to the Clarinet that the Reeds should now pressure, except, perhaps, large instruments for 4 in. variety in the Reeds at no Registers, and this is good, the present, as in 1st point, to the Pedale.

I. With reference to Pedale too pronounce the Tone on the heavier ; but it is importance that





THE PHONOGRAPH.—M. Delcheneen has succeeded in getting phonograms on zinc and brass cylinders, by a process which he has not yet divulged.

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Sc. Am. Aug 9 1879

(55) A. D. writes: Referring to the phonograph described in Supplement, August 9th, 1879, No. 175, will you give more definite instructions regarding the construction of the little wooden spring, size, form, and kind of wood? A. The accompanying

diagram gives the exact size and proportion. A being the portion attached to the wooden pivot, B the portion that rests upon the diaphragm, and C the needle. The width should be about 3-16 inch and the coil, B, should rest with some pressure upon the small soft rubber block placed against the diaphragm. Any wood that springs well will answer; fichy is perhaps as good as anything.

LE PHONOGRAPHE

La Science Pour Tous July 19 1878

A l'époque où parut le phonographe d'Edison, nos lecteurs se souviennent que nous leur en avons donné une description détaillée. On se souvient aussi que cet appareil consiste en un cylindre de cuivre fileté à la surface duquel on applique une feuille de papier d'étain et de plomb. Sur cette feuille appuie la pointe d'un stylet supporté par un ressort d'acier, lequel est mis en communication avec une plaque vibrante fixée au fond d'un entonnoir en métal de la forme d'une embouchure de trompette. Le cylindre porteur de la feuille d'étain est mené sur un axe à vis qui peut avancer ou reculer dans un écrou, suivant que l'on tourne une manivelle dans un sens ou dans un autre.

Quand on parle dans l'embouchure, la plaque du fond entre en vibration et chacune de ces vibrations influence le stylet au point de lui faire exécuter un mouvement plus ou moins rapide de va-et-vient. Chaque fois que le stylet est lancé en avant, il laisse sur la feuille d'étain une trace, une légère dépression. Si le cylindre restait immobile, le stylet frapperait toujours à la même place, accentuerait la dépression, et aucun résultat ne serait produit. Mais si, au moyen de la manivelle, on imprime au cylindre un mouvement lent de rotation, les dépressions produites par le stylet se trouvent, formant suivant les sons et, par suite, les mots des lignes, des séries de dépressions différentes les unes des autres. La phrase étant terminée, le stylet est soulevé, le cylindre ramené à sa position première, puis le stylet presse de nouveau par sa pointe sur la plaque. Si, alors on imprime de nouveau au cylindre un mouvement de rotation égal comme vitesse au mouvement précédent la pointe du stylet repasse par les traces qu'elle a laissées, elle est donc alternativement soulevée et rendue libre; son mouvement se communique à la plaque vibrante qui produit des vibrations, lesquelles se trouvent répéter les vibrations, par suite les sons et les mots qui tout à l'heure l'actionnaient.

Cette répétition des vibrations produit donc, en fin de compte, la répétition des phrases, et rien n'est plus curieux, en effet, que d'entendre la voix de crécelle vous répéter les mots que vous avez prononcés dans le cylindre porte-voix.

Jusqu'à ces derniers temps, le phonographe était un appareil trop coûteux pour la plupart des physiciens amateurs, mais aujourd'hui un ingénieur, M. Pech de Cutel, a réduit à 25 francs le prix du phonographe d'Edison, et cela sans en supprimer aucun organe, sans négliger en rien les soins de fabrication. Ceux de nos lecteurs qui nous ont témoigné le désir de posséder le phonographe le trouveront dans nos bureaux au prix indiqué plus haut.

P. L.

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New York City.

The Deaf Hear.

Mr. Editor: I have just read Mr. Jos. R. Freeman's communication on "The Teeth and Organs of Hearing", published in this week's issue of THE ADVANCE. Mr. Freeman copies from a lecture by Dr. Wooder, of Boston, in which "the teeth", says the doctor, "have the faculty, in common with bodies of bone, of receiving and transmitting the vibrations of sound. The deaf can hear by means of their teeth being connected by a rod of glass or hollow wood to a musical instrument, the piano, for instance."

The deaf mute adam
aug 30 1879

The above is a fact, as I have long been accustomed to *listening* to musical instruments, especially the piano and organ, by a stick or wire (wire is better than a stick), and more often by putting my teeth on the edge or corner of the instrument. By these means I have been able to hear, not many sounds, but the real music in all its force and beauty, even down to the softest or softest sound, even as well as those who do not deaf at all! And as I am by nature fond of music, I am thrilled to a rapturous delight, far beyond what is commonly enjoyed, perhaps because I hear it only once in a long while. The last time I listened thus to an organ, I was sadly affected, almost to tears, because my deaf and dumb wife and I were not able to enjoy such delightful things in common with other folks. I arose and left in haste, my friend who played, for me stopping me, saying, "what's your hurry?" I told her that the music caused me to feel keenly the loss of my hearing. She seemed affected at the idea. I so keenly felt my misfortune, and seemed to realize then and there, as she never had before, notwithstanding her long acquaintance with us and other mutes, of some eighteen years, how sad it was to be deaf.

The blind and the cripples are easily detected by external means, manners and appearances, and the public are constantly reminded of their misfortune, and by this repeated reminding give much aid, also thought to their condition, such, day. But not so with the deaf and dumb, whose misfortune is entirely hid from sight; we may pass one thus afflicted a thousand times, and not know that he or she was deaf and dumb. And even when people discover them by a chance sign, or their not replying to questions and remarks when spoken to, they appear so cheerful, and show no unsightly contortions of the body or face, that people's sympathies are not so fully aroused as they are by the blind and crippled, and hence give little heed to them, little aware that many of those who are deaf and dumb have no hard a road to travel, as to a living, as other unfortunate people, and ten times less enjoyment of life in the way of friendly voices and sweet sounds, &c. Please excuse this little digression and dilating in behalf of the deaf and dumb.

Mr. F. quotes from *The New-York Post* to show that this idea of hearing by or through the teeth was known as far back as 1875. It was original with me, and an experimental discovery, so far back that I have forgotten the exact date, but think it was when I was between fifteen and twenty years old—some thirty-five years ago—between 1836 and 1850. Ever since then I have known more or less what instrumental music is, and have enjoyed it occasionally, or whenever I had a chance to listen (?) to such through my teeth, and it was by this means that I learned what very soft, low sounds are. Becoming deaf at three years of age, I have no recollection of such sounds, &c., by the ordinary hearing. Here let me digress again to say that if Mr. E. P. Needham, of 143-7 east 23rd street, New York City, will improve his mechanical musical cabinet (a reed instrument, as arranged that deaf people can play it as well as any one else), so as to attach a wire or hollow glass rod to it, and hold the same between

"the teeth while sitting in any easy position, playing the cabinet, it might induce deaf people to become his customers, as half is the best cure I have yet seen that deaf people can play to perfection, but not to hear or enjoy it for want of this suggested improvement.

The great electrician and inventor, Prof. Thos. A. Edison, of Menlo Park, New Jersey, has been and still is, as I understand, working to invent an instrument for deaf people, he being deaf (?) himself. His aim is to find how to collect a great volume of sound, or concentrate it so that deaf people can hear it, equal to, or almost as well as, those not deaf. My own experiment in the matter of a greater volume of sound is a failure. It is not always the loudness that is wanted, as it too often confuses, but the ability to distinguish between the different sounds, which I have only been able to do by the *teeth*. But as the wire does not affect the listening (?) wire as a musical organ, the idea strikes me that if Prof. Edison will connect a wire or something with his "sound-collector" that can be held between the teeth, he will then have what he has long sought after, the connecting or distinguishing link—the link between the living voice and the deaf ear. Yours, &c.,

P. A. EMERY.

Chicago, Ill., Aug. 10, 1879.

P. S.—There seems to be quite an increase of deafness among grown people, and an increase of some 23 per cent. of deaf and dumb among children, of late years. Years ago it was one in every 2,000, and then increased to one in every 1,500, but now it is more like one in every 1,200, contradicting the idea that deaf-mutes would decrease as people advanced in intelligence and the multiplied art. Out of the 25,000 or 30,000 deaf-mutes in the United States, I suppose a good 'sixth telephone' would be of use to ten per cent. of them—3,000 to and 90 per cent. of the semi-mutes.

P. A. E.

Aus Stadt und Land.

Mannheimer Unterhaltungs Blatt

Mannheim, 24. September.

—g. Im großen Saale der Kasino-Gesellschaft hatten sich, auf Einladung ihres Vorstandes, die Mitglieder gestern Abend zahlreich eingefunden, um sich belehren zu lassen über Konstruktion und Leistung des vielbesprochenen Edison'schen Phonographen. Herr Sprenger aus New-York, welcher den Apparat vorführte, gab vorher in kurzen Zügen ein Lebensbild von Edison, dem merkwürdigen Manne unseres Jahrhunderts, der, ohne Schulbildung, vom einfachen Setzerlehrling, durch rastloses Denken und Schaffen bis zum Professor der Physik, zum Erfinder par excellence auf diesem Gebiete, sich aufgeschwungen und einen Weltruf erlangt hat. Der Phonograph (Tonschreiber), ebenso einfach in seiner Konstruktion, als in seiner Behandlung, fixirt auf rein mechanischem Wege den Ton der menschlichen Stimme geradeso, wie den eines Musikinstrumentes und gibt denselben in ganz beliebiger Zeit, in seinen verschiedenen Klangfarben, zum größten Erstaunen der Zuhörer zurück! Der Apparat hat sehr gut gearbeitet; er hat gesprochen, gesungen und Trompetenstückchen zurückgegeben, wobei allerdings zur Verstärkung des Tones der Schalltrichter Anwendung findet. Welchen praktischen Werth diese wunderbare Erfindung für die Zukunft haben wird, das läßt sich heute noch nicht voraussehen; vielleicht gestattet sie recht bald geistreiche und andere Reden auf Flaschen abzuziehen, um sie nach Jahren — vielleicht zum Schrecken manchen Volksvertreters — wieder zu Gehör zu bringen! Wie wir vernehmen, wird Herr Sprenger nächsten Donnerstag ebenfalls im großen Kasino-Saale, seinen Apparat nochmals in Thätigkeit setzen, wozu Jedermann Zutritt hat und empfehlen wir dringend diese Gelegenheit nicht zu versäumen mit dieser merkwürdigen Erfindung sich bekannt zu machen.

THE TRADE IN PHONOGRAPHS.

World 2/9/5 1879

A DULL OUTLOOK FOR AN INSTRUMENT WHICH ONCE ASTONISHED THE WORLD.

Passing through Wooster street, near Spring street, yesterday a reporter heard a sound which was a cross between the tuning of pianos in a pianoforte factory and the buzzing of a circular saw in a saw-mill. Looking about him he saw at the head of an alley-way a sign on which was printed in gilt letters the words "Edison's Speaking Phonograph Company." Reflecting that it was now more than a year since Edison had said he intended to revolutionize the world by means of his speaking phonograph and that he had prepared a programme for its use part of which was that novels and music were to be printed within the limits of a square foot, that the phonograph was to be used in counting-houses, banks and other places of business in place of a correspondent, the tin-foil on the phonograph, to which a letter was dictated, being mailed instead of the commercial note and reproducing not only the words but the emphatic parts of a letter, which could not be represented by any amount of underlining—having all these points in view the reporter hastened up the alley-way and entered a building which evidently had been constructed only a short time. On the first floor a number of men were doing something to something in plaster, apparently not models of phonographs. On the floor above were many phonographs, complete and incomplete, on shelves and on work benches, all copies of that original by means of which Edison made the world familiar with "Mary's Little Lamb" (recited) and "Yankee Doodle" (whistled). A dozen workmen of various nationalities were busy about the place, and a polite young man sat at a desk.

"How are phonographs quoted now?" asked the reporter briskly.

"Well, I dunno," said the polite young man cautiously.

"Much doing in that line?"

"Well, we turn 'em out as fast as we have the demand for 'em," was still the cautious answer.

"And how fast is that?"

"Well, eight to fifteen a month."

"Are they sold outright or rented out on royalties?"

"They're all sold now; although they used to rent them."

"And who buys them?"

"Oh, people buy them just for exhibition purposes."

"What do phonographs sell for?"

"A good one sells for $100; but we make them of all prices. Now, there are some on that shelf" (pointing to a kind of toy-phonograph) "that we've been selling for $15; but I think after awhile the price will come down to $10."

"Is $100 the highest price asked for a phonograph?"

"Oh, no; we make them as high as $250. The Emperor William bought one of that kind. So did Dom Pedro. Expense was no object to them."

"Have any improvements been made in the phonograph recently?"

"Not specially. The instruments we make now are shorter than the original pattern. They are only six inches long, but what they lose in length they gain in the fineness of the thread. The newest phonographs are made with forty-two threads to the inch. Still, we have one with twenty-six threads to the inch which works better than any other phonograph I ever saw. Those with the finest threads are the most expensive, but men of money don't mind that. The instruments will run for seven minutes, and in that time, you know, several letters can be dictated."

"Has Edison ever finished the phonograph which was to have a disk capable of containing an entire sensational novel instead of a phonograph with a cylinder such as these you are making now?"

"No, I think he's abandoned that idea."

"Don't you make phonographs that will run by means of clock-work?"

"No. It was found that clock-work would not be strong enough to keep the instruments going regularly. The mechanical details of the instrument are perfect, but it must be run by hand or steam."

"What are the principal improvements made in the phonograph since it was invented?"

"The fineness of the threads, the diaphragm of the mouth-piece, which is now made of mica instead of metal, and the needle or point, which is now made of steel instead of agate, and which has a chisel edge. Mr. Johnson, the manager of the phonograph company, intended to carry out some further improvements, but he is in England introducing Edison's chemical telephone or electro-motograph. I don't believe the phonograph will ever be much further improved."

"Have any offers been made for it as a property?"

"Oh, yes. There was one man who offered $200,000 or $250,000 for the patent right to the phonograph. He wanted to use it as an advertising medium."

"In what way?"

"Well, he could put one [illegible] side of a store door and it would call out, [illegible] lead-ing articles!' or 'Chromos given [illegible] with every package of tea,' or 'A five-dollar [illegible] given away with forty dollar's worth of tea,' [illegible] something of that kind. And of course people would be [illegible] of the thing [illegible] would [illegible] the company [illegible] the [illegible]

Dr Ad. Nicolas.

La Correspondance Scientifique

LA SCIENCE POUR TOUS

Un nouveau phonographe

Tel le phonographe Edison a été présenté l'année dernière, tel il est encore aujourd'hui.

Cet appareil laissait cependant de très intéressantes questions à résoudre.

1° La durée de l'enregistrement du son sur l'appareil est proportionnelle à la grandeur du cylindre.

2° La nécessité d'enlever le papier fixé sur le cylindre ne permettait pas la conservation de la parole.

3° Le papier d'étain qui reçoit les impressions sonores ne peut, à cause de sa malléabilité, reproduire le son qu'un nombre de fois très restreint.

Un jeune professeur de l'Association philotechnique, M. Gustave Gamard, a résolu ces problèmes et nous sommes heureux d'être les premiers à en informer nos lecteurs.

Modifiant complètement la forme du phonographe américain, M. Gamard a eu l'heureuse idée de transformer le mouvement « curviligne » en mouvement « rectiligne ».

Son appareil se compose d'un plateau horizontal sur lequel peut se placer une série de chariots, auxquels on donne un mouvement, au moyen d'une crémaillère fixée à leur partie inférieure et s'adaptant instantanément à une roue dentée munie d'une manivelle.

Au centre de chacun de ces chariots se place à volonté une petite règle de cuivre avec laquelle on fixe d'une manière permanente, si on le désire, une légère feuille de cuivre ou d'argent.

Au-dessus de ce système repose la plaque vibrante munie de son aiguille.

Les choses étant ainsi disposées, si l'on vient à parler dans ce nouveau phonographe en mettant le premier chariot en marche, le son se grave profondément sur la feuille métallique. Il suffit de faire succéder un nombre de chariots suffisant pour obtenir la reproduction intégrale d'un discours.

En ce qui concerne la deuxième difficulté, M. Gamard la résout également, puisque les règles mobiles sur lesquelles se trouvent fixées les feuilles métalliques peuvent se détacher des chariots qui les supportent. Pour leur faire reproduire les sons qu'elles ont enregistrés, il suffit de les remplacer dans l'appareil.

Enfin le troisième inconvénient se trouve supprimé par la substitution de feuilles de cuivre ou même d'argent au papier

Numéro 1.

PRICE NEWS COMPANY

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La Caricature

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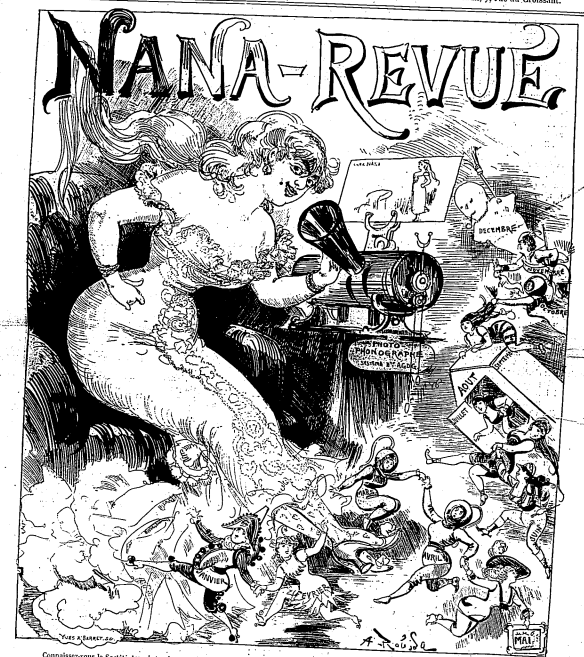

Connaissez-vous la Société des *photo-phonographes pour renseignées naturalistes* ? C'est une société très anonyme qui se charge de déposer secrètement des photo-phonographes chez les particuliers : ces instruments indiscrets recueillent tout ce qui se dit, photographient tout ce qui se fait et le reportent aux romanciers naturalistes. Dans une soirée chez M. Emile Zola, le MAITRE a daigné faire fonctionner devant nous ses phonographes de 1879. La manivelle était tournée par les mains de la célèbre NANA, dont nous sommes heureux de donner, les premiers, le portrait ressemblant.

Attention ! les phonographes d.: M. Zola vont parler.

LA FAVORITE DU VIDANGEUR — après ménagerie de singes pensionnaires

CORRESPONDENCE.

Electrician — Sept 25 1880

TELEPHONY AND TARGETS.

TO THE EDITOR OF THE ELECTRICIAN. 19

SIR: It has occurred to me that the telephone might be used to obviate the possibility of a "Wimbledon scandal," and to avoid those accidents which happen, although rarely, to markers.

The thud or "clack," as it is called, of the bullet against the target is of a different pitch according to the distance it strikes from the centre. A telephone in circuit would enable a person to distinguish this distance with a little practice.* A committee could thus record the scores, or a phonograph could record the sound and reproduce it at any time.

W. H. A.

Miscellanies.

MODERN INVENTIONS.

19

By PAUL CARSON.

A CLATTER of brass, a flash of light,
A telegram speeds through the silent night.
Nobody sees the electric spring,
Or hears the rush of its fiery wing:
But lives are shadowed with grief and pain
When the message is caught from the wire again.

Scarce a moment's delay, the electric fire
Flashes again o'er the quivering wire;
Clatters the brass, speeds the lightning spark,
Another message leaps out of the dark,
And lives are brightened, and hearts are glad,
That a moment before were dark and sad.

'Tis a marvellous age when the words of man
In a moment of time the world can span.
But, accustomed to wonders, the present age
Demands for its rightful heritage,
The works which the brain of the past has wrought
By ceaseless labor and tireless thought.

And the voice of the present, unsatisfied, cries
For something that's new 'neath the sun and skies.
Obeying its summons, the telephone
Comes forth with a muffled "*Hello!*" groan;
While the speech of to-day, both its wheat and chaff,
For to-morrow is stored in the phonograph.

SCIENTIFIC PROGRESS.

19

Practical Value of Science.

Our obligations to the branch of physics are almost unlimited, but we will mention only two or three applications of a single agent in this wide field. It would seem to roll back the world into the dark ages to take from it now the benefits of electricity in its multiplied and yet rapidly multiplying applications.

It seems incredible, from our present standpoint, that so short time ago, in our congressional halls, the electric telegraph was almost ridiculed and voted into oblivion, from which it could never rise. When a bill was presented, appropriating $30,000 to be expended, under the direction of the Postmaster-General, in a series of experiments to test the merits of Morse's electro-magnetic telegraph, one member moved an amendment requiring half the appropriation to be used for the encouragement of mesmerism. Another proposed to include Millerism in the benefits of the appropriation; others to appropriate part of the sum to a telegraph to the moon. And when the bill came to a final vote, this was so close that a change of three votes would doubtless have left us till this day without the benefits of the telegraph. After his invention was in working order, and transmitting messages between Baltimore and Washington, Mr. Morse offered it to Congress, to be attached to the Postoffice Department, for the sum of $100,000, but it was declined, on the statement of the Postmaster-General, who reported that, while the invention was "an agent vastly superior to any other ever devised by the genius of man," he was not satisfied that "under any rate of postage that could be adopted its revenue could be made to equal its expenditures." By this short-sighted want of appreciation of science, the United States Government deprived itself of a source of revenue sufficient, doubtless, to liquidate the entire national debt in a single decade.

The application of electricity, now attracting world-wide attention, enjoys a vastly more hearty reception than did the telegraph. The *telephone* is constructed on the principle of the human ear. It consists of an elastic diaphragm to receive vibrations of air from the human voice or from other sources, so connected with the wires of a battery (or even with wires without a battery) as to communicate the same vibrations in every respect to another membrane or diaphragm situated at a distance. The two diaphragms of a telephone in distant places correspond, in every practical sense, to the two membranes of the human ear, and the connecting wire to the chain of bones between the two membranes. Probably no invention has come more rapidly into popular favor. Already many thousands of them are in practical use in this country and abroad.

The speaking phonograph is also copied from the human ear. The vibrating diaphragm, in this case, has a stylus connected with it, which impresses the peculiarities of vibration, due to any particular sound, upon a roll of tin foil arranged to receive the impression. By reversing the process, the indentations and prominences of the tin foil cause the stylus to fall and rise, which results in vibrations of the membrane, and these reproduce the original sound. These impressed sheets of tin foil may be preserved or mailed to any part of the world, and by putting them into a similar instrument, may be made to reproduce the pitch, tone and quality of the original sound thousands of miles, or of years distant. By this instrument, voice may be phonographed, as the face is photographed, and we may listen to the veritable voice of the dead, or preserve for future comparison the voice of a person from the first infant prattle and the manly utterances of mature life even to the feeble speech of old age. Public speeches and songs may thus be preserved and delivered indefinitely or till the tin foil wears out. In public libraries may be preserved languages of different nationalities spoken from century to century "with all the peculiarities of pronunciation, dialect and brogue."—*Prof. Trowbridge in The Advance.*

Nov 6 1880

... the peculiarities in the motion of the particles of air that belong to sounds of different quality? It has been discovered by Helmholtz that differences of quality are due to differences of shape of vibration; that a vowel sound, for instance, is a chord of several notes differing in their pitch and intensity. In fact, for every different sound there is a different form of vibration.

Prof. Bell then illustrated the curves which various vowel sounds produced, the curves being exhibited by means of the magic lantern. Prof. Bell's experiments began by the construction of an artificial ear. The vibrations which different sounds caused in this ear were communicated to a straw attached to it. Beneath the other end of the straw a blackened strip of paper was moved at an equal rate, and the point of the straw marked the vibrations in the blackened surface. In successive pictures the apparatus—*i. e.*, the artificial ear with the straw and the moving paper beneath, and the various curves produced by different sounds—were successively shown. Each vowel produced its own characteristic curves. The proper curves of each of the English vowel sounds were shown, and also of certain Polish and Hungarian vowels. Prof. Bell continued:

You will therefore understand from the experiments that different qualities of sound are produced by different shapes of the vibration. Now if we want to produce sound by electricity, the problem before us is to move the air after the electricity is transmitted in the same way that it was moved by the human voice when the transmission was started. In my remarks this evening it is not so much to show you my own researches regarding the transmission of sounds, but to lay the foundation for that by showing what experiments have been made before.

All previous experiments have aimed, not at the production of articulate speech, but at the production of musical tone. The vibration for the musical tone is much less intricate than for the human speech. The first person who discovered that sound could be produced by means of electricity was the late Prof. Page of Salem, Mass., who discovered a very curious fact in the year 1837. He was experimenting with a permanent magnet; around the two poles he had insulated wire, and he was struck by the fact that when he passed a current of electricity through this helix of wire a sound was produced, and when the current stopped there was also a sound. He published this in *Silliman's Journal* in 1837. The sounds produced were similar to explosions, and he reasoned that if he were to pass a current of electricity and stop it very quickly, and do this frequently, he would have a succession of these explosive sounds, and if he were to make these very rapid they would produce a musical tone. His experiments proved that a tone of recognizable musical pitch could be produced from the bar of iron by simply transmitting and interrupting the electricity passing around the coil of wire.

The experiments of Prof. Page were repeated and amplified by Prof. de la Rive of France. An instrument of the class to which the early telephones belong is called a rheotome; it makes and breaks the circuit. Descriptions were given and diagrams shown of the telephones of other inventors; those of Reiss, Legatt, Helmholtz, Latour of Copenhagen, and Elisha Gray of Chicago were successively exhibited on the screen, and their peculiarities explained. To each of the inventors in this field of research Prof. Bell wished to give the full honors that are their due. For himself he claimed the discovery of an instrument that was the same for all pitches and varieties of sound; the same at the receiving as at the sending station, and that required no battery.

The experiments shown by Prof. Bell did not essentially differ from those at the private exhibition, except in having a more distant connection, and in transmitting music from an organ of peculiar construction. The reeds of the organ were blown by wind—set in motion by wind—at New-Brunswick, 32 miles away. It was the organ with which Prof. Bell had carried on experiments in his laboratory. The experiments in which musical sounds were transmitted were made with a battery current of electricity. The current was made and broken by the vibration of the reeds. Above each reed there is a metal screw, and as the reed is put in motion it strikes against this metal screw and thus communicates the electric current. The music from this organ was the best that has been given as yet in this city by telephone, so far as evenness of tone is concerned, but the sound was not very loud, because, as was explained, the loudest instruments were not at hand, having been delayed in an express office. The singing was somewhat feeble, although different notes were at times distinctly audible. Mr. Cyrus W. Field, being invited to converse with the operator in New-Brunswick, soon became accustomed to the process, and tested the transmission in a variety of ways, among others asking what time it was there, to which the answer came back promptly, "24 minutes before 10." After the lecture, the most of the audience took the opportunity to come upon the stage and listen to the telephone, one message after another being transmitted to their ears, successively placed at the instrument.

... on purpose for the floats. We are making the sheets into three sizes—one for letters of from 800 to 1,000 words, another size for 2,000 words, another size for 4,000 words. I expect that an arrangement may be made with the post office authorities enabling the phonogram boxes to be sent at the same rate as a letter.

LISTENING TO THE MESSAGE.

"The receiver of a phonogram will put it into his apparatus and the message will be given out more clearly, more distinctly than the best telephone message ever sent. The tones of the voice in the two phonographs which I have finished are so perfectly rendered that one can distinguish between twenty different persons, each one of whom has said a few words. One tremendous advantage is that the letter may be repeated a thousand times if necessary. The phonogram does not wear out by use; moreover, it may be filed away for a hundred years and be ready the instant it is needed. If a man dictates his will to the phonograph there will be no disputing the authenticity of the document with those who knew the tones of his voice in life. The cost of making the phonogram will be scarcely more than the cost of ordinary letter paper. The machine will read out the letter or message at the same speed with which it was dictated.

"I have experimented with a device for enabling printers to set type directly from the dictation of the phonograph and think that it will work to a charm. It is so arranged that the printer by touching a lever with his foot allows five or ten words of the phonogram to be sounded. If he is not satisfied with the first hearing he can make it repeat the same words over and over again until he has them in type. For busy men who dictate a great deal for the press I am sure that the phonograph will be a necessity after a very little experience.

TAKING DOWN AN OPERA.

"For musicians the phonograph is going to do wonders, owing to the extreme cheapness with which I can duplicate phonograms and the delicacy with which the apparatus gives out all musical sounds. In the early phonograph of ten years ago, which was a very imperfect and crude affair compared to that of to-day, it was always noticed that musical sounds came out peculiarly well; the machine would whistle or sing far better than it would talk. This peculiarity of the phonograph remains. I have taken down the music of an orchestra, and the result is marvelous; each instrument can be perfectly distinguished, the strings are perfectly distinct, the violins from the cellos, the wind instruments and the wood are perfectly heard and even in the notes of a violin the over-tones are distinct to a delicate ear. It is going to work wonders for the benefit of music lovers. A piece for any instrument, for the piano or for an orchestra, or an act, or the whole of an opera, musical instruments and voices can be given out by the phonograph with a beauty of tone and a distinctness past belief, and the duplicating apparatus for phonograms is so cheap an affair that the price of music for the phonograph will be scarcely worth considering. As the phonogram will be practically indestructible by ordinary use such music can be played over and over again.

AN ELECTRIC MOTOR.

"My first phonograph, as you remember, consisted simply of a roller carrying the foil and provided with a diaphragm-point properly arranged to scrape or indent the foil. The roller was turned by hand. In the new instrument there is far more complication, but altogether different results. My propelling machinery consists of a small electric ...

San Jose Herald, Cal. Oct. 18th 1887.

A GREAT INVENTION.

The phonograph, Edison's latest invention, is likely to become a great convenience. It is asserted that by the mechanical reversal of the paper ribbon beneath the index, the instrument will reproduce any sound made within its hearing, so to speak, with great distinctness and with the most absolute accuracy. All that will therefore be necessary will be to place any number of these instruments in a church or theater or a concert-hall, and the sermon, the play or the singing can be reproduced at any time in any place. Thus the man who likes to listen to the eloquence of his favorite preacher, can simply send his phonograph to church, while he himself goes to a picnic, or on a fishing excursion, and sit down in the evening in his armchair and quietly unwind the sermon, to the great edification of himself and his family. And those who are fond of the drama, but dislike the trouble of going to the theater and fighting for seats, can place their phonographs behind the wings and take them home at any time and enjoy the play. So with the lovers of music. The phonograph will repeat the sweetest notes of the sweetest singers, and they can be enjoyed without any of the disturbing influences of an unsympathetic audience.

Of course, this wonderful invention will not be without its disadvantages. Supposing, for instance, that the old man has concealed his phonograph under the sofa in the parlor on the evening when his daughter's lover pays his regular visit, and the awful instrument should be made to repeat all the sweet nothings which passed between the pair. What consternation it would cause the next morning at the breakfast table! And how would a breach-of-promise suit be dodged when the young man's words, and even his precise tones can be reproduced in court with the most absolute fidelity? Again, just suppose that the newspapers had their phonographs hidden under the clerk's desk during one of the secret meetings of the Council, and should publish all that was said the next morning. What excuses or explanations could be given of the speeches that absolutely contradicted all the promises and pledges made during the day before the meeting? Why one such publication would be sufficient to break up life-long friendships, sunder all party ties, and ruin the fairest reputations.

It is really awful to contemplate, and we think Congress should pass a law to prevent the reckless inventor from inflicting such miseries upon the human race. And if Congress will not act, then the State Legislature should take measures to protect the people of California at least from such a disaster. And, failing the Legislature, we must fall back upon the City Council—they could surely prevent its introduction in San Jose. Something must be done by somebody, and we call upon the City Council as the nearest legislative body to take action at once.

San Francisco Bulletin
Oct. 19, 87.

MODERN WONDERS.

The phonograph catches the tones of the voice, stores them up and restores them at the will of the operator. The voice that comes back is that of the telephone. In some cases its individuality can be recognized. In a sense this is a realization of the story of the horn of "Baron Munchausen's" postillion. What practical value is in it remains to be proved. Le Noir invented a method of sending handwriting by telegraph, but for obvious reasons it has not entered much into the activities of modern life. The man who wants to use the phonograph must talk into it. This is something that cannot be done by the orator addressing a public meeting or a legislative assembly; by a lawyer addressing the Court or jury, or by a judge delivering his charge or his decision in the case at bar.

But there can be a man beside any of these persons with a phonograph, who can repeat his words into the instrument which can be carried to another apartment and delivered of its contents. If the words from the phonograph could be unwound so as to speak, at any desired rate, so as to suit the capacity of the copyist or the type-writer, the phonographer, for the most part, will have to go. He will in a short time become as much out of date as the stage-coach driver or the maker of silhouettes. But if the sounds have to issue from the phonograph at the rate at which they were originally delivered, the phonographer will still hold his place. The only difference will be that he will be forced into another position in the chain of operations by which sounds uttered in public are reproduced on paper without the assistance of the speaker.

It is claimed, however, that the words stored in the instrument can be taken off at any rate that may be desired. That will be the true test of the invention. The fastest copyist cannot write legibly more than fifty or sixty words a minute. Eighty or ninety words a minute can be written by the type-writer. Short-hand writers in good training can write from 175 to 200 words a minute. Many have been known to have attained still greater speed. The rate at which public speakers deliver their words differs with different individuals. The larger the hall or the meeting the slower they must go. The interruptions, such as cheers or hisses, enable the shorthand writer to catch up when he has a too rapid speaker to follow. The rate of public speaking may be said to run from Daniel Webster, who usually spoke only ninety words a minute and could nearly be followed by a long-hand writer, to 250 and 300 words a minute and even beyond. Speakers of what may be called the highest velocity could not be followed even by a steam engine. They can only be reported by dropping their adjectives and other redundances. They are usually the men with a sharp nasal intonation.

It follows, as already stated, that the great value of the phonograph will depend on the ability to take off its words at any rate that may be desired. If so, not only will all public speaking be taken hereafter by the phonograph, but the merchant or business man will have nothing to do when he opens his correspondence in the morning but to communicate his replies to the instrument, which he can then hand over to his typewriter, and all that will be needed to perfect his work will be to attach his signature to the different letters. More than that, the poet or the editorial writer, when the divine afflatus is upon him, can repair to his machine, confide to it, even in the midnight hours, what he considers to be his burning thoughts, and hand it over next day to the type-writer to be converted into decent "copy." If the phonographer must go, it must be said that the curtain is about to be rung down upon a useful and laborious person. The excessively masterful individual known as Julius Cæsar is said by some to have been the first of the tribe. Modern shorthand writing is done by a combination of curves and lines, which can be thrown together much more speedily than the old cumbersome method of writing. Julius Cæsar, it is said, depended upon abbreviations.

The perfect phonographer mentally sees the combination which forms the word and places it on paper with the speed of thought. He has demonstrated the curious psychological fact that the human mind is capable of two distinct operations at the same time. It is not unusual for the phonographer, when the speaker is not pressing him too severely, to be thinking of something else, while he is recording the words of the latter. Men of the newspaper profession have been known to lay the ground-work of a future editorial, while their pencils were flying over the paper, moved practically by the voice of another man. This double action of the mind has been the subject of a great deal of discussion among the psychologists. The cases recorded of it are supposed to have been, in a sense, abnormal. But the short-hand writer has demonstrated that it can be acquired. A more difficult operation still is to report instantaneously in long-hand a speech not by words, but ideas, for that involves the reduction of a certain train of thought to writing, while note is being mentally made of the new propositions which are following.

But after all, perhaps the phonograph, if practical, should not be considered more wonderful than the photograph. The latter seizes and fixes the waves of light—the former the waves of sound. Nothing was more difficult to the uninitiated when Daguerre's great invention was made public, than to imagine how a likeness could be taken by putting a plate in a box, though a look into a neighboring mirror would have measurably explained the whole operation.

N. Y. Press, Oct. 21st 87.

MR. EDISON'S IMPROVED [illegible]OGRAPH.

THE announcements made of late as to Mr. Edison's promised [illegible] improved phonograph are nothing [illegible] extraordinary. In an interview with the [illegible] printed elsewhere in our columns to-day, it will be seen that he claims to have perfected an instrument which will, at small expense, record the sound of the human voice, or any other sound, for that matter, and will reproduce it in miniature with a perfection which leaves nothing to be desired. The principle of the new phonograph is virtually that of Mr. Edison's invention of some ten years ago—a vibrating diaphragm armed with a short point indents a moving sheet of metal according to the vibrations caused in the diaphragm by the wave sounds which strike upon it. The first phonograph, while regarded as nothing more than a toy, was conceded by every one to contain the germ of great wonders should it ever become so perfected as to reproduce words in an intelligible and certain fashion. The trouble with it was that its operation required great expertness, and the results were frequently merely caricatures of the original sounds which it attempted to reproduce. All the defects which caused the early phonograph to be relegated to the laboratory shelves as a mere curiosity, Mr. Edison says he has now overcome.

For commercial purposes his phonograph, he says, will allow the hurried business man to dictate his correspondence without the aid of stenographer or type-writer; he will simply talk quietly into the machine, and when the letter is finished he will have a sheet which can be sent by mail, and which, when placed in a similar apparatus, will reproduce the original sounds, as Mr. Edison expresses it, "far more distinctly, and with far more of the characteristic accent of the voice than the telephone ever does." The chief improvements effected, according to Mr. Edison, seem to consist in improving the distinctness of enunciation or reproduction at the expense of volume of sound. The old phonograph enabled whistling or singing to be heard in all parts of a large room; the perfected instrument necessitates the use of an ear-phone similar to that used for the telephone, but gives out a sound somewhat larger in volume than that of the best telephones.

If it turns out that the Edison phonograph does half what is promised, it requires no great stretch of imagination to foresee most wonderful things for it. As the reproducing apparatus can be made to work slow or fast at will, the printer at his case may listen to the phonograph and set up his type accordingly. The invalid or the lazy person may at a trifling cost hear all the great lecturers of the world without leaving his arm-chair, by touching a spring which sets the phonograph in motion and providing it with the proper roll of tin foil. The business of the professional reader will be gone. The cost of duplicating the sheets of foil, or other material upon which sounds have been imprinted, is said to be so trifling that whole books will cost, as "phonograms," less than they do now in print, and will occupy far less space. In the old phonograph the frequent passage of the foil under the reproducing part of the apparatus caused a gradual obliteration of the indentations and a consequent loss of clearness in the enunciation of the instrument. This defect is said to be overcome, and the same message or letter or book may be repeated thousands of times without any deterioration. If books can be repeated upon the phonograph, why not newspapers? The field of speculation is endless.

With regard to music there seems to be no doubt that the new phonograph will achieve much that is promised for it, for in the very earliest of Mr. Edison's devices of this kind, the clearness of musical sounds, or singing, compared with spoken words as reproduced by the phonograph, was very noticeable. Songs could be understood, word by word, when spoken messages were unintelligible. From the experiments made with the two instruments already finished, it has been found that the phonograph is incomparably superior to the telephone in its interpretation of the music of any kind—singing, the pianoforte, the violin, or the complex sounds of a whole orchestra. The different instruments in a small orchestra can be perfectly distinguished, and the difference of tone is so minutely rendered that one can tell which of two pianos of different makes was used for playing a piece of music reproduced in the phonograph. The cheapness with which reproductions of the phonograph foil may be made will, it is said, make a whole opera, thus given in miniature, orchestra and voices, cost less than the most worthless piece of sheet music does now. As the phonograph will reproduce whatever it hears, the playing of a Rubinstein or a Joachim or the singing of a Patti may possibly be heard with pleasure for centuries to come. In fact, as we have already said, the more one thinks of the possibilities of a perfected phonograph, such as Mr. Edison now soberly tells us that he has devised, the more bewildering the outlook becomes.

York Dispatch, Pa
Oct. 22, 87.

TELEPHONE NOWHERE.

EDISON'S PHONOGRAPH A MARVEL OF THE AGE.

A Machine That Will Work a Revolution—To be Ready by the End of January—What is Expected of It, Etc., Etc.

Thomas A. Edison has at last perfected his wonderful invention of the Phonograph, which promises to be more wonderful and startling than the telephone.

Mr. Edison has been talking to a reporter of the New York *Evening Post* and has been telling some marvelous tales about his perfected phonograph. Hear him:

THE WONDERFUL PHONOGRAPH.

"You know that I finished the first phonograph more than ten years ago. It remained more or less of a toy. The germ of something wonderful was perfectly distinct, but I tried the impossible with it and when the electric light business assumed commercial importance I threw everything overboard for that. Nevertheless the phonograph has been more or less constantly in my mind ever since. When resting from prolonged work upon the light my brain would revert almost automatically to the old idea. Since the light has been finished I have taken up the phonograph and after eight months of steady work have made it a commercial invention.

"My phonograph I expect to see in every business office. The first five hundred will, I hope, be ready for distribution about the end of January. Their operation is simplicity itself, and cannot fail. The merchant or clerk who wishes to send a letter has only to set the machine in motion and to talk in his natural voice and at the usual rate of speed into the receiver. When he has finished the sheet, or 'phonogram,' as I call it, is ready for putting into a little box made on purpose for the mails. We are making the sheets into three sizes—one for letters of from 800 to 1000 words, another size for 2000 words, another size for 4000 words. I expect that an arrangement may be made with the postoffice authorities enabling the phonogram boxes to be sent at the same rate as a letter.

LISTENING TO THE MESSAGE.

"The receiver of a phonogram will put it into his apparatus and the message will be given out more clearly, more distinctly than the best telephone message ever sent. The tones of the voice in the two phonographs which I have finished are so perfectly rendered that one can distinguish between twenty different persons, each one of whom has said a few words. One tremendous advantage is that the letter may be repeated a thousand times if necessary. The phonogram does not wear out by use; moreover, it may be filed away for a hundred years and be ready the instant it is needed. If a man dictates his will to the phonograph there will be no disputing the authenticity of the document with those who knew the tones of his voice in life. The cost of making the phonogram will be scarcely more than the cost of ordinary letter paper. The machine will read out the letter or message at the same speed with which it was dictated.

"I have experimented with a device for enabling printers to set type directly from the dictation of the phonograph and think that it will work to a charm. It is so arranged that the printer by touching a lever with his foot allows five or ten words of the phonogram to be sounded. If he is not satisfied with the first hearing he can make it repeat the same words over and over again until he has them in type. For busy men who dictate a great deal for the press I say that the phonograph will be a necessity after a very little experience.

TAKING DOWN AN OPERA.

"For musicians the phonograph is going to do wonders, owing to the extreme cheapness with which I can duplicate phonograms and the delicacy with which the apparatus gives out all musical sounds. In the early phonograph of ten years ago, which was a very imperfect and crude affair compared to that of to-day, it was always noticed that musical sounds came out particularly well; the machine would whistle or sing far better than it would talk. This peculiarity of the phonograph remains. I have taken down the music of an orchestra, and the result is marvelous; each instrument can be perfectly distinguished, the strings are perfectly distinct the violins from the cellos, the wind instruments and the wood are perfectly heard and even in the notes of a violin the over-tones are distinct to a delicate ear. It is going to work wonders for the benefit of music lovers. A piece for any instrument, for the piano or for an orchestra, or an act, or the whole of an opera, musical instruments and voices can be given out by the phonograph with a beauty of tone and a distinctness past belief, and the duplicating apparatus for phonograms is so cheap an affair that the price of music for the phonograph will be scarcely worth considering. As the phonogram will be practically indestructible by ordinary use such music can be played over and over again.

AN ELECTRIC MOTOR.

"My first phonograph, as you remember, consisted simply of a roller carrying the foil and provided with a diaphragm-point properly arranged to scrape or indent the foil. The roller was turned by hand. In the new instrument there is far more complication, but altogether different results. My propeling machinery consists of a small electric motor, run by a very few cells. Strange to say, I have found more difficulty in getting a motor to suit me than any other part of the apparatus. I tried various kinds of clock-work and spring motors, but found them untrustworthy and noisy. The motors I am now making are absolutely steady and noiseless. There is no part of the apparatus, the tools for which I am now making upon a large scale here, which is likely to get out of order or to work in an uncertain manner. The two finished phonographs are practically exactly what I intend to offer for sale within a few months."

Among the things at which Mr. Edison is hard at work, taking them up in turns, are a cotton picker, a heat generator of electricity, and a new device for propelling street cars by electricity.

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Boston Times Mon.
Oct. 23rd 87.

Edison's latest triumphs with his phonograph are as marvelous as anything which has ever been received from him. So delicate and accurate is the invention that it will reproduce, he says, all the different tones of an orchestra so distinctly that the several instruments can not only be distinguished, but a trained ear can recognize the over tones in the violins. The machine has simply to be set in motion by an electric motor and talked into. Then it will reproduce all that was said to it. The fall on which the impression is received may be sent by mail any distance, or kept for any time, or used repeatedly, all without injuring it. Such an invention will be of inconceivable practical good to business men and to public speakers.

Edison is giving to mankind far more than will ever be returned to him under any patent he may ever take out. His service, though it may result in a great fortune to himself, is to mankind contrast to the lack of service rendered by men who make their fortunes by their wits, men who take advantage of corners and rattle on stocks to squeeze somebody else and get their property. They add nothing to the world's stock of goods, but Edison gives far more than a quid pro quo. His gives more than will ever be returned to him, for his good work will go into every civilized community and will go down the ages for all time.

THE NEW PHONOGRAPH.

When Mr. Edison's phonograph first made its appearance wonderful claims were predicted for it. It was, indeed, a wonderful instrument, but it has not been very useful. Now, however, Mr. Edison has substituted a new and improved phonograph which he says will really do many of the things which it was expected the old one would be good for, for speech is one of its greatest uses.

Mr. Edison sets forth some of the uses of his new phonograph in an impressive way He thinks that every business man will hereafter have one. The merchant or clerk who wishes to send a letter has only to set the machine in motion and to talk in his natural voice and at the usual rate of speed into the receiver. When he has finished the sheet, or "phonogram," as Mr. Edison calls it, is ready for posting into a little box made on purpose for the mails. He is making the sheets in three sizes—one for letters of from 800 to 1,000 words, another size for 2,000 words, and other size for 4,000 words. The receiver of a phonogram will put it into his apparatus and the message will be given out more clearly, more distinctly than the best telephone messages ever sent." The tones of the voice in the two phonographs which Mr. Edison has finished are so perfectly rendered that one can distinguish between twenty different persons, each one of whom has said a few words. One advantage is that the letter may be repeated a thousand times if necessary. The phonogram does not wear out by use; moreover, it may be filed away for a hundred years and be ready the instant it is needed. If a man dictates his will to the phonograph there will be no disputing the authenticity of the document with those who know the tones of his voice in life.

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Mr. Edison has experimented with a device for enabling printers to set type directly from the dictation of the phonograph, and thinks that it will work to a charm. It is so arranged that the printer by touching a lever with his foot allows five or ten words of the phonogram to be sounded; if he is not satisfied with the first hearing he can make it repeat the same words over and over again until he has them in type. For busy men who dictate a great deal for the press Mr. Edison is sure that the phonograph will be a necessity after a very little experience.

It remains to be seen whether these expectations are or are not realized. But there is no doubt that Mr. Edison is a very wonderful man.

Commercial News
Charleston, S. C.
Oct. 27, '87.

EDISON'S GREATEST WONDER.

HIS PERFECTED PHONOGRAPH THE LATEST MARVEL.

What the New Invention will Do—Vast Possibilities Possible Inventions to Do Away with Letter Writing and Printing—A Feast of Literature and Music for Four People—What Other Scientists Say About It.

New York, October 21.—Special: In the history of prosperity Thomas A. Edison is still the unprecedented, interesting man that he was many years ago, accessible to every one who has any legitimate business with him, intensely interested in every department of science and invention, and the possessor of more than a merry share of intelligence whether an expert in the field of invention or merely an interested observer. There is no greater contrast between Edison's personal position now and in the early days of struggle which ended with the business success of the phonograph in 1878 than the same. Edison never ceased to have interest the electric light in the broad sense of the term; he did claim to have as perfected the lamp that it passed from the laboratory to the commercial state of existence, but of course it became a world factor. The same is true of the motors in the two phonographs which Mr. Edison has finished are so perfectly rendered that one can distinguish between twenty different persons, each one of whom has said a few words. One advantage is that the letter may be repeated a thousand times if necessary. The phonogram does not wear out by use; moreover, it may be filed away for a hundred years and be ready the instant it is needed. If a man dictates his will to the phonograph there will be no disputing the authenticity of the document with those who knew the tones of his voice in life.

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While "human nature feels 'frightening' out" Dudley he still takes an active part in each of three vaudevillians, but he looks upon the whole scheme as practically finished, and his attentions are to simplify or discard.

With the extension of the Edison electric light, the question of money for the inventor himself has become a secondary one. Edison's work is a philanthropy. Probably would still spend ten hours a day in his laboratory if he had his choice. He has a large staff of skilled mechanics and other workmen in his employ, and they are with his own hands, and gaining further pleasure out of this detail work. But Edison's personal money has passed out of value to him in making possible all sorts of costly experiments in every direction of science, and pursues the study of science for experts, perhaps for months, which are of really tantalizing and interesting.

In the laboratory which Edison is now building within sight of his superb country home at Orange, New Jersey, he will realize the dream of his life. He has long been engaged in developing the ore-milling plan, such ore more than one-half of which is low grade, and putting through millions of tons of it in the most substantial manner. Edison's interest in this direction for the commercial work which the scientific mind can do for the world. In the most perfect workshop of this kind in the world. It will be limited by what the highest by electricity and modern machinery can accomplish in every possible device for the economical handling of ore, and the most effective and rapid results. In the department of materials Edison has already begun a study from which he will have experiments, every metal, every wood, that can be found in the world for experiments. He has already the mineral and vegetable kingdoms ransacked, and from the latter he thinks he has been laid under contribution, for he has tested nearly half a ton of every kind of remaining. Sitting in his large factory office, surrounded by patent attorneys, engineers, and experts in the fourth story of the great building, and looking out upon the river, one can spell through half a dozen machine shops as many more workshops, smoke permeating the air, no one visitors may not get within the inventor. Edison said in his quiet way: "I have no time for visitors. I do not see rather what will happen. I get a world-wide, every time, in short, everything that the scientific men can imagine is of possible use. As one instance of the value of the phonograph, I may say that it has been stripped from the two days in his work upon the quadruplex system of sending electricity directly from spark to spark need of a sufficient quantity of nickel; he knew that Edison was in Europe, and he sent a man during his visit to Europe to have conversation with Edison, and for him to be found in this country.

Of all wonders that Edison has devised this coming phonograph, which he claims will reproduce the human voice in such a manner that it will be impossible to distinguish the tones of the original sounds was, in the Edison phonographs which were shown in this city years ago in different parts of the world, singing, whistling, and a great many instruments, but to really distinguish the individualities of the musicians was impossible. The new phonograph, however, for the reproduction of speech, it was a phenomenal success. Under a great, intelligible result at all it was necessary to speak for some little time, close, and even then the words were often but a mere caricature of the original. The new phonograph was undertaken and carried through and was then placed upon laboratory table as a curiosity.

About 1877 the electric light began to take up all Edison's attention, and from that time until within the last year he has had but the slightest connection with the phonograph. He says himself that he became a perfect "dumb Dutchman" in the matter of knowledge of the phonograph when, not with the diligence and energy which he has since displayed, he took up the work. He has since made the phonograph more of a wonder than it was in its conception or the splendid possibilities of the instrument, and

Herald, Utica, N.Y.
Oct 25th 87

EDISON'S NEW PHONOGRAPH.

One would regard Edison's latest idea as an absurdity, if it be that he must have specimens of every kind of material that the world affords—animal, vegetable and mineral—stored away in a storehouse so that he can lay his hand on them in a moment of need. The list of minerals alone will be quite large, but he would the variety can be very great. Edison is said to be much annoyed by having to send to Japan to get bamboo for cartons, and to England for nickel, and the like; and therefore he will have all these things handy if possible.

Lately Mr. Edison has been working in his new laboratories at Llewellyn park, New Jersey, where he has three large buildings, each 100x50 feet and four stories high, in which to conduct his experiments and to manufacture his electrical and other apparatus. Edison's fame rests largely upon his telephonic, phonograph and electric light system. But these are a small part of his numerous and useful inventions.

His energies are now bent upon the practical improvement of the wonderful phonograph, which at present is only a scientific toy. This, with his electric lighting apparatus, and the new cotton picker and the steam car motor, keeps Mr. Edison so busy that his young wife begins to regard his inventive genius as a positive nuisance. Nevertheless, he is a most devoted slave of the lamp—electric lamp—and turns out about 1,000 of them per day. He says that his new commercial phonograph is so wonderful, as now perfected, that no one would believe him if he told what it would do. The former phonograph was only the germ of this. When the electric light assumed commercial importance, Edison "threw everything overboard for that," and placed its manufacture on a good and enduring basis. Which shows that Mr. Edison is not only lucky and ingenious, but shrewd as well. The new phonograph is certainly a marvel. It runs by clockwork, which is set in motion by power from a small battery, so that the motion is noiseless and steady. It records its words upon a phonogram, or card, which can be sent by mail, and is not easily damaged. This card can be used over again any number of times, as occasion requires the message or letter to be erased. All that is necessary is to run the phonogram back thro' the same or another phonograph, and the message is "talked back" as distinctly as it was spoken into the receiver. Not only is speech easily and perfectly recorded, but as was noticed to be the case in the former experiment, music is still more distinctly recorded, so that by the multiplication of the phonograms, which is easily and simply done by a copying process, the music of the finest orchestras and sweetest singers can be issued up and sent to any part of the country by mail or express, to delight the ear and soothe the wearied mind.

By a rachet attachment the machine can be made to talk a few words at a time, and the editor seated in his luxurious chair can breathe wisdom into his phonograph, while the typo with his foot on a lever can have a similar instrument on his case, and by running the phonograms or sound sheets thro' the instrument set type from it as fast as the machine will talk.

Of course there will be occasional lapses of speech in the "copy," which the intelligent compositor must learn to recognize and avoid. The annual visit of the spring poet, who interrupts a half finished editorial on the tariff question, will of necessity bully into the copy, and Mr. Edison must invent some kind of a safety shut-off which can be applied to the receiver at proper times.

For business men, the new phonograph will be invaluable. But it will make sad havoc with expert stenographers and penny typewriter girls. The kings of business and mines, instead of dictating to shorthand clerks, will merely sit still and talk all day. However, in this age of luxury, they will in many cases speak only a few sentence words, leaving the phonogram to be filled in or out by expert talkers. Here's where the women will again come to the front, and as it is universally acknowledged that they have no superiors in the art, they will, of course, be generally employed. In fact it will soon be a much larger field of labor to them, for whereas only a few women are equal to the straits of an editor's work at the typewriter, any woman could talk all day into a phonograph and still feel fresh and vigorous at the end of the session.

Verily if there are to be any more statues set up in the house of representatives, let there be two kept cool, one for Edward Burgess and the other for Thomas A. Edison.

Newburgh Herald, N.Y.
Oct 25th 87

Edison's perfected phonograph, if it should prove to be what he claims, would be of great utility, and very easily might prove a great success. That which was published from time to time years ago, was in-distinct in enunciation, so that it required a quick ear to catch the words and the tone was squeaking. He says of the perfected instrument that it is plainer to be understood than the telephone as the best, and that the tones of individual voices can be distinguished. The matter is regular and moderate, and the talk can be repeated a thousand times without wearing out, while the record can be used as cheaply as ordinary letters. It would be exceedingly awkward in some instances to have one's exact words and tones of voice accurately recorded, so that there could be no doubt nor denial. If a public man wanted to modify or explain away an unfortunate expression, it could not be done if the report of the speech were taken by the phonograph, inexorable as fate, and accurate as the stars in their course.

New York Tribune, Oct
Oct 25, 87.

SAVING AND MAKING LABOR.

Mr. Mr. Edison's claims in regard to his newly perfected phonograph are not exaggerated ones but assuredly have a most important addition to the world's ever expanding list of labor-saving machines. It will outrequal the telephone nor the dynamo machine nor the cotton gin nor those wonderful, mechanisms which at one period revolutionized spinning and weaving and, in England, led to the machine breaking riots. But a quick substitute for letter writing, a machine which may take the place of both the type writer and the telegram pen, which dispenses with amanuenses and substitutes spoken speech for slow penmanship is surely what be classed as one of the truly great inventions of the century. It belongs to the division of inventions which add to the capacity of the world's productive forces, especial industries, to which they are applied and which are apt to be viewed with alarm, naturally by the people whose very livelihood they threaten. Invariably, however, by such discoveries in general who know not what many connection next to superiors the work of their hands.

It is a great and wonderfully intricate question this of the source of labor-saving machinery, on the condition of the laborer. Economists differ widely both as to the results which have followed in the past and those that are to follow. A good many attribute our present labor troubles in the lower state to which powerful machines have brought our industrial classes while quite as many unconditionally contend that labor saving machinery has positively lessened the condition of the workers. But a few facts the experience of everybody will confirm. When that every piece of labor saving machinery creates a certain amount of new labor and work in making the machine itself which in various parts has to be handling its speedy production. A second and very vital point is that every cheapening of the cost of the article enlarges its demand and thus enforces a greatly increased supply. Illustrations of both these points will crowd upon memory. The invention of the locomotive, for instance killed off many stage lines but it upbuilt a vast industry in creating locomotives railroads and the operation of both. The discoveries in the work of ... substituted in the ... work of ... for girl or of a young boy for many adult men cheapened the product but so enlarged the demand that cotton and woolen and silk mills all over the world employ ... to ... millions of operatives. The sewing ... ches doubtless threw many seamstresses out of work but it opened labor for thousands in the factories which stitch, cotton, ready-made clothing and scores of other articles are made from textile fabrics. It is now saying to one direction but about the work on a ... Will this phonograph do so, or will ... very finally overtake all these factors? ... the time ... [illegible]

Reading Times, Pa.
Oct 25th 87

A Wonderful Device.

The readers of the TIMES have already been informed of the perfection of an instrument invented by Mr. Edison which will, as small exploit, record the sound of the human voice, or any other sound, for that matter, and reproduce it in miniature with a perfection which leaves nothing to be desired. The principal of the new phonograph is a vibrating diaphragm armed with a short point which indents a moving sheet of metal according to the vibrations caused in the diaphragm by the wave sounds which strike upon it.

In an interview with the inventor, the *New York Evening Post* learned many things about this remarkable device and the possibilities and probable extent of its usefulness and application. Among them are the following set forth in an editorial summary by that paper:

"For commercial purposes his phonograph, he says, will allow the hurried business man to dictate his correspondence without the aid of stenographer or typewriter; he will simply talk quietly into the machine, and when the letter is finished he will have a sheet which can be sent by mail, and which, when placed in a similar apparatus, will reproduce the original sounds, so Mr. Edison expresses it, "for more distinctly and with far more of the characteristic accent of the voice than the telephone ever does."

If it turns out that the Edison phonograph does half of what is promised, it requires no great stretch of imagination to foresee most wonderful things for it. As the reproducing apparatus can be made to work slow or fast at will, the operator at his case may listen to the phonograph and set up his type accordingly. The invalid or the busy person may at a trifling cost have all the great lecturers of the world without leaving his arm-chair, by touching a spring which sets the phonograph in motion and providing it with the proper roll of the foil. The business of the professional reader will be gone. The cost of duplicating the sheets of foil, or other material upon which sounds have been imprinted, is said to be so trifling that whole books will cost, as "phonograms," less than they do now in print, and will occupy far less space. In the old phonograph the frequent passage of the foil under the reproducing part of the apparatus caused a gradual obliteration of the indentations and a consequent loss of clearness in the enunciation of the instrument. This defect is said to be overcome, and the same message or letter or book may be repeated thousands of times without any deterioration. If books can be repeated upon the phonograph, why not newspapers? The field of speculation is endless.

With regard to music there seems to be no doubt that the new phonograph will achieve much that is promised for it, for in the very earliest of Mr. Edison's devices of this kind, the clearness of musical sounds, or singing, compared with spoken words as reproduced by the phonograph, was very noticeable. Songs could be understood, word by word, when spoken messages were unintelligible. From the experiments made with the two instruments already finished, it has been found that the phonograph is incomparably superior to the telephone in its interpretation of the music of any kind—singing, the piano-forte, the violin, or the complex sounds of a whole orchestra. The different instruments in a small orchestra can be perfectly distinguished, and the difference of tone is so minutely conferred that one can tell which of two pianos of different makes was used for playing a piece of music reproduced in the phonograph. The cheapness with which reproductions of the phonograph foil may be made will, it is said, make a whole opera, thus given in miniature, orchestra and voices, cost less than the most worthless piece of sheet music does now. As the phonograph will reproduce whatever it hears, the playing of a Rubenstein or a Joachim or the singing of a Patti may possibly be heard with a pleasure for centuries to come. In fact, as we have already said, the more one thinks of the possibilities of a perfected phonograph, such as Mr. Edison now soberly tells us that he has devised, the more bewildering the outlook becomes."

Ut. Morning Leader, Iowa
Oct 25th 1887

A GREAT INVENTION.

News of tremendous import comes from the workshop of Thomas A. Edison. It has been hinted at in THE LEADER for some months, but now it comes from Edison himself, and it is more wonderful than we had imagined. And this is the substance of it.

The phonograph is ten years old. At the Paris exposition it was awarded a premium as the most wonderful invention of the century. But before it was perfected to the point of practical, every-day use, the inconcerent light struck a winning gait, and absorbed the inventor's time and attention, so that the phonograph was crowded out of his mind.

He has lately taken it up again and has transformed it into one of the most remarkable inventions of the day, as well as the most wonderful. He has two perfect machines made, just as they are to go on the market, and hopes to have 500 ready for sale in January.

The principle of the phonograph is probably understood by all our readers. Sound is caused by vibrations of the air. Loud sounds are caused by large vibrations, high notes by rapid ones. All differences of sound are therefore caused by the differences in the size and rapidity of the vibrations. Fasten a pointed cone of horn or metal on an elastic diaphragm, lay a sheet of wax parallel with the diaphragm and just far enough away so the point will barely touch it when at rest, then talk and move the wax sheet and the point will make impressions in the wax, which will be deep or shallow, according to the loudness of your talk, and close together or scattered apart according to the pitch of voice in which you speak.

If you stop talking, and run the wax through the machine exactly as it was first traversed before, it will do the talking itself this time. You have a rude phonograph. Edison has made one that isn't rude. The foil he uses is probably not wax, for it won't wear out until it has repeated your words a thousand times. And besides, it can be copied any number of times, and very cheaply.

This is the interesting part of the story. This foil can be sent around the world, or kept a hundred years, or multiplied by a hundred thousand, and when put into the receiver the phonograph it will reproduce not only the words but the tones of the original speaker. Some of the foils will hold one to 1,000 words, and others as high as 4,000 or more. The message conveyed by one of them is called a phonogram. It can be heard much more distinctly than any telephone message.

The uses of these phonograms are so many and important that the future they promise is fairly unthinkable. They may be sent through the mails like ordinary letters. They may be copied, and the

New York Sun
Oct 28 87.

copies jointly bound together into books. Reading will be made as easy and pleasant as listening to a lecture, and the eyes will be saved. They may be used as printer's copy to set type from, the printer slapping at every few words, and if he don't quite catch them sensing, he can make the sensitive repeat until he does.

In fact, the phonograph, if it does what Edison claims that the two already manufactured will do, is bound to take the place of the type-writer to a great extent. The business, instead of dictating to a girl, will talk to his phonograph. Not one of his words will be either omitted or misspelled. He can retain a copy. The success of correspondence an ordinary man will be able to attend to is simply enormous.

The probable uses of the new invention are also important. It always did do better work on words than on conversation. The new song you buy, which will cost you less than at present, will come to you neatly in cold black and white, for you to lecture, post into vocal music, but in the voice of some good singer, full of expression. So you may sing it correctly if you like, and if you don't sing you may enjoy the song anyhow. Your phonograph will be all the musical instrument you will really need, in order to have a world of musical enjoyment. For not only will it repeat the concerts of the single instrument, bringing out the soft and soul of that instrument, but it will give you a whole chorus of voices or instruments, and even an opera. At last no shall all have a chance at Wagner.

All this Mr. Edison promises us, not in the uncertain future, but just as soon as he can get the machines turned out and put on the market, and this shall begin to be realized yet this winter. So we shall not be obliged to walk long.

Oct 28 87.

A WONDERFUL WORKSHOP.

The Resources of Edison's Laboratory.

What the New Phonograph Is Expected to Do—Work Upon the Great Electric Generator—A New Cotton-Picker and a Street-Car Motor.

Eight miles of Delaware, Lackawanna, Orange, New Jersey, Thomas A. Edison, the inventor, is now hard-fisted wizard promises to be the most perfect physical and chemical experimental laboratory in the world. His laboratory at Menlo Park is to grow too restricted for the needs of the inventor, a body of expert workmen whom he have continuously employed in carrying out the suggestions which he makes to them. For years he has wished to build such a laboratory as he is now finishing, and to embrace that this use of money is that which has given him the most pleasure of recent years. The new laboratory building has an eighth of the pleasant country house which Mr. Fedder, the former master at Menlo, Arnold & Constable, built at great expense, and which Mr. Edison bought last year from them. The main buildings consist of three massive structures, each 100 about 100 feet long by 60 feet wide, four stories high, and built of brick in the most substantial manner. Mr. Edison hopes to begin work in them soon time next month. They are supplied with every device for experimental work which the scientific mind can imagine. The buildings will be heated by steam and lighted by electricity.

The engineer will be supplied to all the machinery. Every accurate laboratories will be fitted up with every known apparatus for experimental work in physics or chemistry, and scores of experts, brought from all parts of the world, will attend daily to place their knowledge at Edison's disposal.

In the contests with which the enormous new to be stocked, there have been thousands of thousands of dollars spent, and if Edison does not have every needful article used in his science, it will not be the fault of his assistants. He has given directions to go through had a dozen weeks on chemistry, physics and mechanics, and make a list of every article required. For instance, in turning over Watts' Chemistry one comes across the materials at every page, and heard of containing the most complicated chemical laboratories all these Edison must have if he can obtain them. He will have every kind of iron and steel, every kind of all known wood, every kind of glass, every metal in all their different forms, every stone, every variety of clay, chalk, every vegetable substance that may be of use. From the finest the Arctic regions to the plant grown in the Amazon. Half-a-dozen times in Sidney's life his work has been brought to a standstill by the lack of even one material wanted in order, but which could not be obtained without long delay and great cost. If a battery used to Japan to get the bamboo fibre with which he makes his carbons for his lamps. As yet he is interrupted in his work upon the apparatus for generating electricity directly from heat, by the impossibility of finding nickel in sufficient quantities in the country to be rolled in England, and has had to succeed operations until the metal can be had. Any museum he may require from almost exhaust of material can be seen by this wonderful collection, the list of which already reaches 5,000 items, to provide against annoying delays.

When found yesterday morning in the laboratory of his lamp factory in Newark, from which, 4,000 lamps a day are now turned out, Edison said that the commercial phonograph is now the most interesting thing in the world to him, although it is perfectly finished, and tools are being made for its manufacture upon a large scale. The apparatus is so simple, so effective, and so immediately useful that he is certain of its rapid introduction into business—for more certain than he was of the universal adoption of the telephone as a business instrument. Edison said of his newly finished phonograph: "You know that I finished the first phonograph more than ten years ago. It remained more or less of a toy. The germ of something wonderful was perfectly distinct, but I did it impossible with it, was when the circumstances happened commercial importance. Now everything is overboard for that. Nevertheless, the phonograph has been more or less constantly in my mind ever since. When reading the prolonged work upon the light, my brain would revert almost automatically to the phonograph. Since light has been finished, I have taken up the phonograph, and after eight months of steady work, have made it a commercial invention. My phonograph I expect to see in every business office. The first five hundred will, I hope, be ready for distribution about the end of January. Their operation is simplicity itself, and cannot fail. The merchant or clerk who wishes to send a letter has only to set the machine in motion, and to talk in his natural voice and at the usual rate of speech into the mouthpiece. When he has finished, the sheet, or 'phonogram,' as I call it, is ready for putting into a little box made on purpose for the mails. We are making the sheets in three sizes—one for letters of from 600 to 1,000 words, another size for 2,000 words, another size for 4,000 words. I expect that an average user will not be much below the four-inch sheet, combining the phonogram boxes to be sent at a small rate in letter paper.

"The receiver of a phonogram will put his sheet in position and the message will be given over correctly, more distinctly than the best-spoken words ever were spoken. The tones of the voice in the two phonograms which I have finished as to be perfectly reproduced under the notion of best, and Edison has perfectly succeeded in that one thing. The two tones have been which he wrote in the receiving of an iron which came to him from Europe in the last winter. He is not quite sure that it will answer in a practical cotton-picker, but he has faith enough in it to make the experiments. He will say yet say in what consists the essential features of his proposed machine. The last week which he proposes to undertake very soon is to run the Greenstreet-cars upon an electric system which he says will not need any overhead wires or underground conduits, both expensive and troublesome necessities of all existing electric railways. He is confident that he can do this, and I may hear him upon the first working models.

Scientific American No 9
Oct 29 1887.

Edison's New Phonograph.

A reporter of the *Evening Post* lately interviewed Mr. Edison, and obtained the following interesting particulars:

When found in the laboratory of his lamp factory in Newark, from which 4,000 lamps a day are now sent out, Edison said that the commercial phonograph is now the most interesting thing in the world to him, although it is perfectly finished, and tools are being made for its manufacture upon a large scale. The apparatus is so simple, so effective, and so immediately useful that he is certain of its rapid introduction into business—for more certain than he was of the universal adoption of the telephone as a business instrument. Edison said of his newly finished phonograph: "You know that I finished the first phonograph more than ten years ago. It remained more or less of a toy. The germ of something wonderful was perfectly distinct, but I did it impossible with it, was when the circumstances happened commercial importance. Now everything is overboard for that. Nevertheless, the phonograph has been more or less constantly in my mind ever since. When reading the prolonged work upon the light, my brain would revert almost automatically to the phonograph. Since light has been finished, I have taken up the phonograph, and after eight months of steady work, have made it a commercial invention. My phonograph I expect to see in every business office. The first five hundred will, I hope, be ready for distribution about the end of January. Their operation is simplicity itself, and cannot fail. The merchant or clerk who wishes to send a letter has only to set the machine in motion, and to talk in his natural voice and at the usual rate of speech into the mouthpiece. When he has finished, the sheet, or 'phonogram,' as I call it, is ready for putting into a little box made on purpose for the mails. We are making the sheets in three sizes—one for letters of from 600 to 1,000 words, another size for 2,000 words, another size for 4,000 words. I expect that an arrangement may be made with the post office authorities enabling the phonogram boxes to be sent at the same rate as letter paper.

"The receiver of a phonogram will put it into his apparatus, and the message will be given out more clearly, more distinctly, than the best telephone message ever sent. The tones of the voice in the two phonographs which I have finished are so perfectly reproduced that one can distinguish between twenty different persons, each one of whom has his own words. One tremendous advantage is that the letter may be repeated a thousand times if necessary. The phonograph does not wear out by use; moreover I may say in a few days that I have used the same wax cylinder for a hundred years and be ready the instant I wish to do so to use it for the purpose of taking a new dictation. There will be no disputing the authenticity of the document with those who know the tones of his voice in life. The cost of making the phonogram will be scarcely more than the cost of ordinary letter paper. The machine will read out the letter or message at the same speed with which it was dictated.

"I have experimented with a device for enabling printers to set type directly from the dictation of the phonograph, and think that it will work to a charm. It is so arranged that the printer by touching a lever with his foot allows five or ten words of the phonogram to be sounded; if he is not satisfied with the first hearing he can cut out and repeat the same words over and over again, until he hears them as type. For busy men, who dislike spending time on the press, I am sure that the phonograph will be a necessity after a little experience."

"For musicians the phonograph is going to be a wonder. Owing to the extreme sharpness with which I can duplicate phonograms and the accuracy with which the apparatus gives out all musical sounds, by the early phonograph of ten years ago, which was a very imperfect and crude affair compared to that of to-day, it was always noted that musical sounds emerged out peculiarly well. A machine would withstand one *ting tar* better than wound fails. This peculiarity of the early phonograph remains. I have taken down the sounds of an orchestra, and the result is marvellously exact. Instruments can be perfectly distinguished, the strokes are sounded

GOOGLE

72 ing, he can make it repeat the same words over and over again until he has them in type. For busy men who dictate a great deal for the press, I am sure that the phonograph will be a necessity after a very little experience.

"For musicians the phonograph is going to do wonders, owing to the extreme cheapness with which I can duplicate phonograms and the delicacy with which the apparatus gives out all musical sounds. In the early phonograph of ten years ago, which was a very imperfect and crude affair compared to that of to-day, it was always noticed that musical sounds came out peculiarly well. The machine would whistle or sing far better than it would talk. This peculiarity of the phonograph remains. I have taken down the music of an orchestra, and the result is marvelous. Each instrument can be perfectly distinguished, the strings are perfectly distinct, the violins from the cellos, the wind instruments and the wood are perfectly heard, and even in the notes of a violin the overtones are distinct to a delicate ear. It is going to work wonders for the benefit of music lovers. A piece for any instrument, for the piano, or for an orchestra, or an act, or the whole of an opera, musical instruments and voices, can be given out by the phonograph with a beauty of tone and a distinctness past belief, and the duplicating apparatus for phonograms is so cheap an affair that the price of music for the phonograph will be scarcely worth considering. As the phonogram will be practically indestructible by ordinary use, such music can be played over and over again.

"My first phonograph, as you remember, consisted simply of a roller carrying the foil, and provided with a diaphragm point properly arranged to scrape or indent the foil. The roller was turned by hand. In the new instrument there is far more complication, but altogether different results. My propelling machinery consists of a small electric motor run by a very few cells. Strange to say, I have found more difficulty in getting a motor to suit me than any other part of the apparatus. I tried various kinds of clockwork and spring motors, but found them untrustworthy and noisy. The motors I am now making are absolutely steady and noiseless. There is no part of the apparatus, the tools for which I am now making upon a large scale here, which is likely to get out of order or to work in an uncertain manner. The two finished phonographs are practically exactly what I intend to offer for sale within a few months."

Among the things at which Mr. Edison is hard at work, taking them up in turns, are the cotton picker, the heat generator of electricity, and a new device for propelling street cars by electricity. As already mentioned, the heat generator has been brought to a standstill by the lack of nickel in this country. Edison found that the rapid heating and cooling of iron plates in his generator, which was described at length in the *Evening Post* at the time of the September meeting of the American Association for the Advancement of Science, caused them to disintegrate very rapidly. Nickel does not attain so high a degree of magnetization as iron, but it loses it more rapidly under the action of heat, and Edison expects better results from it than from iron. The cotton picker upon which he is at work is the result of an idea which came to him down in Florida last winter. He is not quite sure that it will result in a practical cotton picker, but he has faith enough in it to make the experiments. He will not yet say in what consists the essential feature of his proposed machine. The last work which he proposes to undertake very soon is to run the Orange street cars upon an electric system which he says will not need any overhead wires or underground conduits, both expensive and troublesome necessities of all existing electric railways. He is confident that he can do this, and is now busy upon the first working models.

Boston Record Oct. 31, '87.

NEW YORK LETTER.

EDISON'S PHONOGRAPH AND ITS POSSIBILITIES.

Coming Experiments in Flying Machines—The Woman's Congress—The Yachting Sensation and Other Topics.

[FROM A SPECIAL CORRESPONDENT.]

NEW YORK, Oct. 29.—What is news, Mr. Editor? What have been the salient events of the week here? Is it the principal news that Mr. Nicoll is running on an anti-machine ticket for district attorney, or that Capt. Reilly has raided the Silver Grill Restaurant, or that Mrs. James Brown Potter has had a stage quarrel with Mrs. Langtry, or that Paying Teller Jackson of the sub-treasury has stolen $10,000 and ran away to Canada with it and a strange woman?

I shall not decide among them, nor shall I aspire to treat them, but content myself mainly with two or three dry items of science. To be sure they concern the convenience and value of human life, but what is that as news compared with the arrival of the Irving troupe yesterday in the Aller and the City of Richmond?

The first of these items relates to the Edison phonograph as recently "boomed" by its great inventor. The account of the instrument as perfected, which he gave a few days ago to a reporter of the Evening Post, has excited the deepest interest in scientific circles and in fact throughout the world generally. Edison has the reputation of not spoiling a good story in the telling when under interview, and in the present case I learn that he speaks of his accomplishments with greater moderation to scientific people than to reporters. Still, after making all due allowances, the newspaper story of the perfected phonograph is a true and legitimate sensation. It looks very much as if we might be at the threshold of another scientific evolution equal in importance to that of the telephone, and thrifty individuals are quietly asking where stock can be had.

THE IMPROVED PHONOGRAPH.

Mr. G. H. Stockbridge, the patent attorney and electrical expert, tells me that he understands the improvement is in the plate which receives the impressions from the sound-needle. In the original instrument, he says, tinfoil was used, but this was found too soft for good results. Experiments were subsequently made with plaster of paris and celluloid, the idea being to print the sounds on a plate that would subsequently harden. Gelatine has also been tried, and this is probably the substance which Edison has now fixed upon as the most available.

But can the human voice be printed in gelatine so perfectly that a contract or a last message or a fond word will be imbedded in such a matrix, to be repeated endlessly at will? The song goes, "Kind words can never die,"—are science and religion to agree at length on this point? Let us hold our admiration in check till at least the latter part of January, when the machines are promised to the market. We know what a cold and disembodied thing echo is, and certainly it seems as if that phenomenon of nature were the simplest and the perfect phonograph. Can Edison, wizard that he is, catch in his gelatine the quiver of the lip, the beam of the eye, the gesture of the hand that makes one human voice sweeter to us than all others? Will it not after all be a Frankenstein and not a friend or parent or lover whose speech we churn out by the yard?

A FLYING MACHINE.

And now, while I am writing about scientific miracles, I will pass on to the second of my dry items, which is that New York is soon to be treated to some experiments in flying machines. A company of sober and practical men claim that they have solved the problem of aerial locomotion, and they intend to give exhibitions of their machine at the American Institute fair, now in session. As everybody knows who has kept up with the times, the "Darius Green" epoch in flying machines has gone into the myths. For years the subject of aerial locomotion has been studied with intense seriousness by some of the keenest and best-balanced intellects, and the scientific world expects the problem to be solved now at any moment. It was only the other day that The Boston Advertiser treated the subject seriously, taking as a text the recent investigations of Professor Richard A. Proctor, so that the readers of that newspaper may be better prepared than less discriminating persons to learn that there are hard-headed and responsible capitalists who are about to show mankind how to fly. If they accomplish their intention what a hubbub will follow! For did you ever sit down and think what success in aerial locomotion would mean? It would simply bring about a new heaven and a new earth. How it would worry the protective tariff, for example; for it would be difficult to patrol the frontier to the height of the atmosphere.

THE ALUMINUM PUZZLE.

The flying machines I speak of are to be propelled by that modern scientific maid-of-all-work electricity. What the fabric is built of, or what its plan of construction is, I do not know. Ah, if we could but reduce aluminum easily and cheaply, that would settle the business at once! This is perhaps the grandest "if" that baffles science today. Here is a metal as strong as steel and as light as wood, and filling the world with its abundance, and yet nobody can resolve it save at an expense which deprives it of commercial usefulness. The largest block of it in the world, I believe, is the triangular cap which crowns the apex of the Washington monument.

I am told that there are more inventors at work on this aluminum puzzle than on almost any other. Every few weeks we hear a shout of "Eureka!" but somehow the metal remains as scarce and costly as before. I could tell a very pretty romance of aluminum if I wished, but I won't. But the greatest romance of all will be the actual discovery of the way to get it out of its sulks and into the service of man. That done, and we shall soon be flying through the air, and doing about as we please with nature generally.

N.Y. Star, Nov. 13, 87.

OPERA IN EVERY HOUSE.

A Wonderful Revolution in Music which Edison's Phonograph Will Make—The Possibilities of the Invention.

From time immemorial one of the chief arguments in favor of a life in town as against the life in the wilderness has been that in great congregations of men dramatic art and musical art, inasmuch as the two are inseparable in their highest forms, can only be studied with profit. The performance of great symphonies, great oratorios, great operas, calls for large numbers of singers who are to be found only in the great centers of the world. Remarkable voices are few; to get many of them together there must be an immense supply to choose from. In order to keep together an immense chorus, sufficiently large to give the highest expression to such works as Bach's "Passion" music or Mendelssohn's "Elijah," we must have co-operation with large masses. It is possible in countries where music is the inheritance of ages, such as in Germany and in certain parts of Wales, to draw farm laborers to the village church at night in order to learn and practice music. In this country we have had nothing of the kind. It has always been uphill work to get together any large body of instrumentalists or choristers, and the old associations for the cultivation of music may be counted on one's fingers. Even in New York here our oldest choral society dates only from 1874, and we have but one musical society which goes back to 1850.

The argument of experts upon this question is that in order to attain any love for great art work, either in music or in the drama, it is necessary to hear the best the world has done. The boy who is brought up never to hear music or to go to the play will certainly not be either a musician or a playwright, and it is only in great cities that he can find out what the world has achieved in these directions. If half is true that is told of Mr. Edison's new phonograph, all this is going to be changed, and the lonely pioneer on the border land of civilization may solace himself with performances of the Vienna Opera House or the Paris Comedie Francaise. It will not be astonishing to have the most remarkable works in music or in verse coming from the depths of the wilderness, because genius may find the necessary kindling spark in the phonograph's reproductions in miniature.

Years ago, when Edison first showed his early phonograph, its musical performances were by far the most remarkable of its doings. It would reproduce singing or whistling far better than ordinary speech. But, at best, its reproduction was more or less of a caricature of the real thing, and as a help to the study of art it was never considered seriously. To-day Mr. Edison quietly announces that with his new and perfected phonograph he can render the tones of an orchestra so clearly that one can distinguish the violins from the 'cellos, the 'cellos from the basses, the oboes from the flutes, etc. His faith is such in the instrument that he declares one can tell whether it is music from a Chickering or a Steinway piano that the phonograph is reproducing, provided one is familiar enough with the differences of tone between these two excellent instruments. When it comes to reproducing the music of instruments and voices blended, as in an opera, Mr. Edison indulges in what appears to ordinary persons to be the wildest kind of rhapsody. He declares that each voice is distinctly heard, each instrument in the orchestra; every feature in the musical performance has its proper place, and the listener really hears the opera in all its details, and in all its perfection of color, but reduced in tone. For the piano, it will give us the playing of all the great masters of the instrument, but in a subdued form. For the organ, we shall have everything except the sense of physical power caused by a tremendous pedal pipes. In a word, Edison's phonograph is to duplicate musical performances in miniature at a ridiculously low price, and enable every one to carry away from the concert room or the opera not only the programme of the evening, but a record of the performance which will enable the owner to reproduce it at will any number of times in the future.

And this marvelous apparatus, which is to do for the art of music what printing did for the art of literature—spread it broadcast over the land and cheapen it to popularity—is to cost less than $100, and will last a lifetime. Not only is it to reproduce sounds of every kind with absolute accuracy, but it makes its own copy. This little machine, composed of a vibrating diaphragm, a sharp needle, a roll of zinc foil, and a little electric motor, is to do more wonderful things than have been accomplished by the steam engine, the telegraph or the telephone. Time may not be far off when we shall see the patrons of the Metropolitan Opera House, or the symphony concerts in Steinway Hall, arriving with their phonographs under their arms in order to carry away with them the record of the performance, and disputes in the next century as to the comparative merits of the singers of to-day may be settled at once by taking down the dusty boxes labeled "Adelina Patti" or "Albert Niemann" and putting the right sheets of foil into the phonograph. All this seems like most utter nonsense, and yet I have not found a scientific man—and I have asked many in the last three weeks—who tells me that there is anything impossible or even improbable in what Mr. Edison's phonograph promises to do for music and musicians.

Every year or two we hear of some announcement to the effect that a great genius has perfected an apparatus for the mechanical reproduction of piano or organ playing—a sort of automatic piano player. A few years ago an ingenious inventor in New York made a device by which a piano or an organ sounded the notes marked by perforation upon strips of paper passed through a suitable machine. These devices were more or less successful, but they were expensive, and there was always something painfully mechanical about the effect produced—it was never better than the music of a really fine musical box. Even a fine musical box is not bad music, in its way; but it is an expensive toy and the range of music is limited. After one has heard the bridal chorus from "Lohengrin" or the "Boulanger March" a few thousand times it is apt to pall upon the listener. The grand advantage of the coming phonograph is that the machine itself will cost less than a good music box; less than an organ, less than a piano, and the range of music which it can perform will be unlimited. The duplication of phonograms, as the metal sheet carrying a phonograph message is called, can be done at merely nominal expense, so that there is no reason why an official phonographic record of every important event in music cannot be made and filed away as a business. From that one copy thousands of duplicates can be made if they are wanted. Patti may sing particularly well upon a particular evening in "Semiramide" and the phonographic record of that performance may be scattered through the world; the next evening she may not sing so well and the official record will never be duplicated. So with Rubinstein's piano playing or Joachim's violin playing. Mr. Edison estimates that a phonographic record or copy of a whole opera need not cost more than a few cents.

There are some features about this future of music which will even fill with admiration those persons who look upon music as Dr. Johnson did—"as the least disagreeable of noises." Certainly when one can buy for a few cents a little strip of foil which will reproduce the playing of a Rubenstein to perfection, and do it over and over again, thousands of times, if necessary, there would be small use of a constant piano torture which goes on in nine houses out of ten in this city. The proportion of persons who get music out of the piano to those who merely wear the nerves and spoil the tempers of their unfortunate victims is about one to one thousand. Not only will the phonograph make it needless for millions of misguided young women to waste their time and torture their fellow beings, but the phonograph itself is so modest a little instrument that it need not annoy any one who does not care to listen. Mr. Edison estimates that the phonograph's notes will not be more than about three times as loud as the sound from a telephone in good working order, but the sound will be infinitely clearer, more distinct and more full of color than can be hoped from the best telephone.

This brings me to say that almost inevitably, should the new phonograph do any of the wonders predicted for it, the next step in advance will be some method of magnifying the sound so that it will no longer be a reproduction in miniature but in actual tone, or something like it. The first phonograph of 1878 whistled loudly enough to be distinctly heard all over a large room, but quality and distinctness were sacrificed for loudness. In perfecting the instrument, Mr. Edison has sacrificed this volume of tone for a clear and perfectly distinct utterance. But the mere amplifying of the tone can be but a question of detail; already an English scientist has enabled the human ear to detect the noise made by a fly walking across the ceiling. If the microphone can do that, the phonograph of the future will certainly be made to roar like the Bull of Bashan, should that be thought desirable.

Opera by telephone was tried last year in Paris at the electrical exhibition, and proved to be a curiosity, but rather an expensive one. A number of telephones were placed in the Grand Opera, and the wires were run to a room in the exhibition. The visitor paid a franc and was entitled to listen to five minutes of "Faust," "The Huguenots," or whatever opera was going on at the opera house a mile away. But music by telephone is too much in miniature, too microscopic to give real pleasure; besides which, it will always be an expensive pleasure. The veteran manager of opera during the years from 1835 to 1855, the late William H. Frye, who was bedridden for many years before his death in an upper room in a house in Union square, asked, as a great favor, that Mr. Mapleson would permit him to place a receiver on the stage of the Academy and run the wires to his house. This was done, and the old gentleman got a great deal of pleasure, which was witnessed with almost equal pleasure by many of his friends and by me, out of such echoes of the Academy performances as came over the wires. He told me in confidence that he did not think much of the new fangled operas as compared to the old

sums of money that he is not as careful as most people would be. The other day he was hunting through his office at the Navy department for an official paper which had been mislaid. One of the drawers of his big desk which he was searching thoroughly

74 Herald, Boston, Mass. Nov. 28 '77.

THE new phonograph that Edison has just perfected is the greatest wonder of this age of wonders, if it is all that the inventor claims. A person can talk or sing and make any other sound of the voice into one of these instruments in motion and the whole is faithfully recorded, so that it can be reproduced by a duplicating instrument as many times as desired, and can be preserved a thousand years. The tones of the voice, and even of the different instruments of an orchestra, are exactly reproduced. It may yet be possible for us to hear a speech of Gladstone in the very tones in which it was uttered, without ever going to England or his coming to America. The debates and speeches in Congress can be more fully and accurately taken down than by any shorthand reporter and reproduced in every hamlet in the country. It was ten years ago that the first instrument was invented, and all this time the inventor, has been at work to perfect the invention, the hardest task being to proclaim the power. The duplicating instruments are said to be very cheap.

Wheeling W. Va. Nov. 28, 77.

THE PERFECTED PHONOGRAPH.

Mr. THOMAS EDISON has "got" a new wrinkle into his phonograph, the "wonderful speaking machine." He has, after assiduous work, perfected it so that it will be a very useful adjunct to the business offices. He told a reporter the other day that the commercial phonograph, which he has succeeded in perfecting, is the most important of his inventions. He says that the apparatus, is so simple, so effective, and so insignificantly useful that he is certain of its rapid introduction into business—far more certain than he was of the general adoption of the telephone as a business instrument.

Mr. EDISON says that the operation of his commercial phonograph is simplicity itself, and cannot fail, and he expects it to be part of the equipment in every business office. According to the inventor, the merchant or clerk who wishes to send a letter has only to set the machine in motion, talk in the natural voice and at the usual rate of speed into the receiver. When he has finished the sheet, or "phonogram," it is ready to send through the mails, where his correspondent places it in a phonograph and grinds out the message much more distinctly and accurately than messages can be sent over the telephone.

Mr. EDISON says that one tremendous advantage is that the message may be repeated a thousand times if necessary. Moreover, printers may set up copy from the phonograph, and people may enjoy concerts by means of the same invention, and what is once acted is practically indestructible. Mr. EDISON says:

My first phonograph, as you remember, consisted solely of a tinfoil carrying this foil, and provided with a diaphragm-point properly arranged to scrape or indent the tinfoil. The cylinder was turned by hand. In the new instrument there is far more complication, but altogether different results. My speaking machinery consists of a small electric motor, run by a very few cells. Strange to say, I have found more difficulty in getting a motor to suit me than any other part of the apparatus. I tried every form of clock-work and spring motors, but found them untrustworthy and noisy. The motors I am now making are absolutely steady and noiseless. There is no new part of the apparatus, the tools for which I am not making on a large scale here, which is ready to get out of order or work in an incertain manner. The two fields of phonographs are practically exactly what I intend to offer for sale within a few months.

What next?

Post-Dispatch, St. Louis Nov. 6. 77.

WIZARD EDISON TALKS.

HE TELLS WHAT HIS FORTHCOMING PHONOGRAPH WILL DO.

More Wonderful than the Telephone—To Be Ready in January—Almost Incredible Claims—Writing This a Year to Become a Lost Art.

Special Correspondence of the Post-Dispatch.

NEWARK, N. J., November 1.—Thomas A. Edison was found yesterday by the POST-DISPATCH correspondent in the laboratory factory but not at all disturbed by the criticisms of some scientific skeptics, who doubt that his coming phonograph will be able to do half or a quarter of what he claims for it. In answer to a few hundred questions, more or less, Mr. Edison said:

"Further, I am wrong in telling you anything about my phonograph, because what I claim for it is so extraordinary that I get only ridicule in return. I am so confident that when the apparatus appears it will dispel all doubts as to its workings and novelty, that I will be silent for the present to ignore all idiotic criticism and keep at my work regardless of the storm which I have been raising by telling of how good that work was such a thing as a perfected phonograph is existence. I am sure that when I settle down many doubts that I have entertained as well as I say I have, they will admit that there is nothing at all impossible in what I claim, and that the germ of the perfected phonograph, should such a thing appear, is a very clear in my old toy of ten years ago, which was exhibited all over the country, and was then acknowledged to be one of the wonders of the century. Just consider for a second what my old phonograph is, and think how little needed to be done to bring it to a working instrument. With my roughly-constructed instrument of 1877 I reproduced all sorts of sounds, getting back from the phonograph something like the original sound. Of course, you had to put into the tilling, and the reproduction of conversation was often accordingly of a caricature of the original. Nevertheless, to obtain a result that could be understood was doing wonders, and most people who remember my exhibitions will admit that while I did not produce a commercial machine I made a very interesting and creditable attempt, and my whistling and singing phonograph was a wonder.

THE FIRST INSTRUMENT.

"There were all sorts of objections to detail to my first instrument. It ran only a few hundred pounds; it cost a mint of money to make; no one but an expert could get anything intelligible back from it; the record made by the little steel point scratching on the foil lasted only a few times after it had been put through the phonograph. I myself doubted whether I should ever see a perfect phonograph, ready to record any kind of intelligible speech and to give it out again intelligibly. But I was perfectly sure that if we did not accomplish this, the next generation would. And I stopped the phonograph and went to work upon the electric light certain that I had sown seed which would come to something. For ten years the phonograph has been constantly on my brain automatically and unconsciously, and I would turn it over and over mentally every night when I went to think about. When I started talking about it, when traveling, when I was in the laboratory, I would turn it over and over and 365 days say now and then experimenting. Night months and I began to see my way clear to it. Then, and a month ago I stopped because really was no further improvement to be made. It is now complete, practical, cheap, effective, not liable to get out of order, and in fact everything that I ever claimed it does, everything that I ever claimed it could do, everything that I ever claimed it would do. THE PHONOGRAPH WILL SPEAK AS MUCH AS

anyone on the continent's desk "before the size of the desk, as a typewriter does. It will work automatically by a small electric motor, which will be started by the touch of a button, and will dictate, and stop and start at any point by the touch of a finger.

"Suppose a business man wishes to write a letter; he calls another to the mouthpiece of the phonograph to take, and starts the machine. He then dictates his letter in the ordinary manner, uttered. When he is done he pulls out the cylinder, and it is ready to be put in the mail. The receiver places the cylinder in a similar phonograph, touches the button, and the letter is dictated. Instructions will also be given about the letter. In some places distinct, clearer, more characteristic speaking will be required than any telephone can, or ever will be used. The phonograph would of a bad, loud voice, particularly if the person speaking does would not always want to talk, because persons can hear all over one office. In signing for goods at railroad stations and express offices the phonograph would save time for clerks' and customers' fingers. Instead of writing his name, the receiver would simply call into the phonograph his name, and the record would be taken off by the clerk. Many other uses will suggest themselves.

YOUR EXPECTATION.

"Now for my expectation. I expect that this machine will be found in the office of every business man, and particularly in the office of the lawyer and the reporter of business will never think of losing time by writing when they can dictate to a phonograph, should such a thing appear, in very clear in my old toy of ten years ago, which was exhibited all over the country, and was then acknowledged to be one of the wonders of the century. Just consider for a second what my old phonograph is, and think how little needed to be done to bring it to a working instrument. With my roughly-constructed instrument of 1877 I reproduced all sorts of sounds, getting back from the phonograph something like the original sound. Of course, you had to put into the tilling, and the reproduction of conversation was often accordingly of a caricature of the original. Nevertheless, to obtain a result that could be understood was doing wonders, and most people who remember my exhibitions will admit that while I did not produce a commercial machine I made a very interesting and creditable attempt, and my whistling and singing phonograph was a wonder.

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"Now for my expectation. I expect that this machine will be found in the office of every business man, and particularly in the office of the lawyer and the reporter of business will never think of losing time by writing when they can dictate to a phonograph, should such a thing appear, to be. I expect that the duplicating phonograph will be a great success, and that the records will be sent by mail to subscribers, who will have them reproduced at their homes and give it out again

Menlo Park Scrapbook, Cat. 1033

No. 20. "Polarization and Secondary Batteries"

This scrapbook contains clippings about polarization and secondary batteries. It covers the years 1873-1885; most of the material is for the 1880s. There are 140 numbered pages.

Blank page not filmed: 140.

Polarization 1033

of

Secondary Cattlines.

20

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ELECTRICITY BOXED.

New York, May 31, 1881.

To THE EDITOR OF THE HERALD:—

The main deep-rock resource published in the HERALD concerning the transmission of stored up electricity in a hand-up battery announces a discovery of positively high importance in its bearing on the electric light problem. One of the great difficulties in the way of cheaply furnishing electricity for lighting purposes was its impossibility of storing the current. A "motor" of electricity cannot be made during the day accumulated in reservoirs to be drawn off as wanted at night—as may be done with gas—but, on the contrary, electricity must be produced as it is needed. The consequence of this is that when a company undertakes to supply a given district it must manufacture and send through the wires enough current to supply all the lamps therein, even though only a fraction of the number of the lamps be connected with it. Of course this wasted power is an important item in the cost of electric illumination, first to produced ultimately to consumer.

Mr. Camille Faure, and lately following him Mr. Gaulin Faure, with what appears to be a feasible way of storing up electricity. It stands to understand that this is not a plan for gaining incessant power, as might be inferred from the statements of the London *Times'* correspondent quoted in the despatch, because nothing is more certain than that not one jot more power can be got out of any contrivance that is put into it, HENRY KEELY & Company apparently in the contrary notwithstanding. But one for accumulating weak energy over a long time and delivering the accumulation in a short time, so that a small force may be adjusted to work through passages—and into places—where only an extended series of weaker forces can now go. In this material "secondary element" consists of two strips of lead coiled in a spiral form, with a porous sheet of felt or flannel between each fold. By means of a current from a Grove or Bunsen cell, or from a dynamo machine, the lead in the positive element is changed into peroxide, a sea of acids and impurities lead is formed on the surface of the metal, and the negative element is changed into spongy lead. Either by a reversal of the current or connection in reverse, the peroxide of lead is changed back to lead, and the spongy lead to peroxide. Thus the chemical action is reversed, and the battery is ready again to give out the energy that stored in capable of doing it was first put into it. A battery weighing 4 pounds, and provided with lead, kept in one cubic foot.

The bearing of this invention on the economical problem of electric lighting is that the accumulation of weak energy during many hours may be concentrated on a single hour, or even minute, when the demand for that energy may happen to be greatest, thus overcoming the objection to the practicability of electricity for illuminating purposes will be considerable. PAUL DUPARDIN.

LIBRARY SALES.

Scientific American (Combined), Mass.)
June 4, 1881.

ON M. C. FAURE'S SECONDARY BATTERY.

The researches of M. Gaston Planté on the polarization of voltameters led to his invention of the storage cell, composed of two strips of lead immersed in acidulated water. These cells accumulate and, so to speak, store up the electricity passed into them from some outside generator. When the two electrodes are connected with any source of electricity the surfaces of the two strips of lead undergo certain modifications. Thus, the positive pole retains oxygen and becomes covered with a thin coating of peroxide of lead, while the negative pole becomes reduced to a clean metallic state.

So long as the secondary cell is separated from the primary cell, it forms a veritable voltaic battery, for the symmetry of the poles is destroyed, and one is ready to give up oxygen and the other eager to receive it. But when the poles are connected, an intense electric current is established, but it is of short duration. Such a cell, having half a square metre of surface, can store up enough electricity to keep a platinum wire 1 millim. in diameter and 8 centims. long, red-hot for ten minutes. M. Planté has succeeded in increasing the duration of the current by alternately charging and discharging the cell, so as alternately to form layers of reduced metal and peroxide of lead on the surface of the strips. It was soon that this cell would afford an excellent means for the conveyance of electricity from place to place, the great drawback, however, being that the storing capacity was not sufficient as compared with the weight and size of the cells. This difficulty has now been overcome by M. Faure; the cell as he has improved it is made in the following manner:

The two strips of lead are separately covered with minium or some other insoluble oxide of lead, then covered with an envelope of felt, firmly attached by rivets of lead. These two electrodes are then placed near each other in water acidulated with sulphuric acid, as in the Planté cell. The cell is then attached to a battery so as to allow a current of electricity to pass through it, and the minium is thereby reduced to metallic spongy lead on the negative pole, and oxidized to peroxide of lead on the positive pole; when the cell is discharged the reduced lead becomes oxidized, and the peroxide of lead is reduced until the cell becomes inert.

The improvement consists, as will be seen, in substituting for strips of lead masses of spongy lead; for, in the Planté cell, the action is restricted to the surface, while in Faure's modification the action is almost unlimited. A battery composed of Faure's cells, and weighing 250 lbs., is capable of storing up a quantity of electricity equivalent to one-horse power during one hour, and calculations based on facts in chemical chemistry shows that this weight could be largely decreased. A battery of 24 cells, each weighing 14 lbs., will keep a strip of platinum ¼ths of an inch wide, 1-32nd of an inch thick, and 5 feet 10 ins. long, red hot for a long time.

The loss resulting from the charging and discharging of this battery is not great: for example, if a certain quantity of energy is expended in charging the cells, 80 per cent of that energy can be reproduced by the electricity resulting from the discharge of the cells; moreover, the battery can be carried from one place to another without injury. A battery was lately charged in Paris, then taken to Brussels, where it was used the next day without recharging. The cost is also said to be very low. A quantity of electricity can be produced, stored, and delivered at any distance within 3 miles of the works for 1½d. Therefore these batteries may become useful in producing the electric light in private houses. A 1250 horse-power engine, working 4 dynamo machines giving a continuous current, will in one hour produce 1000 horse-power of effective electricity; that is to say 80 per cent of the initial force. The cost of the machines, establishment, and construction will not be more than £40,000, and the quantity of coal burnt will be 2 lbs. per hour per effective horse-power, which will cost from 1½d. to 2d. The apparatus necessary to store up the force of 1000 horses for twenty-four hours will cost £48,000, and will weigh 1500 tons. This price and these weights may become much less after a time. The expense for wages and repairs will be less than 1½d. per hour per horse-power, which would be £24 per day, or £8800 a year; thus the total cost of one-horse-power for an hour stored up at the works is 3½d. Allowing that the carriage will cost as much as the production and storing, we have what is stated above, viz., that the total cost within 3 miles of the works is 7½d. per horse-power per hour. This quantity of electricity will produce a light, according to the amount of division, equivalent to from 5 to 30 gas burners, which is much cheaper than gas.—*Chemical News.*

Scientific American (Combined), Mass.)
June 4, 1881.

THE announcement is made of an improved method of storing electricity, by M. Camille Faure, of Paris, the *London Times* asserting that "a box of electric energy nearly equivalent to a million feet, contained within less than a cubic foot of space, intact and potential, has been transported from France to Great Britan."

Sir William Thomson is said to have given some endorsement to the discovery, and tests and measurements are in progress at the laboratory of the Glasgow University.

The principle involved in M. Faure's discovery is understood in this country, and the possibility of its general correctness is conceded. The language employed in the announcement is rather equivocal, and the misuse of scientific terms render the exact extent of M. Faure's discovery a matter of some doubt.

We gladly welcome any progress in electical science; but as the necessity for storing electrical energy is of value only in very rare cases, the practical usefulness of M. Faure's discovery must be limited in extent.

MR. EDISON has courteously responded to a request on our part, to offer his opinion on M. Faure's discovery, and we take pleasure in placing before the readers of "SCIENCE" his reply, received since our own notes were in type.

To the Editor of "Science."

DEAR SIR: The Faure battery is an improvement on the Planté battery.

Planté was, I think, the original inventor of the battery which bears his name, invented some years ago for the purpose of storing up electricity.

Faure has simply made a Planté battery, by some means reducing its resistance, and thus reducing the percentage of loss. This is all there is in it.

Some two years ago I patented and applied a method for using the Planté battery in connection with electric lighting. Yours truly,

THOS. A. EDISON.

STORAGE OF ELECTRICITY.—A new secondary battery, of greatly enlarged capacity, is now attracting attention in Paris. It is the invention of M. Faure, but is confessedly a development of the well-known secondary battery of M. Planté, which is formed of sheets of lead immersed in acidulated water. The latter gains in capacity as the process of charging and discharging is repeated, through increasing thickness of the layer of peroxide of lead that is slowly formed by the currents. M. Faure has conceived the idea of coating the two electrodes with layers of minium, or the red oxide of lead, and by this means the capacity is greatly increased. The Faure battery is stated to have forty times the power of accumulation of the Planté. A battery weighing 75 kilogrammes will develop 75 kilogrammètres, or one horse-power, during one hour. As to the source of the action, the electric current appears to change the minium to peroxide on the positive electrode, and to reduce lead on the negative. In discharging, the reduced lead is oxidized, and the peroxidized lead is reduced. The battery was lately exhibited by M. Reynier to the Society for the Encouragement of National Industry. There were 24 couples, weighing seven kilogrammes each, connected to a Siemens machine of medium size; these furnished a work of 47 kilogrammètres, which is about a third of M. Reynier's figures; but the conditions were unfavorable. Next in hand of platinum, three mètres long, 12 millimètres broad, and 4-tenths of a millimètre thick was made to glow; then two incandescence-lamps were lighted. The superiority to the Planté battery was well demonstrated. Some competent physicists speak hopefully of M. Faure's battery as a means of distributing electricity to any house or workshop independently of others that may be supplied, and free from the drawbacks of a system of accumulation. The method is also regarded as very promising for domestic electric lighting. A company, it may be added, has been lately started in Paris by M. Philippart, for obtaining force and light by electricity, by combination of the Reynier and Faure batteries. M. Hospitalier has pointed out the expensiveness of charging the Faure battery with electricity from chemical action.

SECONDARY BATTERIES.

THE important part that secondary batteries will eventually play in electric lighting, renders any items in connection with their construction of great interest. As will have been expected, several patents have been recently taken out, and many others are awaiting publication. Of some of the devices we are enabled to give a brief description, which may be of interest, though there is reason to believe that later forms have superseded them. As we mentioned some time ago, Mr. Sellon has taken out several patents for secondary batteries, and as the development of that invention will form a feature in the electrical history of the nineteenth century, we give a short account of some of his various specifications. In the first of these he mentions, that in manufacture of batteries with lead, he describes the use of perforated plates, electro-roughened, serrated, or indented, composed of lead, platinum, or carbon, upon, in, or against which are held films of spongy lead, or salts of lead, or other suitable substances. In the drawings accompanying this specification, Mr. Sellon shows lead plates bent so as to form a series of dovetails over the surface, or serrated like the teeth of a saw, both being perforated with numerous holes, in which and in the folds of the serrations or the dovetails, the active material can be packed, the object being to get as much as possible of that into the smallest compass. Five days after that specification was deposited, Mr. Sellon appears to have found that a mixture of sulphate of lead with the use of magnesium had a finish resembling as the material of which the plates are to be composed. It is clear that the ingenuity of the inventor has tolerably wide scope in determining what shall be the actual form of the elements or supporting plates of the secondary battery, and it is obvious that if perforated lead plates are an advantage, they can be made up of a number of short pieces of lead tube, arranged with their axes parallel. We have reason to believe that experience has declared in favour of an alloy of lead and antimony in preference to the simple metal, and for convenience in working or for remedying any accidental damage to the active plates, plates of many perforations, reinforced by the corrugated and other devices mentioned, for the purpose of gaining surface. It will be understood that one object of these inventions is to dispense with the canvas or felt supports for the coating of oxide, because in practice it is found that nothing yet tried will long withstand the effect of the acid liquors used to excite the action. Corrugating the plates possesses an advantage in presenting greater surface in an equal space; but when felt or canvas is dispensed with, there is some flexibility of "lead-trees" forming a core and connecting the two elements of a cell. Hence, it is found advisable to corrugate the plates that any points of contact of the plates to be readily removed. M. de Kabath, of Paris, has taken out two patents for secondary batteries, the facts of which his invention being the method adopted to prevent the coating of lead-oxide from falling off. He forms a composite electrode of thin sheets of lead, folded around a thicker sheet, which acts as a support, the whole being enveloped in a sheet of parchment-paper, a substance which, having been already acted upon by sulphuric acid, is only slowly destroyed in the battery. In M. de Kabath's design the sheets are either plain or corrugated; but in all cases a thin coat of sulphate of lead is formed upon them, and the two kinds of alternate plain and corrugated lead, packed between stout lead covers held together by indiarubber bands, the whole being immersed in the liquid with holes. M. de Kabath has also taken out a patent for a method of regulating the discharge of secondary batteries (September 20th, 1881). That is accomplished by increasing or diminishing the depth of solution in the battery-cell by means of a tap moved by magnets actuated by a relay. Thus when the current in the main circuit decreases, the spring of the relay moves the index and puts into action the magnet controlling the inlet of solution, so that a greater surface of the plates is immersed, and the current is increased in proportion. Similarly, if the current be too great, the tap is so turned as to cut off some of the solution from the battery, so leaving a smaller surface of plates under action. MM. Degrez and Carpentier have also obtained a patent (September 27th, 1881) for distributing and regulating the transmission of electrical power, in which they use two secondary batteries, so connected by means of a commutator that while one is being charged the other is giving out current; but as they do not specify any form of battery, the claim is only for the details of the arrangement.

Secondary batteries having some really novel features, have been patented by Mr. A. Watt, of Liverpool (October 1st, 1881). He uses the lead-plates, but coats them with a mixture of caustic hydrate, manganese dioxide, and sodium chloride, or preferably with what is known as "Weldon mud," mixed in equal parts with manganese dioxide. The positive plate is a sheet of hammered lead, and in a solution of salt or of manganese one be employed, it soon coil, as the sulphate decomposes and covers the action with peroxide of manganese. Another form of battery consists of alternate layers of carbon and granulated manganese dioxide mixed with granulated carbon, preferably in equal volumes, or of lead and manganese dioxide or layers arranged as follows: — MnO_2, $Pb|O$, $MnO_2|O$, $Mn_2O_3|O$, $Pb|MnO_2|O$ and so on, or Pb, $MnO_2|O$, Pb, $Mn\ O$, $C|O$, the vertical bars representing porous diaphragms. The exciting liquid is salammoniac, common salt, or dilute sulphuric acid. A convenient form of cell consists of an ordinary battery jank divided down the centre by a porous diaphragm. The charged porous pots, fresh or exhausted, of Leclanché cells, may often be used without further preparation than emptying out the exhausted of the solutions. If one pot be fresh and the other exhausted, the couple is charged and ready for work. Another modification consists of a porous pot containing a plate of carbon charged with a mixture of manganese dioxide and carbon or coke, in a state of coarse powder, and placed in a lead vessel containing dilute sulphuric acid, the space between the pot and the leaden vessel being filled with a mixture of manganese dioxide and carbon or coke, or simply with granulated lead.

Another secondary battery, which is based on the action of chlorine on copper, has been patented by Mr. A. P. Laurie, of Edinburgh (October 4, 1881). The cell is made up of a thin plate of copper, coated with a paste of cuprous chloride, and wrapped in parchment-paper; that, together with a plate of zinc, is placed in a solution of chloride of zinc, and the two being connected a current is set up, which continues until the cuprous chloride is reduced to a state of spongy copper. The zinc plate is then withdrawn, and another one put into the cell, which is then ready for charging. The action of the chlorine on the spongy copper can be regulated by means of copper plates placed over the spongy coat, and connected to the copper plate. These notes, together with those given in p. 413, and elsewhere in the last volume, will serve to convey some idea of the different methods of making up secondary batteries. It is tolerably obvious that, but for its weight, lead would be the only metal exploited upon, its advantages being so considerable, especially in the shape of cost; where, however, flexibility is desired, it is probable that Sutton's some modification of the copper-lead cell will be utilised. Possibly, the researches of Dr. Gladstone and Mr. Tribe may lead to the discovery of something more valuable than is yet available.

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several additions made to the meter to increase its utility, and appears to cover every mode by which electrolytic action can be practically used to register the quantity of electricity passed into a circuit.

The original idea of plates of metal acting alternately as anode and cathode, reversing the direction of the current by the weight of the metal transferred, and registering the number of reversals, is still the basis of the instrument; but all the mechanical modes of supporting the plates by springs or balance-beam are done away with. A single moving plate is used, which floats in the liquid like a hydrometer, and which sinks or rises in the liquid exactly in proportion to the weight of metal added to or taken from it. As the quantity of metal which serves as the measure of the electric quantity is added to the electrode, it sinks till the limb is raised, when a contact is made, which sends a

receives ... metal while the other dissolves, the centre of gravity is displaced, and the cylinder rotates on its axis, and by its motion records the electricity passing. The idea is no doubt promising; but how it will perform in practice, would probably require to be determined by actual trial.

But another modification appears to offer considerable promise of utility in connection with electro-metallurgy. The motion of the electrode is transferred to an index which traverses a scale, showing the subdivisions of the interval between reversals. This scale may be made to show ounces of silver or gold deposited during each interval, and a shifting contact is placed over each of these divisions, so that, if a silvering vat contains articles on which it is desired to deposit five ounces of silver, the stop would be adjusted at that point. When the indicator reached this spot it would touch the stop, and send a current into a con-

T ON A BATTERY.

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..., who describes in Nature
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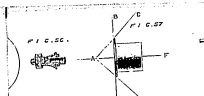

... 57, therefore, shows the
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... a square washer, which goes
... dle it does not slip. C is chuck,
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... s are screwed on to the chuck
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... nsert screws 1 and 2. F is a
... which holds barrel, and H is the
... ... chuck with jaws true to
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... ... to Fig. 54; the section shows
... bread; the chuck C (Fig. 54) is
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(*To be continued.*)

...S ELECTRIC METER.

... ... is just published of a
... ... for improvements upon
... ..., invented by Mr. Sprague in
... ... simplify the construction
... ... instrument, while extending
... This new patent contains also

... ated in a very simple manner by the reverser. The moving part of this carries a small wheel, upon which lies a lever also carrying a small wheel, and when the reverser is at rest these wheels are in close contact. The end F of the lever, therefore, lifts the lever by the action of the two wheels passing each other, and each such raising of the lever moves the locking-train one tooth.

An automatic heating arrangement, which may be applied to various other uses, is employed to prevent the solution from being frozen. It consists of a coil of fine wire inclosed in the space between two glass tubes placed vertically in the liquid. When this wire is heated by the current, a stream of warmed liquid will flow out, and thus warm the liquid in which the cells are immersed in a very economical manner, and other means of effecting the same object will suggest themselves to any one conversant with the subject.

The current passing through the heating-coil is automatically regulated by a thermometer-switch, which closes the circuit when the temperature falls to a fixed degree.

The influence of change of temperature upon the liquid and metal of the meter circuit, by which the latter is guarded against by balancing it with a compound of graphite and German silver, is adjusted that the variation is equal in both circuits; but the core taken by the various designs shown in the specification, appears to indicate that the intention is rather to do away with the complication of shunts by sending the whole current into the meter-plates which will no doubt give less scope to the suspicions of consumers.

There is another mode of action shown which is based on a new idea, which may, however, be seen fourteen years ago employed in a reversible electrical motor, in which the motion was produced by the metal in transference from one electrode to the other without reversal; but three plates and this metal, though they do the work, have nothing to do with the measuring. The current in this case does not require weighing between faces do not require weighing between them, but possess them to a cylinder forming one of the bearings. As the ends of the cylinder

ments must be preferred, to my mode of merely weighing a deposit at intervals.

EDISON'S CURRENT METER AND OTHER IMPROVEMENTS.

A MEANS of measuring the quantity of current passed along a given wire is as much a necessity of the present system of lighting by electricity as the gas-meter is to the existing system. It may be remembered that Mr. J. T. Sprague patented a simple device for calculating the quantity of current by the amount of copper deposited in a decomposition cell, and it so happened that Mr. Edison patented, or applied for a patent for, an invention which is practically identical with the first form of the invention, and described in the specification (1550, 1881) the new meter indicates a correct result with a smaller current than was required by the copper cell. The invention has been on view at the Crystal Palace, and was briefly described by me some time ago. It consists of amalgamated zinc electrodes in a solution of sulphate of zinc, and the meter is charged to the maximum of current it is to record by the increase in weight of the zinc plates, which are taken out from the electrode, and the plates—zinc, being deposited on the opposite—ad ed on the other. According to the specification, a lower rate of speed is to be given to the plates, which also is to be accomplished by clock-work or electric motor; but according to the description of the process given by those connected with the invention, the plates are coated with chemically pure zinc, so as to reduce local action to a minimum, and they are then amalgamated. The plates are about the size of ordinary sash sashes, 30in. by 18in.; they are a quarter of an inch thick, and are kept apart by a little strips of ebonite about a quarter of an inch thick, and clamped together by ebonite screws passing through the centre of their lengths. The depositing cell is separated from a shunt from the leading conductor of the house or other circuit in which it is desired to measure the amount of current consumed,—a resistance being placed in the

lice as about a small definite portion of the current through the meter. In the wire leading to the latter is another resistance in compensation for the effects of change of temperature. This resistance is formed of copper wire, the electrical resistance of which increases with a rise in temperature, while that of the solution in the cell diminishes. A sufficient length of copper wire is, therefore, put in the circuit to equal the loss of resistance in the cell, and the arrangement is thus permanently compensated for temperature. Arrangements are, however, made to prevent the temperature of the apparatus (including the compensating resistance) for which it is reached on Fahrenheit, wherein into circuit, the heat from which quickly raises the temperature of the box in which the meter is enclosed. When not in current is being worked on a three-ranged beside that shown, thereby rendering the establishment of a counter-current and the recognition of the solution. The practice it is proposed in use two meter-cells placed in a cast-iron box so connected that one replaces at a greater rate than the other, but in some proportion. One of the cells would be examined monthly by the ordinary officers of the company; the other would be left in the cells entirely at superior officers, and would be examined quarterly. It is proposed that the by-cell on coming to "take the meter," should remove one of the cells, and replace it by a fresh one, the cells so removed being taken to the local office, and the plates carefully weighed after being protected. The difference in weight will be calculated in values, suspicion of waste, or whatever term may be used to denote the amount of current consumed, and the bill will be made out accordingly. Whether it will be paid scrupulously remains to be seen, for it is difficult to see what check the householder will have on the Electric Light Company, and remembering the perennial misery which prevails in most of the toll-bars, which every householder must avoid if he can, we are afraid great charges will be made when consumers have no choice at all. The upper cell, with the tipping plate, which registers the current consumed on the "make" side of the galvanometer, is considered sufficient for use in the houses of customers, but will require a further.

Another of Mr. Elliott's improvements is a method of regulating the gravitative force of the chronometric machine. In this invention (1,752, 1881) a device is adopted for diminishing the mass of the pulse imparting the cause of the train-impetus. The electromotive force is kept constant by means of an electrolytic cell, which sets upon a central block, fixing a central spearing in the centre of the pulse. In Elliott's chronometric escapement machine, this method is to control block drawn into the hole in the pulse by the electro-magnet, and forced out by a spring and its heavy weight, can be easily adapted, but for other purposes the pulse to connect the block to the pulse.

Another invention recently patented relates to a method for establishing the electromotive force of a current from secondary batteries by reference to the same current from time to time, so as to keep up the electromotive forces in the consumption circuit; such as the arrangement cannot be explained without diagrams, we must refer those interested to the specification, No. 4153, of 1881.

WILLOUGHBY SMITH'S INDUCTOPHONE.

WE mentioned in the "Scientific News" last week that Mr. Willoughby Smith had, in the course of some investigations into the phenomena of telephony, made a remark with discovery—if, indeed, it may be so called—that the magnetic lines of force from a flat coil of insulated wire could be made to act upon it, would produce the same musical note as that given by a tuning-fork used as a make-and-break contact in the circuit with the coil, although there is no audible connection between the fork and the coil. The apparatus, which has recently put taken a definite form, has been called the inductophone, a name which satisfactorily expresses the nature of the phenomena. It consists of a bound, on which is mounted horizontally a tuning-fork, one arm of which carries a light platinum contact piece normally pressed against the point of a platinum screw placed on one side of the fork. The fork is actuated by a small electro-magnet, which, when the current is passed, maintains the vibrations of the fork indefinitely. The connections are so arranged that the current alternates, when the fork is vibrating, between the make-line and a short circuit, and in the main circuit is placed the flat disc of coil, made up of insulated wire, rather fine, laid between two pieces of ebonized wood in a frame so as to resemble in shape an ordinary bedroom looking-glass. One end of the coil is connected to the battery—Mr. Smith used a number of Leclanché elements—and the other is connected through the tuning-fork with the other pole of the battery—that is, when the fork is making contact. The fork being set in motion, the current passes through the coil of the magnet, and the make-and-break arrangement is put in full working, corresponding in number of contacts to the normal pitch of the fork. Then, if the latter is held in ordinary fork giving c.c.f., and it follows that exactly the same number of magnetic changes take place in the coil as are due of insulated wire—consequently also in the magnetic field which it creates. If, then, a thin diaphragm, a tuning-fork, or any suitable piece of iron is held in such a position that it comes within the magnetic influence of the coil, the lines of force can impinge upon it, a sound is produced which is identical with that due to the tuning-fork, although there is no physical connection between the receiver and the make-and-break. It must be confessed that this is a most curious effect, for the action is perfect, even when the transmitter and receiver are separated by a wall, and several feet of earth, the actual distance being limited only by the delicacy of the receiver. It is obvious that the greatest effect will be found in that position in which the largest number of lines of force can impinge upon the receiver of plate, and this will be found in the centre line of the coil. A call or two-notice, the intensity varying as the square of the distance. The greater the number of lines of force, and the greater the intensity of the field, the greater will be the effect produced on the receiving diaphragm. As to the distances through which the effect is produced, we are informed that experiments are being made to determine what the extreme degree of accuracy; but as it obviously depends, to a certain extent, upon the apparatus employed, end-to-end will, no doubt, be made to Paris and Berlin, etc. Meantime we have given sufficient particulars to enable experimenters to take up the study of a very interesting phenomenon.

ELECTRICAL ACCUMULATORS, OR SECONDARY BATTERIES.*

By Prof. Carus J. Lenox, B.Sc.

(*Continued from page 256.*)

PLANTÉ and a Faure cell, though the principles underlying the construction of the two forms is different, are, generally, the plates, of formation the same thing; and consist of sheets of lead, pretty much the same with black peroxide of lead (PbO$_2$), the other with a spongy metallic state. Both are immersed in a fluid state of division and mass, of dilute sulphuric hydrogen; both plates immersed in dilute sulphuric acid. In short ordinary battery strength. Two plates in this condition exist, as explained last week, given a current sufficient to decompose a wire, the positive current dashing along the wire from the peroxide coated plate—the spongy lead plate—the metallic—plate, and back through the liquid in the other direction; the spongy lead becoming gradually peroxidised, and the peroxide becoming less by one atom of oxygen, all the time the current lasts—i.e., until the condition of the surfaces has become the same. Temporarily or permanently the same. In ordinary cells of this kind, however, the active condition they are not continuous with sets of lead, either electricity—by which we mean mechanically—by Faure, which is then acted on by an electric current passed through the cell in the opposite direction, the current being made to enter the liquid at the plate which is to be peroxidised, and to leave it at the plate which is to be reduced. Hence the former of these plates may be perpetually indicating, for when charging the cell the current enters at it, and when discharging the cell the current sets out from it. The other plate is similarly strange — There need, therefore, be no difficulty in understanding how the cells of the storage to be connected to the motive power of the dynamo, whether the latter is supplying the current to the battery and charging it, or whether the dynamo is receiving the current from the battery and being driven by it.

Theory of Electro-chemical Decomposition.—It will be seen that work that electricity was employed through a definite by means of two opposite processes, the first being decomposition of water, the second the subsequent re-liquid is undergoing decomposition, and that every such reliable possesses a certain definite charge of electricity which it carries with it and delivers up to the electrode, either when it is set free or combines with the electrode. It was also stated that the charge of electricity possessed by a dissociated atomic particle is constant; and that dual have twice the charge, treble theirs, and so on. From these considerations it follows—as was proved by Faraday—that for a given weight of substance dissociated or liberated a certain quantity of electricity is required, a quantity which will be constant, and as we know the number of atoms liberated, the electrical charge of each, and the weight of each. Let y be the dissociation charge of a five-hydrogen or other monad atom or radicle. We do not know the value of y yet, we only know that it is proportional to the atomic weight. Let x be the weight of the atom or compound radicle formed from a combination in which n atoms of the other words, let its active atomicity have been reduced by n, or let d be the number of bonds which have been broken in the act of making it a free radicle—whichever way of expressing it is preferred—then nx is necessarily possessed of an electric charge ny.

Let Σ be the number of such atoms delivered up to an electrode in any time, then in the same time a quantity of electricity $Q = N\,\frac{x}{y}\,n\,y$ must have passed through the cell; and the weight of the substance liberated at the same time is $N = \frac{Q}{ny}$ and this M. Then

$$M = \frac{Q}{y}$$

Now, in the right-hand side of this equation $\frac{x}{y}$ is the only thing we know; we only know the relative weight of different atoms and the absolute weight of one, that of the hydrogen atom, and we know the relative weight of a hydrogen atom, and so the number ordinarily known in chemistry as "atomic weight" of any atom relatively to hydrogen, so that $x = a\,\frac{x}{y}$; then the above equation may be written

$$M = \frac{a}{y}\,\frac{x}{y}\,Q$$

Now, though neither $\frac{x}{y}$ nor y are yet known, their product has been determined by Joseph Stefan, and it is 1·0365 in C. G. S. units; in other words, the electrical charge of a five-hydrogen atom is 9565 times its weight in grammes. And the charge of any other radicle or atomic weight is

$$\frac{9565\,x}{n}$$

and with d from bonds $\frac{9565\,x}{n}$ times its weight in grammes.

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If the weight of the substances be expressed in pounds, and the quantity of electricity concerned in its liberation or decomposition be determined—as for practical purposes is rather convenient—the above number 9565 becomes 12,933, or, with sufficient accuracy in ordinary cases, 13,000. So we may repeat the above equation in an easy and simple form, a useful one—

Weight of substance acted on in ounces	=	ordinary "atomic weight" of the substance
Quantity of electricity passed through it, in Ampere-hours	=	13,000 multiplied by number of bonds broken

Whether the "substance" is the constituent which is liberated at the positive or at the negative pole, or whether it is the original compound, which is "dissociated" as all but decomposed, matters nothing. The above equation is perfectly general and universally applicable. It applies also when it is recomposition that is going on instead of decomposition.

The expression "number of bonds released or broken per molecule," is not a happy one, but the usual "change of valency" is no better, and the very simple conception is not to be expressed in best conveyed by an example. Suppose Cu SO$_4$ is being decomposed; the molecules are released when its separate from SO$_4$, hence

Weight of sulphate of copper decomposed

$$= \frac{\text{Quantity of electricity passing through it}}{63·5 + 32 + 64}$$

$$= \frac{63·5}{21,000}$$

But we might equally well write—

$$\text{Weight of copper deposited} = \frac{63·5}{21,000}$$

$$\text{Quantity of it required}$$

Take as another example the decomposition of common dilute sulphuric acid, with copper electrodes, say,

Weight of hydrogen set free	=	$\frac{1}{77}$
Quantity of it passed through cell	=	77,000
Weight of sulphuric acid decomposed	=	98
Quantity of it	=	24,000

Weight of sulphate of copper formed at the same time as the hydrogen is liberated

$$= \frac{159·5}{24,000}$$

Quantity of it

Suppose nitrate of silver is the substance acted on. Here only one bond is released per molecule, so

Weight of silver deposited	=	108
Quantity of it	=	12,000
Weight of nitrate of silver decomposed	=	170
Quantity of electricity	=	12,000

Finally, suppose the substance acted on is Pb O, the protoxide of lead, then

Weight of litharge oxidised to peroxide	=	223
Quantity of it required	=	24,000

Weight of litharge reduced to metallic lead, the same.

Thus a current of one ampère is able to oxidise on one side of a Faure cell $\frac{223}{24,000}$ lb. of litharge per hour, provided there is no waste, one ampère flowing all the time, and reduces the same amount on the other side. Or, reduced, of litharge on either weight of lead, the same formed oxide formed from a combination in which n atoms of the other words, let its active atomicity have been reduced by n, or let d be the number of bonds which have been broken in the act of making it a free radicle—whichever way of expressing it is preferred—then nx is necessarily possessed of an electric charge ny.

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Now, though neither $\frac{x}{y}$ nor y are yet known, their product has been determined by Joseph Stefan, and it is 1·0365 in C. G. S. units; in other words, the electrical charge of a five-hydrogen atom is 9565 times its weight in grammes. And the charge of any other radicle or atomic weight is

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and with d from bonds $\frac{9565\,x}{n}$ times its weight in grammes.

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Weight of substance acted on in ounces	=	ordinary "atomic weight" of the substance
Quantity of electricity passed through it, in Ampere-hours	=	13,000 multiplied by number of bonds broken

Whether the "substance" is the constituent which is liberated at the positive or at the negative pole, or whether it is the original compound, which is "dissociated" as all but decomposed, matters nothing. The above equation is perfectly general and universally applicable. It applies also when it is recomposition that is going on instead of decomposition.

The expression "number of bonds released or broken per molecule," is not a happy one, but the usual "change of valency" is no better, and the very simple conception is not to be expressed in best conveyed by an example. Suppose Cu SO, is being decomposed; the molecules are released when its separate from SO, hence

Weight of sulphate of copper decomposed

$$= \frac{\text{Quantity of electricity passing through it}}{63·5 + 32 + 64}$$

$$= \frac{63·5}{24,000}$$

But we might equally well write—

$$\text{Weight of copper deposited} = \frac{63·5}{24,000}$$

$$\text{Quantity of it required}$$

EFFECT OF HEAT ON A BATTERY.

A BOSCO usually recent attempts to improve the galvanic battery, Mr. Gaston Plante, the well-known engineer, Sorbier Gaudini, who describes in the results of experiments in heating batteries. He considers that his application of heat to such batteries, both from a theoretical and a practical point of view.

All the various types of batteries tried, that which is known as Leclanché was as follows:—A carbon-lined vessel containing porous tubes of terra-cotta, surrounded by the depolarising mixture, which acted as the positive electrode. A piece of carbon within the porous pot served as negative electrode. The exciting liquid was a solution of chloride of sodium, and the depolariser a superficial solution of bichromate of potash and sulphuric acid.

To the cold state, this couple gives an intense but transient current. When placed, however, on a small gas-boiler, its current increases considerably in intensity, and continues constant, with closed circuit, as long as desired if properly managed. The fluid should be regulated so as to keep the temperature of the various parts at about 100°. Experiments were also made to ascertain if the porous vessel a few centimètres of potassium bichromate, with sulphuric acid, and to the current were still weaker.

With such cars the battery will furnish a current much more intense than that produced in the cold state. The increase of intensity arises from the diminution of the internal resistance, and a notable increase of the electromotive force, as will be seen from the following:—

Battery used cold	II	II
" hot	2·10	0·81
	2·14	0·71

Here the values of E are expressed in Volt units: equal to 100 millions, or 10^8 absolute C.G.S. electromotive force, corresponding nearly to that of a Daniell element; and the values of R are expressed in ohm units equal to a billion, or 10^9 absolute units of resistance, nearly corresponding to that of a column of mercury at 0°, one metre long and 1 mm. in section.

The fact of diminution of the internal resistance is in perfect accordance with known properties relative to mixtures of liquids, and need not cause any surprise. The increase of electromotive force observes more consideration: it may, perhaps, be explained by supposing that the heat promotes the chemical action, and the current through the porous diaphragm. As to the diminution of resistance, it is evidently a consequence of the increased polarisation of the electrodes; because, with increased polarisation, the development of gaseous bubbles is facilitated.

In fine, the advantages claimed for this heated battery are as follows:—

1. A great and constant electromotive force.
2. A small and invariable resistance.
3. Economy.
4. Very composition, always presenting the same conditions.
5. Facility of adding new materials.
6. Cost comparatively slight, from the unprecedented consumption being small, the saving in that point alone compensates the greater expense of heating.

7. Lastly, a battery of six elements, formed each of an iron vessel about 6in. high, and 3½in. diameter, with all the rest in proportion, may cost about sixty lire (say, £2 8s.), and, used with heat, will give a current comparable to the maximum obtainable from a Daniell-Siemens-electric machine, modified known, which, with supports, will cost about 1000 francs. It may be noted that this battery in the cold state will have a nearly current of brief duration, as it remains a long time unaltered with open circuit.

SECONDARY BATTERIES OF M. PLANTÉ.

By A. HIGHTON-DIEUDÉ.

Secondary currents, or currents of polarisation, have formed the subject of numerous researches from the period when they were discovered, present century; but it is only within the last few years that it has been ascertained that they are capable of being applied to purposes of practical utility.

December 1, 1879.

During the last fifteen years M. Gaston Planté has been engaged upon the investigation of this subject, and, by continuous efforts and by successive stages of progress, he has arrived at results of the greatest interest—results of the nature of which we shall now endeavour to give an idea.

The reader knows that the Voltameter is an instrument in which water is decomposed by the current from an ordinary galvanic battery; in principle, it is represented one of the fundamental experiments in Physics. At the exact instant when the Voltameter has been just subjected to the action of the battery, it may be regarded as a secondary couple or element; if the two electrodes are now connected with the wire of a galvanometer the needle of the latter will be deflected during several seconds, and will show the passage of a current which grows gradually weaker and becomes imperceptible after a somewhat short space of time. This current is what is called a secondary current; it has been supplied by the battery to the Voltameter, and it is given back again by the latter.

M. Planté showed, as early as 1859, that lead is the most suitable metal for employment in secondary batteries, and he has, since that time, still further confirmed the superiority of this metal.

Fig. 2 shows a secondary element as now constructed. In a tall vessel of glass, gutta-percha, or ebonite, are placed two sheets of lead, rolled spirally, and parallel one to the other, and kept up with touching by two cords of indiarubber rolled mersed in a solution of one part of sulphuric acid to nine parts of water. The vessel is closed by a sealed cover pierced with a small hole, through which also allows the escape of any gas which may be generated during the charging of the battery. The apparatus is surmounted by a disc of ebonite, upon which are fixed two contact pieces in connection with the two electrodes; two

electrodes; for i quantity of electricity which the apparatus wou furnish is in proportion to the extent of leaden surface subjected to the action of the polarising current and covered with an active electro-chemical deposit.

It should be remarked that the particular (spiral) form of the electrodes gives an element having a large surface and a small resistance within a small space, so that one of Planté's secondary elements is equal to an ordinary element of a very unusual size; the small pattern has an active surface of 8 square decimetres (124 square inches), the large pattern a surface of 40 square decimetres (620 square inches).

The current furnished by the secondary element will effect chemical decomposition, act upon an electro-magnet, &c.; but if its intensity is measured by any of the ordinary methods, as, for example, by means of a galvanometer, it will be found to decrease gradually from the maximum spoken of above. This diminution is rather slow if the circuit has a large resistance, and if, in consequence, the electricity passes in small quantity; but it is, on the contrary, very rapid if the circuit

resistance, because the elec large quantity.

harge gives rise to an interest te battery is to all appearance d, but if it is allowed to rest th the circuit disconnected, it acquired a certain amount of again to give forth a certain city. The battery being then rst *residuum*, and again left to se, will give a second *residuum* nan the first. The latter will eral other charges can still be

ry clearly explained this pecu ulary element when it comes regard, and is at the same time case of batteries with a single ulum acquires after a certain t equal to that of the weakened , and the action then ceases or . If the battery is now allowed e itself, as happens in the case teries polarized by their own ly, once depolarized, is then e forth a current, but in the

becomes polarized afresh and so on.

Let us now suppose that the secondary element has been entirely discharged or nearly so, it can be recharged by means of the two Bunsen elements as at first; but it is worthy of notice that a fresh charge is communicated all the more quickly as the operation is performed more promptly after the discharge.

Moreover, a secondary element is all the better for having been charged and discharged a greater number of times; at first, when it is almost new, there is an advantage in polarizing the electrodes, sometimes in one direction and sometimes in the other, reversing several times the direction of the charge; but when the element is formed the greatest care must, on the contrary, be taken to charge it always in the same direction. If this precaution is neglected the time required for charging will be much increased, for the oxide of lead which may happen to remain upon one of the electrodes must be reduced and the plate, previously negative, must be oxydized. But after this operation the secondary element regains all its power and may even be said to be all the better for it.

December 1, 1879.

position all the outer electrodes are joined to one metallic bar, and all the inner electrodes to another similar bar, so that the whole apparatus is equivalent to a single element of very large surface; it is whilst in this position that the secondary battery is charged; two Bunsen elements are sufficient to effect a complete charge, the time occupied during longer or shorter according to the size of the charging cells and the extent of the leaden surfaces to be polarized. In the second position of the commutator, the exterior electrode of each element is connected to the interior electrode of the next element, and the apparatus becomes a real battery of twenty cells; it is whilst connected in this manner that the battery is discharged; the power at the beginning of the discharge is equal to thirty Bunsen elements of very large surface.

As the discharge proceeds, the tension falls, as we have explained when speaking of the single secondary element. If one minute has been the time occupied in charging the secondary battery,

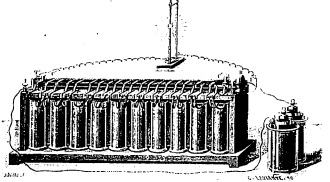

FIG. 4.—*Secondary Battery of twenty elements capable of being charged with two Bunsen elements when arranged for quantity, and producing light when being discharged with intensity connections.*

in quantity, from the two Bunsen elements, it cannot be expected that the discharge, in intensity, will produce the effect of thirty Bunsen elements of the same size during more than four seconds, for the apparatus does not produce electricity, and can only transform that which is imparted to it. M. Planté has made exact experiments upon this point, and has found that in the transformation about one-tenth part is lost, or, in other terms, that the apparatus gives back nine-tenths of what has been expended.

It is easily perceived that the secondary battery can only produce effects of short duration, but in a very great number of cases such effects are all that is required.

If, for example, it is desired to explode simultaneously a large number of mines by means of fuses of fine wire, the object can be attained by joining all the fuses as branches out of a single wire, and discharging a secondary battery into all of them simultaneously. This plan is a very economical one; there is no doubt that it involves much less labour and cost to set up two Bunsen elements and charge the secondary battery than to charge the twenty or thirty Bunsen elements whose place is supplied; it being of course understood that the work is required from the battery during but a few seconds, and that the operation is repeated but four or five times in the course of the day. Moreover, the secondary battery can be easily carried about to the different workshops where the works extend over a considerable area, as during the construction of a long tunnel or the sinking of shafts for mines.

In small laboratories the expense of setting up a large Bunsen battery is an obstacle to the carrying out of certain experiments, either for demonstration to pupils or for the investigations and researches of the teacher. The greater number of these experiments become possible by the use of the Planté battery. If, finally, this apparatus is used in combination with a Gramme machine in steal of an ordinary battery, all handling of acids is got rid of as well as all other expense except the purchase of the apparatus, which will last an indefinite time.

We have the greatest confidence in the future of this combined employment of the secondary battery and the Gramme machine, and we shall show in conclusion how it furnishes a solution to the important problem of lighting ships with a view to the avoidance of collisions at sea.

It is not by any means necessary to exhibit at the top of the mainmast a permanent electric light; it will be enough to secure a vessel from collision if it gives warning of its presence around the horizon by a signal of two seconds duration shown once a

November 1, 1854.]

THE TELEGRAPHIC JOURNAL.

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ON THE EFFECTS OF POLARISATION WHICH RESULT FROM THE PASSAGE OF CURRENTS THROUGH BAD CONDUCTING MATERIALS.*

By the COUNT DU MONCEL.

In my preceding articles on the electric conductivity of figurative bodies I showed that these substances are chiefly conductors by reason of the moisture they absorb. A similar effect is found in most mineralia, and certain of them even possess this property so highly that very sensitive hygrometers may be formed of them. Calcareous stones of a fine grain, like the stone of Caen, are of this description; and the moisture pervading them in consequence of their contact with atmospheric air suffices to furnish, with zinc and copper electrodes fastened to the extremity of a small prism 10 c.m. in length, currents—varying with the moisture of the air—capable of affecting a sensitive galvanometer. Hard, unexpalishable stones, also, have a conductivity varying with atmospheric moisture, but to a less degree, whilst a moderately strong and prolonged heat will diminish it considerably. Like hard woods, these descriptions of stones, having slowly parted with their moisture, as slowly take it up again. This gives most curious effects. With regard to this I will give at a later date some details, and I will speak, at the same time, figures to represent the conductivities of different kinds of stones. At present I wish only to refer to certain effects of polarisation that presented themselves on studying the conductivities of these substances, and which are so far beyond known effects that grave errors might be committed if we contented ourselves with a superficial glimpse of them. The following experiment, wherein these effects showed themselves as great as to make it impossible to be overlooked, induced me to investigate them:—

Desiring to measure the conductivity of an excellently irregular piece of yellow silex, I enveloped the two extremities in very thin platinum plates, so shaped as to fit the irregularities of the ends; and to attach the plates more firmly to the stone, I used for the one end a small iron vice, for the other a copper nipper. On closing the circuit, the current from my bichromate of potash battery, of six elements, gave a deflection of 30°. and, leaving the whole concern to itself, I was surprised —at the end of ten minutes—to read a deflection of 45° instead of having to register a great diminution as results of polarisation,—a diminution which with substances are, in the space of ten minutes, often become equal to half the first strength; and yet, by breaking the circuit and rejoining up the electrodes to the galvanometer, I was able to record a polarising current of 12°, which required ten minutes to completely disappear. By reversing the polarity of the electrodes—that is to say, by changing the electrodes' connexions with the battery—I obtained at first a deflection of 55°, which became reduced at the end of ten minutes to 28°, and yet the polarising current was only 9°.

* Communicated by the Author.

A fresh inversion of the electrodes' polarities gave a deflection of 38°; but this did not rise to 42° at the end of the ten minutes, until it had fallen to 35° in the first moments of the experiment; the polarising current was 10°.

These experiments, repeated a great many times at different periods, and always with the same results, caused me to examine attentively the arrangement of the experiment. I ascertained that the increase in current strength by prolonging the closure of the circuit only took place when the iron vice was in connexion with the battery's negative pole. On the other hand, on taking off my electrodes, I no sooner had that which corresponded to the iron vice was slightly pierced by one of the stone's rough edges. Therefore the phenomenon was easily explained, for it was in consequence of a copper and iron local couple created in the heart of the stone, which—by interfering with the effects produced by the battery and by the polarising currents—modified them, in effect or reverse, according to the direction of the battery current through the stone.

In the case in which the electrods in contact with the iron vice is in communication with the positive pole, only ordinary effects are produced. The local and battery currents flow in the same direction through the stone, like currents from two batteries joined in series placed in two different points of a circuit, and the strength of the battery current is naturally augmented by that from the local current. Hence we have the greatest observed deflection—viz., 55°—as compared with that produced under similar circumstances with the current reversed; and, since the effects of polarisation are in ordinary currents, the diminution of deflection takes place in a continuous manner, more rapidly than in liquids, on account of the slow dispersion of the polarising gases. Nevertheless, as at the moment of breakage of the battery current and of metallic tension of the two electrodes, the polarising current becomes inverse in direction to that of the battery, whilst the local current remains under the same conditions, the polarising current which is collected is only a differential one, and might even be overcome by the polarising current, if the local currents were sufficiently energetic.

In the instance when the established electrode that in connexion with the iron vice is in communication with the negative pole of the battery, *that electrode receives the deposit of hydrogen* which provokes polarisation; and, *as the oxidation of this gas substitutes itself for that of the electrode itself which is more or less enchroped*, as the case may be, *different effects may result therefrom, according to the relative energy of the electromotive forces of the local and polarising currents.* In the case when the local current is the most energetic, the effect of the cancelling of the metallic oxidation ought to result in *an increased force of the battery current, by destroying more and more the contrary force which had previously weakened it.* When the two electromotive forces are able to counterbalance each other, the strength of the current may remain sensibly the same, at least during a certain time. Lastly, when the polarising current's electromotive force overpowers it, the current should continue to become weak, but in a much less degree than when the battery and local currents are together. This effect I have been able to obtain in other experiments, quite easily, by employing a condensing current less powerful, that is, by diminishing the electromotive force of the battery.

February 1, 1855.]

THE TELEGRAPHIC JOURNAL.

The value of T in) independent of the way in which electricity escapes from the conductors; it is easy to see, therefore, that this value remains the same when two equal quantities of contrary electricities recombine themselves. Let us suppose, in effect, that two quantities of electricity $+a$ and $-a$ recombine upon a value M, in order to form neutral electricity; let V be the potential function of this point. Let us suppose, that, at the point M, the $+a$ electricity to be repulsed by a force $= a\,\frac{dV}{ds}$; the portion of the work T necessary to extend $+a$ to infinity, starting from the point M, is V a. The quantity $-a$, on the contrary, placed at the point M, is attracted, the attractive force has the same value as that of the repulsive force, and when $-a$ is extended from M to infinity, the corresponding work is equal to the preceding, and of contrary signs. The value of T remains consequently the same, whether the two electricities are extended to infinity, or whether their recomposition takes place at any known point; it is necessarily the same if the recomposition is produced upon a conductor.

This is the case presented, for example, in the discharge of the Leyden jar. Let us consider a spherical bottle; let us call r the radius of the sphere which forms the interior armature, r the thickness of the glass. If we designate by q the charge of the interior armature at a given instant, by dq the quantity of electricity repulsed from the interior armature upon the exterior armature, when these two armatures are connected by a conductor, the work effected in the repulsion of the quantity of electricity dq is—

$$\int_{r}^{r+e} \frac{q\,dq}{dr^2}\,dr = q\,dq\left(\frac{1}{r} - \frac{1}{r+e}\right) = q\,dq.$$

The work of repulsion which corresponds to the quantity of electricity q, primarily contained on the interior armature is—

$$R = \left(\frac{1}{r} - \frac{1}{r+e}\right)\int_{q}^{0} q\,dq = \frac{1}{r}\left(\frac{r}{r+e}\right)q^2.$$

The factor contained in the parenthesis represents the potential function of the interior armature; we find then, in the particular case of the Leyden jar, the expression for the potential of the electricity.

We may deduce from what precedes the demonstration of a theorem established by Gauss in the case of a system conducting and submitted to generalised by M. Liouville for a system of conductors. When conductors endowed respectively equal quantities of the two fluids, all those conductors are in a mutual condition, in effect, in this case, the potential is nil; consequently the exterior discharge of the system of conductors cannot give place to work.

ON GALVANIC POLARISATION IN GASLESS LIQUIDS.*

By Professor HELMHOLTZ.

It is known that when a Daniell's element is connected with a water-decomposing cell by platinum electrodes, a current flows, which soon, however, decreases and becomes very weak, but does not quite cease, even after a long time. We may call current this the *polarising* current. If the decomposition cell is then separated from the Daniell, and its platinum electrodes are connected with a voltameter, we have another current, the *depolarising*, which is opposite in direction to the former, and, from being at first strong, soon decreases, generally, till it becomes imperceptible.

This simple experiment was my starting-point. The difficulty presented itself—Why has the polarising current an apparently unlimited duration? For in a circuit of the kind described, unless some other changes occur, the electrolytic conduction in liquids (according to Faraday's law) cannot take place without a violation of the law of conservation of force. If, that is, no other equivalents of potential energy be consumed, then the mechanical equivalent of the heat produced in the circuit must be equal to the work-equivalent of the chemical forces brought into action in electrolysis and consumed. The latter, however, is *negative* if the decomposition take place according to the law of electrolytic equivalents, and consequently cannot be equal to a *positive* heat-work produced by the current. Decomposition of water, therefore, if Faraday's law is exclusively applicable here, cannot be continuously maintained by a Daniell, even in the smallest degree. An example of the liberation of the gases forming water comes after a time in the above experiment.

But it is not to be thought that by diffusion, or some like process, the molecules of hydrogen and oxygen, forced against the plates by the polarisation of them, become free again, returning to an electric state from the plates. Such a phenomena would ever more give a work-equal to decomposition of water for which no equivalent of force would be found in the Daniell. The electrical attraction of the two elements, strong enough to overcome chemical affinity, could only be overcome by a force of equal or greater equivalent of work, so as to set the attracted particles at liberty in the liquid.

If, now, the electromotive force of the Daniell, in our present case, produces no visible decomposition of water, it produces polarisation of the electrodes, and this is itself a work-equivalent. For the polarised plates are, afterwards, when separated from the Daniell, capable of giving a current which bears a considering wire, and produces other effects of current.

The state of polarisation is to be regarded as a new state of equilibrium to which the decomposition-cell tends, under electrisation of the electrodes; and if the electricity accumulated in the electrodes can discharge itself, the cell tends to return to the state of electro-neutral equilibrium. But since, for the production of an altered equilibrium in a finite system of bodies like the decomposition-cell, an only finite amount of work is necessary, the production of polarisation must only give a current of finite duration, or one whose intensity approaches zero asymptotically; and the polarising current can make only so much electricity flow in the one direction as the depolarising in the opposite direction.

In so far as this is the case,—and my experiments show that with gaseless liquids and gaseless electrodes we may come very near such a state,—the decomposition-cell acts like a condenser of very

* Abstract of a recent Paper to the Berlin Acad.my.

over

Electrical News
July 29 1875

ELECTROLYTIC POLARISATION.—Professor W. E. Ayrton and John Perry, from experiments carried on by sending a current from one or more Daniell cells through a voltameter and measuring its strength after a certain number of minutes, then suddenly reversing and observing the current strength a fixed time after, find that when the cathode is of copper wire, the anode being a copper plate, there is a quick falling off in the first current and a slow falling off in the reverse one; with a platinum wire cathode opposed to a platinum plate anode the reverse effect takes place; but with a platinum wire anode the same effect takes place. Messrs. Ayrton and Perry explain these facts by pointing out that since the surface of the wire in the voltameter is extremely small compared with that of the plate, the gases deposited on the wire will have more effect than those deposited on the plate in the polarization of the voltameter; and also that oxygen deposited on copper will, on account of its forming an oxide, be less operative in producing a reverse current than hydrogen; while on the other hand on account of the great absorption of hydrogen by platinum and of the difficulty of forming an oxide of platinum, it will be deposited oxygen that will produce the chief polarisation in the platinum voltameter.

POLARISATION.

So much interest is shown by our correspondents in the difficult subject of polarisation that we have determined to collate into a series of papers the opinions and deductions of foreign scientists. Reference will be made, *en resumé*, to the labours of our countrymen, and these remarks will include the description of several original experimental results with which we have been favoured. The chief labourer in this field recently is the Count du Monsel, and we will commence the series with a translation of the table and accompanying article from the *Comptes Rendus*, on the effects produced by electric currents on mercury immersed in different solutions.

"In my last two communications on the action produced by currents upon mercury immersed in solutions of sea-salt, of cyanide of potassium, &c., I have principally attributed the origin of the secondary current, which is produced at the same time as the current of polarisation, to a resultant action of the combination of the two gases disengaged at the two electrodes; but some later experiments have shown me, as I have indicated in *Les Mondes* 12th April, that the effect is more complex, and is related to the action of the metals entering the saline solutions and the amalgams of mercury under electric influence. Having removed the globule of mercury from the electrolytic solution, and washed it with distilled water, the water became alkaline. After this experiment there was no longer a doubt that an amalgam of sodium and potassium is formed in the same manner as the ammonium-amalgam with a solution of sal-ammoniac. The effects which I have described are thus capable of very simple explanation.

"The work I have since undertaken on this question has shown me that, conformably to the observations of M. Planté, the mercury employed as electrode in an electrolytic may increase the evolution of secondary currents, more or less powerful, according to the energy of the chemical effects developed by the mercurial electrode, whatever may be its polarity.

"When mercury constitutes the negative electrode, these secondary currents accrue most often from the amalgams formed, and the energy of these currents depends upon the degree of oxidability of the metal alloyed with the mercury, the degree of concentration of the solution, the greater or less facility with which these metals alloy with the mercury, and, finally, upon the stability of their saline combination. The extension of action of these currents, on the other hand, appears to be in relation with the time of electrolysation, and to depend upon circumstances which permit a larger quantity of the metal to amalgamate with the mercury. Generally, the first action of these secondary currents, which is similar to that of the polarisation current from the reaction of gaseous elements, remains nearly the same for from five to fifteen minutes, but the differences increase after five to ten minutes' interruption of the polarising current. Sometimes, also, there is formed upon the negative electrodes, when these are insoluble, particular deposits which, without being a metal, are susceptible of furnishing an energetic chemical reaction; this occurs with the solution of sal-ammoniac when the negative electrode consists of a plate of platinum: there is then produced a secondary current, most transient it is true, which attains at the first moment an intensity of 40°, whilst with ammonium amalgam the intensity is only 56 to 60. It may be remarked that the platinum plate is covered with a brown deposit, which is strongly adherent.

"One important point is, that a very small proportion of a salt is capable of furnishing a very energetic secondary current. Also, that a solution of pure sulphate of binoxide of mercury does not give rise to an appreciable secondary current; but carbonate of soda or sulphate of zinc, however, affords a most energetic current. It is from this cause that sulphate of mercury batteries, when they are new, polarise but little, and whether there has been some time in use become very inconstant, because the mercury reduced in contact with the carbon is surrounded by a solution more or less impregnated with sulphate of zinc, or with other salts which always exist in the commercial sulphate of mercury. It is for this reason that I have advised the construction, for this kind of battery, of porous cups with a double bottom pierced with holes, in order to isolate the carbon from the mercury and from the liquid charged with sulphate of zinc."

When the mercury constitutes the positive electrode there are also produced very energetic secondary currents, which more often accrue from oxidation of the mercury, and the reduction of the salts by the hydrogen condensed on the negative electrode. These currents are much less permanent than those which are set up by the negative electrodes. The most important occur with solutions of sulphate of soda, sulphate of zinc, sulphate of iron, and sal-ammoniac. Sometimes the currents are more energetic, for the same solution, than when they are obtained by a negative mercurial electrode. At other times the contrary obtains; and in order to give an idea of the said results, I have composed the accompanying table, which indicates not only the intensity of the currents after different periods of interruption* of the polarising current, but also the initial current due to the action of the solution on the mercury. These intensities were given upon a zinc-platinumeter of 24 turns, with a resistance equal to 12 kilom. of telegraph wire (4 m.m. diam.). The primary current was derived from a battery of eight Chaloux elements, charged some time before, and the figures are the mean of a certain number of experiments, made at different times. The experiments were difficult to perform, on account of the inconstancy of the currents.

Solutions.	Initial Current before Electrolysation.	Intensity of Secondary Current. Mercury Negative. After 1′.	2′.	5′.	Mercury Positive. After 1′.	2′.	5′.	Negative Platinum Plate. After 1′.	2′.	5′.
Distilled water	0 0	2 0	0 0	—	1 3	0 0	—	2 0	0 0	—
Spring water	0 6	9 0	1 3	0 0	3 3	0 0	—	2 0	0 0	—
Acidulated water (1 in 10)	0 40	4 0	0 0	—	15 0	2 3	—	4 0	0 0	—
Chloride sodium	0 60	25 0	20 4	11 25	6 0	0 0	—	15 0	0 0	—
Potash	0 20	25 0	14 0	7 45	6 0	0 0	—	15 3	0 25	0 0
Bicarbonate soda	0 20	30 0	23 0	20 1	13 0	0 0	—	16 0	0 12	0 0
Sulphate soda	0 42	30 0	16 3	16 4	31 0	0 0	—	6 2	0 0	—
Sulphate lime	0 0	16 3	6 0	4 0	13 0	0 0	—	12 1	0 25	0 0
Sal-ammoniac	0 18	56 0	3 0	0 0	13 0	0 0	—	6 3	0 0	—
Oxalate ammonia	0 0	27 0	0 0	—	3 0	0 0	0 0	49 0	1 25	0 24
Sulphate mercury	2 30	5 0	0 0	—	19 0	3 0	0 0	3 3	0 0	—
,, zinc	0 0	17 3	3 0	—	4 0	0 0	—	2 0	0 0	—
,, copper	0 0	5 0	0 0	1 48	36 0	3 0	1 3	19 15	4 1	—
,, iron	0 10	16 3	3 0	0 4	13 0	0 0	0 0	3 0	0 0	3 0
,, magnesia	0 0	8 3	0 0	0 0	30 0	1 3	0 0	23 0	4 1	3 3
,, alumina	0 28	15 3	3 3	—	6 0	0 0	—	4 3	0 0	—
Nitrate ammonia	0 30	8 3	0 0	2 15	16 3	3 0	0 0	2 3	0 0	—
Cyanide potassium	0 30	8 3	0 0	—	16 3	3 0	—	2 3	0 0	—
Iodide cadmium	0 0	17 0	6 0	0 0	8 0	0 0	—	2 0	0 0	—
Carbonate baryta	0 0	3 0	0 0	0 0	18 0	2 0	—	26 3	23 0	3 0
		4 3	0 0	—		2 0	0 0		2 0	0 0

These experiments were made after five minutes' electrolysation.

* See pp. 1-4 of Application de l'Electricité, 2nd edition, vol. i. p. 31.

Continued

Electrical News
July 29 1875

Poggendorff's Annalen der Physik und der Chimie, No. 6, 1875.

Time of Expiration of the Polarisation Current.—Prof. J. Bernstein.—Suppose a constant current sent through a decomposition cell, and the electromotive force, of a given moment, to disappear, it is required to find the time at which the polarisation current diminishes in the same manner to zero. The author describes a number of experiments bearing on this. It is shown, *inter alia*, that the curve of polarisation currents is only in the first moments an approximately logarithmic one; in course of time it departs more and more therefrom, while it sinks more slowly to the line of abscissæ. This is explained partly by the behaviour of the gases deposited on the electrodes, smaller quantities of gas collecting more tenaciously to the metallic surface. The mode of solution of hydrogen by many metals, and the change of surface of the hydrogen electrode, also influence the phenomenon. From another series of experiments, it was proved that the electromotive force of polarisation in a closed circuit, resistance and surface of electrodes remaining the same sinks the more slowly the greater its initial value; with increase of this, the velocity of disappearance, up to the maximum of polarisation, approximates to a minimum, and with decrease it approximates to a maximum.

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The arrangement also continued after the current ceased to act. The crystallites were always directed so that their longer axes lay in the direction of the curves.

The same behaviour was exhibited by various powders suspended in water, viz., copper-oxide, chrome-oxide, sulphide of iron, cinnabar, glass powder, fluoride of calcium, black *Indian* ink, carmine, coal, bubbles of oxygen and hydrogen, hypochlorite (previously boiled, to prevent boiling together), copper, platinum, zinc, and brass. The conductors of electricity among these substances presented a more complex phenomenon, for the metallic particles, with whirling motions, changed their places extremely quick, and at the same time little gas bubbles rose from their projections in the liquid. This development of gas, which was only observed from powders of metal, appears to arise from a decomposition of the water, and not from adherent air particles, etc., such an adherence would also have been observed in non-conducting powders. This gas-development makes the rotary movements of the metallic particles intelligible. Both phenomena are absent when the electricity acts only a short time; in this case the curves of metallic particles take the same form as those of non-conductors.

Thus the good conductors differ from the other bodies examined, inasmuch as they very soon change the position required through the alternating currents, in consequence of development of gas, due to a dielectric charge of the particles, and for the same reason a state of rest of the system, such as in the case of non-conductors and semi-conductors, does not occur.

To elucidate the cause of the phenomenon a series of modifications were introduced into the experiment. First, the conductive resistance of the distilled water in which the particles were suspended was diminished with ordinary salt or some sulphuric acid; the effect of this was that the phenomena of direction and arrangement were absent.

A constant battery current being allowed to act on the particles suspended in water, instead of the alternating currents of the induction apparatus, the long-known phenomenon of transference could be observed; the particles wandered (with a certain strength of current) towards the positive pole. A double movement of the particles was frequently perceptible. When the water was rendered conducting the transference phenomenon ceased.

When the constant current was, by means of a tooth wheel or other arrangement, frequently interrupted, so that intermittent battery currents, going in the same direction, acted on the suspended particles, these latter moved towards the positive pole, just as in the case of the uninterrupted battery current. The movement was a continual, not a jerking one when the number of interruptions was not too small. With exalted conductivity of the water, the phenomenon did not occur. It must, however, be remarked that the intensity of the currents available was not sufficient to carry forward

ELECTRIFICATION OF PARTICLES FLOATING IN WATER.

If coarsely pulverised Iron nuts be shaken with ether, there appears a white powder which shows a distinctly crystalline structure under the microscope. The so-called crystalloid forms obtained thus have been subjected by M. Wegt to the action of electric currents under the microscope. For this purpose two triangular pieces of tin-foil were fixed in a glass plate with opposite points about two millimetres apart. Between them was put a drop of distilled water, in which the crystalloids were suspended. When the alternating currents of a sliding induction apparatus were sent through the crystalloids, which before were quite irregularly distributed in the water, arranged themselves in a perfectly regular manner under the microscope into a position parallel to the direction of the current. After several discharges nearly all the particles were brought into the parallel direction, with exception of the larger particles, which were hindered by friction on the glass. Further opening discharges on the directed particles drove them towards the positive pole. In one case, when copper powder and quartz powders floated in the water, the "reduction of the particles was at first produced quite as usual, but, on making further opening discharges, the copper particles wandered towards the positive pole, the quartz particles towards the negative. If to the opening discharges were made in close succession, the particles stood with their long axes in the direction of the current, arranged in curves, as in the first experiments. Each further opening discharge approximated the particles to the positive pole. On addition of common salt or sulphuric acid all these phenomena disappeared.

Lastly, when alternating currents from a constant battery were caused to act on glass powder, coal, Indian ink, or carmine, distributed in water, each particle kept the same place which it had before the action of the current, during its action, and the particles were arranged in the usual regular curves their longer axes lay in the direction of the curves. These experiments prove that the action of the induction alternately with the and the alternating currents of a constant battery are the same; but they especially show that the state of rest of the curve system may be regarded as a function of the alternating currents.

The phenomena here described, of direction and still state of the particles, M. Wegt explains by the supposition, according to Faraday's view, that each particle reached by the current (conductor, half-conductor, non-conductor) becomes dipolarly electrical thereby. The separated electricities accumulate in each particle with predominant longitudinal direction at the two poles, and in consequence of the alternation of the two tinfoil poles, the charged particles must take direction. Each individual particle must attract the other, and so there arises a chain of particles whose oppositely charged poles are turned to each other.

"All this," says M. Wegt, "holds good for the case in which a single current impulse of short duration has come upon the particles suspended in water. If now the direction of the current impulse is altered every instant, the attraction and direction of the particles produced by the first current impulse will not experience any change through the second current impulse, which is oppositely directed to the first; this merely reverses the signs of the poles. And the particles do not any further change their place under influence of the second impulse, since they are already, through the first current impulse, in the place to which the attracting or repelling forces of the two neighbouring poles of opposite sign have brought them. All subsequent current impulses act in like manner."

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Electrical News July 1 1875.

On Rotatory Magnetic Polarization. — Henry Becquerel.—It has been remarked that bodies endowed with strong rotation generally possess a great magnetic rotatory power; but the exceptions seem to this rule hinder the full acceptance of these two physical properties. Thinking that if bodies were endowed with rotatory refracting, the influence of refraction might become convincing, and that it would be possible, under these conditions, to display a relation between refraction and magnetic rotation, a very powerful electro-magnet was made use of, through whose armatures was pierced a cylindrical hole following the line of the poles. The measure of the rotations was effected by means of one of Jullet's penumbra polariscopes. The sources of light were the mono-chromatic flames of sodium, of thallium, and the flame of lithium seen through red glass to eliminate the orange light. Several experiments were made, and tabulated in two tables. In one of them the substances chiefly comprised compounds of chlorine, phosphorus, sulphur, and carbon, and they present a regular increase of rotation for the same length of wave, in proportion as the index of refraction increases. The second table does not show the same feature of regularity; and this may be attributed either to effects of lamellar polarisation, as in the diamond and garnet, to the presence of magnetic bodies, or to unknown causes. May we not possibly account for these effects by assuming that the rotation of the plane of polarisation to be due to an action of magnetism upon the inter-molecular ether, and that at the same time the molecules of the body influenced are magnetically polarised, so as to present poles of a contrary name to those of the magnet. These molecules will then be as many small magnets inverse to the magnet influencing them, and acting at very small distances upon the medium which transmits the luminous vibrations. The intensity of this action is eminently variable with different bodies; it may depend upon their specific magnetism, and upon the reciprocal distance of the molecules. It is thus possible to conceive that the true action of these molecules may considerably lessen the action of the magnet; and even if the body is very magnetic, and under suitable conditions, this molecular action may become preponderant, producing a negative rotation as is observed with certain kinds of magnetic metals. *En resumé*, the experiments demonstrate that in bodies feebly magnetic and very refracting, which have not hitherto been studied, the increase of the magnetic rotatory power follows as a rule the increase in the index of refraction.

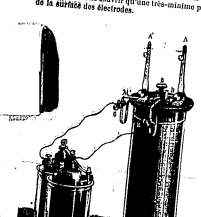
No. 21, 1875.

20. Les electrodes sans polarisation, par Overbeck. (Ann. de Poggendorff, vol. CLIV, page 445).

Du Bois-Reymond avait trouvé que des plaques de zinc amalgamées dans des solutions de sels de zinc ne se polarisent pas sous l'influence du passage du courant. D'après M. Oberveck, cette découverte ne serait exacte qu'autant qu'il s'agit de courants faibles. Si l'on emploie des courants d'une intensité un peu forte, les effets de la polarisation, par suite de la décomposition de l'eau, se produisent sur ces électrodes comme sur des électrodes formés d'un autre métal quelconque.

[32.IX.] — **Plante's Secondary Battery.** — I. The capacity of the cells usually used for secondary batteries is about 11 pint; the limiting pressures are 0·07 to 2·3, diameter. 2. If you want a "simple form" employing the electric light by the "simple arrangement" of the size of the primary battery with platinum, for each cell, do the next following cells. Connect the free wire of your primary battery with the first plate of lead of your first cell of your secondary battery, and the free carbon of your primary with the last lead of the last cell of your secondary battery. Now suppose you work with the four plates of which you have two in each cell, the one in each cell with the letter *L*, the other with the letter *P*. Then connect in each plate marked *L* with the plate marked *P* in the following cell. This is coupling for electro-motive force. For obtaining heating effects join all the plates marked *L* to one primary wire, connected with the carbon of your primary battery and all the plates marked *P* to the platinum wire. The same. 3. Six of these cells charged for one hour or two Bunsen cells charged for thirty minutes equal to three of Grove's or thirty Bunsen cells.—WILDERMANN

plus volumineux; M. G. Planté en a conclu qu'il y avait lieu de les rechercher et de les mettre à profit pour accroître la force électro-dynamique. Cet effet qu'il obtint réellement en 1860 au premier étonnant secondaire de grande intensité, formé de deux longues et larges lames de plomb enroulées en spirale, séparées l'une de l'autre par une toile grossière et plongées dans du bois plein d'eau acidulée au 1/10 par l'acide sulfurique. — Il lui suffit de multiplier plusieurs de ces couples pour former une batterie secondaire de grande surface. La seule modification qu'il apporta à cette disposition primitive fut de substituer à la toile des lames de caoutchouc présentant l'avantage de ne pas s'altérer dans l'eau acidulée, et de ne couvrir qu'une très-minime partie de la surface des électrodes.



Pile secondaire en train de se charger.

Étudiant ensuite très-savamment les actions chimiques produites dans ses couples secondaires à lames de plomb, l'auteur expose les conditions suivant lesquelles il doit être procédé à leur *formation ou préparation* électro-chimique de manière à en obtenir le maximum de résistance et le plus grande intensité de charge.

Le couple secondaire ayant été rempli à l'avance d'eau acidulée au 1/10 par de l'acide sulfurique pur, on le fait traverser, le premier jour et pendant une heure, par un fort courant alternativement dans l'un et l'autre sens, et on huit fois, dix minutes de charge, dix minutes sens inverse de courant de deux éléments Bunsen. On déchargea le couple secondaire entre chaque changement de sens, et on recommence, sans pause autre effet, que la durée de la décharge va sans cesse en croissant.

La disposition faite à tout le temps pendant lequel le couple reste soumis dans le même sens à l'action du courant jusqu'à ce qu'il donne à l'heure et 1 heure on le laisse reposer, ensuite chargé dans un sens déterminé pendant une heure. Le lendemain, on les recharge deux heures en sens inverse, puis deux heures dans le premier sens et ainsi de suite. On constate les progrès de la formation à l'aide du volta. On constate les progrès de la formation à l'aide du voltamètre.

Après un certain nombre de charges et décharges successives, on arrive à un maximum de résistance et de force électro-motrice. Mais il arrive bientôt une limite au delà de laquelle cette durée n'augmente plus sensiblement, surtout lorsque la pile primaire n'était pas puissante, c'est difficile peu à peu par de actions successives et n'a plus une intensité suffisante pour que l'électrolyse pénètre plus profondément à l'intérieur des lames.

On laisse alors le couple secondaire au repos, pendant huit jours, et on le recharge pendant plusieurs heures, sens faire, le même jour, de nouveaux changements de sens, puis, au porte peu à peu l'intervalle de repos à quinze jours, un mois, deux mois, etc., et la durée de la décharge va sans cesse en augmentant. Elle n'a d'autre limite que l'épaisseur même des lames de plomb. La lame positive, en effet, finit par être transformée presque entièrement, avec le temps, en peroxyde de plomb à texture rigide. La lame négative se trouve peu à peu formée, jusqu'à une certaine profondeur au-dessous de la surface, de plomb réduit, spongieux et cristallin.

Il n'est pas toutefois nécessaire de pousser la préparation électro-chimique des couples secondaires jusqu'à cette transformation complète de la nature physique et chimique des lames; car les couples finissent alors par acquérir une plus grande résistance et exigent plus de temps pour être chargés.

Lorsque des couples secondaires donnent une force suffisamment puissante pour l'application qu'on veut en faire, il n'y a plus lieu de changer le sens du courant primaire, chaque fois qu'on veut les mettre en circuit primaire, plomb secondaire sur la lame positive avait trop longue à produire, et l'on n'abandonnait aucun effet de couple avant plusieurs heures. On arrive dans un sens déduit dans qu'ils sont suffisamment formés.

Rien n'empêche de multiplier indéfiniment le nombre des piles Planté, comme on le voit par la photographie du laboratoire de l'inventeur.

Les couples secondaires acquièrent, par l'opération de la *formation*, une propriété précieuse : celle de conserver une grande partie de leur charge pendant un temps assez long. Après l'action du courant primaire, ils peuvent rougir un fil de platine d'un demi-millimètre de diamètre, pendant quelques minutes, deux ou trois semaines après avoir été chargé.

—

Les applications des courants secondaires à la galvanoconstique et à la thérapeutique sont très-fréquentes aujourd'hui, et tendent à se généraliser par l'emploi d'appareils très-habilement construits à cet effet, et pouvant être facilement chargés pour fournir, sans aucune manipulation auprès d'un malade, la chaleur nécessaire à l'opération. La puissance d'électricité emmagasinée dans un couple secondaire suffit même pour exécuter plusieurs opérations successivement sans avoir à le recharger.

Il serait impossible de donner une nomenclature complète des usages innombrables auxquels est appareil si intéressant se prête.

Nous devons cependant faire remarquer qu'il est admirablement disposé pour l'éclairage des cavités obscures du corps humain et des cavités obscures en général à l'aide des pyroscopes de M. Trouvé, l'habile constructeur, que tant de dispositions ingénieuses ont signalé déjà aux savants.

Parmi les applications qu'on peut faire des couples et des batteries secondaires, l'une de celles auxquelles ces appareils se prêtent le plus naturellement est l'*inflammation des mines*, car elle n'exige qu'un effet calorifique de courte durée, répété à certains intervalles.

Nous signalerons encore le *lebiquet de Saturne*, petit instrument si commode pour obtenir facilement du feu dans les laboratoires et pour les usages domestiques.

Les batteries secondaires peuvent produire des effets d'une énergie prodigieuse dans la manœuvre des *freins électriques* sur les chemins de fer; elles donnent à la guerre des effets lumineux instantanés d'une force inouïe.

Du moment qu'on n'a pas besoin d'une action longuement continuée, on peut dire que M. Planté a trouvé moyen de mettre véritablement la foudre en bouteille.

STORING ELECTRICITY.

[17196.] Crard, Jean-Jacques-Alfred-Napoléon, Count, and Gaulard, Lucien, Engineer, both of Paris. [Provisional protection only.] [Dated 7th October, 1882.]

"If, it is said, we could store up electricity, as we can water or steam, we should have a motive power which would be much more economical than any other." (17195, p. 129) that has been referred to as the "ideal case. The fact is, "not realising the importance of the idea from any fear that we may ever discover a means of doing so. The importance, and that it is nothing but what I, in common with every scientific electrician, have been constantly dealing with this many a year. If [illegible] I have put forward to "day not far distant when it will be possible to purchase of "electricity sufficient to work a number of electric lights, when exhausted, they will return to the central station, "to be there what many people do not know every in the distance for what lies under their noses, "and every [illegible] battery. As I pointed out my former paper, the "storage of electricity" is nothing but a common gravity form of "[illegible]" the only question about it is one as to the relative charging and convenience of charging it at [illegible] and the [illegible] of copper and zinc, or pondering these relationships in the cell itself by means of electrolysis. I think it will be possible that the conditions named might be modified, but to settle it would require experiment and time, which I do not feel inclined to undertake; but I can say this at once: to store the work from a 1-horse power engine in an 8-volume gross of work, requires how the effort may be reduced to a minimum of trouble or expense.

"But the fact of the principle of least action being mathematically deduced from the principles of motion would seem to prove that there is, in reality, no choice in the matter, and that the most economical system is such as that of the least distance between two points on a sphere being that which is traced by the great circle joining them."

After treating this geometrically and dynamically, he urges that "the dynamical minimum stands on the same footing as the geometrical . . . . I think we ought to recognise the fact that there is unity in the order of nature, that the mind must be at last satisfied with nothing short of the great Arithmetic, and in reality be the result of geometrical and other necessity, inherent in the conditions of space, or time, or matter."

Scientific.

ELECTRICAL RESISTANCE.

[17196.] Langdon, J. Brown, 23, Bedford-street, Strand, London. [Dated 7th October, 1882.]

This is a thoughtful and intelligent title where there is much to approve and admire; but, as it is not all gold that glitters, one might perhaps administer a gentle rebuke to that fatally characteristic feature of modern science which leads to research and mystery, ultimate results which, in the main, are not the result of facts are often [illegible] distorted in the scholastic methods of an illegitimate explanation. Let us cite two cases in the law of gravitation, and that of gaseous tension or pressure, taking Clerk-Maxwell's lucid definition of the latter.

"The distinguishing property of gases is their power of indefinite expansion. This has sometimes been explained by supposing that the molecules of gases are in rapid motion, and that they act at first sight, but on it is not all gold that glitters, one might perhaps administer a gentle rebuke to that fatally characteristic feature of modern science which leads to research and mystery, ultimate results which, in the main, are not the result of facts are often [illegible] distorted in the scholastic methods of an illegitimate explanation. Let us cite two cases in the law of gravitation, and that of gaseous tension or pressure, taking Clerk-Maxwell's lucid definition of the latter.

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des lignes alternativement blanches et noires tournant avec une vitesse modérée, de manière qu'on y voie courir du papillotage; si, pendant qu'on le regarde, on se comprime graduellement les yeux, le papillotage s'efface et le disque se montre d'un gris uniforme, qui n'a nombril pas à yeux.

« M. Exner paraît faire dépendre le phénomène de ce principe, que l'action de la lumière épuise continuellement une substance photochimique nécessaire à la fonction visuelle, substance continuellement restituée aussi par un afflux dû à la circulation. Dans ses idées, en effet, pendant la compression des yeux, l'afflux libre de la substance visuelle tendait à ramener la rétine à son état normal pendant le passage de chaque secteur noir, et ainsi amoindrissait rapidement la persistance de l'impression incomplète engendrée par le passage du secteur blanc précédent; mais la compression diminuant l'afflux dont il s'agit et, amoindrissant ainsi la cause qui ramène la rétine à son état normal, l'impression persistante du secteur blanc décroît d'une quantité trop petite pour que l'œil puisse s'en apercevoir, et, par suite, la teinte grise lui semble uniforme. »

En réfléchissant à cette expérience, je me suis dit que si la compression des yeux amoindrit la réaction de la rétine, cette réaction doit perdre de son influence sur la largeur de la bande d'impression propagée, et qu'alors conséquemment l'irradiation doit s'étendre beaucoup plus loin. Comme M. Exner signale le danger de se comprimer ainsi les yeux, je n'ai pas osé soumettre à l'expérience les personnes qui observent pour moi; mais je trouve, dans deux Notes de Brewster[1], des faits qui apportent une nouvelle preuve en faveur de la propagation de l'impression, et peuvent, en outre, permettre de se passer de la compression volontaire des yeux.

Dans la première Note, il s'agit de l'affection passagère signalée par plusieurs auteurs et consistant en ce que le patient ne voit qu'une portion des objets. Brewster, chez qui cette affection s'est présentée plusieurs fois, a constaté que lorsque l'image de caractères d'impression ou d'autres petits traits sombres tombait sur la portion de la rétine ainsi affectée, ces petits objets disparaissaient complètement, sans que le fond sur lequel ils étaient tracés perdît de son éclat. Il en conclut que l'impression du fond était propagée par l'irradiation sur les images de ces mêmes petits objets, et il ajoute :

« ..... Les portions qui sont affectées dans ce cas, s'étendent irrégulièrement du *foramen centrale* au bord de la rétine, comme si elles étaient en relation avec la distribution des vaisseaux sanguins de cette membrane, et conséquemment il est probable que la paralysie des parties correspondantes de l'organe était produite par leur pression. Cette opinion aurait pu être considérée pendant longtemps comme une explication simplement rationnelle de l'hémiopie, s'il ne s'était présenté à moi un phénomène qui la met hors de doute. Pendant une attaque assez intense, j'allai accidentellement dans une chambre obscure, et je fus surpris d'observer que toutes les parties affectées de la rétine étaient légèrement lumineuses, effet qui est invariablement produit par une pression sur la membrane. »

La seconde Note commence ainsi :

« Dans un écrit sur l'hémiopie, ... j'ai mentionné

[1] *On Hemiopsy, or Half-Vision* (Edinburgh, or the Roy. Soc. of Edinburgh, t. XVII, 1865, volume publié en 1867, p. 15). *On a new property of the retina* (Ibid., ibid., 1868, p. 321).

le fait remarquable que les parties de la rétine qui sont insensibles aux impressions visuelles sont sensibles aux impressions lumineuses, la lumière étant due à une irradiation émanée par les parties adjacentes de la rétine. »

Et, plus loin, Brewster décrit une affection de même genre qu'il a constatée dans son œil droit, avec cette particularité qu'elle était permanente, et constituait ainsi une sorte d'amaurose locale, et il dit :

« Quand l'image d'un objet lumineux couvre en tout ou en partie cet endroit, elle est invisible; ..... l'œil est donc dans cette portion absolument insensible à la lumière qui le frappe tentant de l'extérieur; mais si je dirige l'œil vers le ciel, vers le plafond blanc d'une chambre ou vers toute surface blanche étendue, je ne vois pas, dans le champ de la vision, la moindre tache présentant le plus petit degré d'obscurité. Conséquemment la portion de la rétine insensible à la lumière qui tombe sur elle directement, c'est-à-dire de l'extérieur, est éclairée par l'irradiation des portions environnantes. »

Je n'ai pas besoin d'insister sur ces faits; il me semble impossible de les expliquer autrement que par une propagation de l'impression, et ils rendent bien probable comme je l'ai dit, qu'une compression artificielle, en même temps qu'elle diminuerait la sensibilité aux impressions directes, augmenterait au contraire la sensibilité aux impressions propagées. Il est vivement regrettable que l'expérience offre du danger, car si elle donnait le résultat que je prévois, c'est-à-dire un développement extraordinaire de l'irradiation, la théorie que j'ai soutenue serait absolument prouvée.

J. Plateau,
Membre de l'Académie des sciences de Bruxelles.

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RECHERCHES
EFFETS DE LA MACHINE RHÉOSTATIQUE

La longueur des étincelles que peut donner la *machine rhéostatique*[1] est sensiblement proportionnelle au nombre des condensateurs.

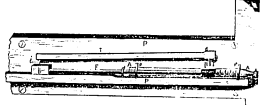
Avec dix condensateurs, j'obtenais des étincelles de 0m,015 environ, avec trente condensateurs des étincelles de plus de 0m,04; en employant une machine de quatre-vingts condensateurs[2], chargée par une batterie secondaire de huit cents couples, j'ob-

[1] Voy. *La Nature*, n° 255, du 1er décembre 1877.
[2] Le cylindre de caoutchouc dans du commutateur a 1m de longueur sur 0m,25 de diamètre.

NEW GRADUATING APPARATUS.

This apparatus was designed to facilitate the accurate graduation of glass tubes—burettes used in volumetric analyses, technical assays, pharmaceutical work, etc.

The tube, A A', to be graduated is secured by brass clamps, *c c*, to the wooden frame, P. The piston, B, of brass, loosely packed with rubber, is rigidly connected by the brass rod, F, with the block, k. The smaller end of the glass tube, A', is tightly connected by a piece of rubber tubing with the glass tube, G, which joins, at right angles, the small upright graduated glass tube, E E. This tube is continued downward, and connected by a short piece of rubber tubing with the feathered delivery tube, D, a pinch cock serving to stop the tube at O. The upper part of the tube, from *e* to *e*, is graduated to contain one cubic centimeter of water, and this space is subdivided into tenths of a centimeter. Water from D is introduced into the tube through the small funnel. The hard-wood rod, T, has a fine steel point rigidly affixed at *s*, the other end being similarly fitted with a wedge-shaped blade, *p*.



In using the apparatus the tube to be graduated is uniformly coated with a thin film of white wax or collodion. A small quantity of water is then put into it, the piston adjusted so as to fit snugly but loosely, and the tube securely clamped in position, connection having been made with the tube, G, the pinch cock at O is opened, and the piston forced up to the end, A', of the tube, expelling the water (and air) through G and D. The pinch-cock is then closed and water (at 0° Fah., or 16° C.) let into the tube, E, from D, until it is filled to the mark, C, any excess being drawn off through D.

The block, k, is then grasped and slowly drawn back until the water in E E has fallen to *o*, the first mark on the scale. The steel point, *s*, on the rod, T, is then inserted in a fine hole, *nick*, or cut line on the upper side of the block, k, and held in position, while the blade, *p*, at the other end of the rod is brought down on the coated tube, and a fine line cut through the coating to the surface of the glass. The block, k, is again drawn back until the water in E E' falls to the next line on the scale, when the rod is brought into requisition, as before, and another mark made on the tube. These operations are repeated until the water in the tube, E E, falls to C', when it is again filled to C, from the reservoir, D, and so on, until the graduation of the tube, A A', is completed.

The lines are etched in by exposing the tube to gaseous hydrofluoric acid—evolved from a mixture of powdered fluor-spar and warm oil of vitriol contained in a suitable leaden dish—or by the use of liquid hydrofluoric acid. Wherever the film of wax or collodion has been cut so as to secure sufficiently etched in a few minutes.

The wax may be removed from the glass by washing with benzine, the collodion by hot water and a brush.

Tubes graduated in this way are much more accurate than those graduated by the usual methods, or where variations in internal diameter of the tube are not taken into consideration. The time required in the operation is reduced nearly one half over the older methods of volumetric graduation.

Statue of Marco Polo in Venice.

A statue of Marco Polo, discovered in Canton, has been received at his native city, Venice. It is life-size, made of wood, and gilt. According to a foreign contemporary, the Chinese artist, although the clock and hat are after the European fashion. His moustache and beard, which surround his face, are tinged dark blue, and while the Chinese artist has given him a peculiar form, the features in no way resemble those of a Mongolian type. Opposite the large, ray armchair upon which Marco Polo is seated is placed a porcelain bowl, intended to receive perfumes, with which he was honored in the same manner as in the processions at the feast, an Imperial [illegible] character.—

The Future Battery and the Electric Light.

Some experiments of considerable importance have lately been carried out by Mr. Keates, the Consulting Chemist to the Metropolitan Board of Works, in which a Faure accumulator has been employed in the production of the electric light. The lamps used on this occasion were respectively those of Maxim and Swan, one of each description being stretched at a time. Mr. Faure states that in those experiments 40 cells represent about half an available horse power for three hours. The Maxim light being placed in connection with the accumulator, 30 cells were found to give the light of 10 candles. With the same number of cells the Swan lamp gave the light of 22¼ candles, with 35 cells the lights became respectively 45·6 candles and 67·5. With 40 cells the Maxim light rose to 101 candles, and the Swan to 141. Thus far the Swan light gave the greatest amount of candle power. But with 45 cells the Maxim light rose to 229 candles, while the Swan only displayed 224. The capacity of the latter was evidently being overtaxed, for in about a minute the carbon loop broke. A power of 50 cells was then connected with the Maxim light, which then rose to 321 candles, but in about a minute the carbon loop shared the same fate as the Swan. The experiments are also interesting as showing the great increase of light obtained by a comparatively small increment of power. Thus, in the case of the Maxim lamp, taking 35 cells as the standard, an increase of one-sixth nearly trebled the light; an increase of two-sixths augmented the light more than six times; three-sixths increased it fourteen times, and four-sixths twenty-one times.

IMPROVEMENT IN TABLES.

The engraving represents a simple and inexpensive device for uniting the rails of tables and the legs with the rails in

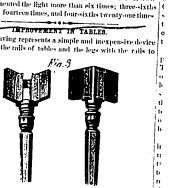


Fig. 3

facilitate the "knocking down" and putting together of the table. The invention is a corner or angle plate provided with vertical wing sockets for the reception of the rails at opposite rails, and with inner central socket for receiving

Fig. 1

Fig. 2

LANGSTON'S IMPROVED TABLE.

L'EMMAGASINEMENT DE L'ÉLECTRICITÉ

Peut-on emmagasiner l'électricité, on, pour employer une expression plus figurative, peut-on mettre *l'électricité en bouteilles*, pour la dépenser ensuite d'une façon proportionnée aux besoins, jusqu'à complet épuisement du récipient qui la contient? C'est en nous plaçant à ce point de vue que nous voulons examiner rapidement quelques appareils qui nous permettent de répondre oui hardiment, à la condition de bien déterminer à l'avance dans quelle mesure cet emmagasinement peut s'effectuer.

Nous commencerons d'abord par la pile secondaire de M. Gaston Planté, car c'est celle qui a donné jusqu'ici les meilleurs résultats pratiques et fourni le plus grand nombre d'applications.

Pile secondaire de M. Gaston Planté. — Nous n'avons pas à décrire ici l'appareil, bien connu de nos lecteurs (voir *la Nature*, n° 56 du 27 juin 1874, p. 51), où à exposer sa théorie. Nous nous contenterons de reproduire (fig. 1) un élément du modèle primitif, dans lequel M. Planté a substitué depuis, à la boîte qui séparait les lames de plomb, deux lames élastiques de caoutchouc.

Quelle que soit la source électrique employée, la pile emmagasine le courant électrique et le restitue ensuite dans des conditions souvent tout à fait différentes de celles de l'emmagasinement.

Fig. 1. Pile secondaire Planté.

1° Nous avons représenté (figure 2) Planté ressuscitée expérience effectuée par MM. Gaston Planté et Niaudet en 1877, expérience qui est une des plus belles démonstrations de l'*unité des forces physiques* et de leurs transformations mutuelles. Une machine Gramme à aimant lamin transforme le travail mécanique en électricité, qui, emmagasinée dans une pile secondaire de Planté, s'y emmagasine. Si, après avoir chargé le couple, on arrête la machine, elle se remet en marche dans le même sens, sous l'action du courant produit par le couple secondaire, et transforme de nouveau le courant électrique en travail mécanique.

Fig. 2. Pile secondaire Planté chargée par une machine Gramme à aimant lamin.

Dans cette expérience, la machine tourne moins vite qu'au moment du chargement du couple, qui n'a agi alors que comme *réservoir*; c'est un *emmagasinement*.

2° Si nous relions un couple secondaire à trois ou quatre éléments Bunsell, et que nous fassions passer ce courant pendant quelques heures, il y aura un seulement *emmagasinement* de travail chimique de la pile arrivant au couple secondaire sous forme d'électricité, mais il y aura *accumulation*, et nous pourrons produire, pendant un temps beaucoup plus court, il est vrai, des effets calorifiques, magnétiques, etc., incomparablement plus puissants que ceux que le courant de la source primitive aurait pu fournir.

Cette propriété précieuse de la pile secondaire a été habilement mise à profit par M. Achard dans son train électrique, dont nous parlerons bientôt, et dans le polyscope de M. Trouvé (voir *la Nature*, n° 297 du 12 juillet 1878, p. 107).

Nous nous sommes signaler ainsi les expériences sur l'électricité de hauteur faites par M. Planté avec huit cents couples chargés à l'aide de quelques éléments Bunsen seulement.

Le nombre des applications des piles secondaires devient immense, sans l'inconvénient que nous devons maintenant signaler. Dans un couple bien formé, l'emmagasinement est limité par la surface des lames de plomb qui constituent leurs électrodes; comme le volume et le poids des éléments dépendent de cette surface même, il en résulte que la pile secondaire, en égard au travail emmagasiné qu'elle peut fournir, est un appareil relativement lourd et encombrant. Ces considérations ont amené MM. Boussion et Thomson à chercher une combinaison nouvelle d'un accumulateur électrique, dans lequel le procédé d'emmagasinement est tout différent.

Appareil Boussion et Thomson. — MM. Boussion

THE ALTERNATING ELECTRIC DISCHARGE.

The alternating discharge apparatus devised by M. Thenard is well adapted to show the shower of electric fire in different gases under various pressures, for the phosphorescent lights, invisible in full day, which illumine the gas placed in the annular space comprised between the two tubes of concentric gas, when analysed with care in the obscurity, always exhibit the character of a shower.

If the phenomenon is very difficult to observe in oxygen, it is, on the contrary, found by M. Hautefeuille and Chappuis to be very easily recognised in fluoride of silicium.

When produced at atmospheric pressure in this substance, the spark has the appearance of a homogeneous luminous sheet. The manifest space is filled with little luminous globules of a greenish yellow hue in darkness, and retarder zone colours in diffused light, the flame of a candle. In examining the tube by a magnifying glass during discharge, we are struck with the analogy which the phenomenon presents with that described by MM. de Monduir and Schuermg in their beautiful experiments on "electric butterflies," where the burning of hydrogen in the air gives lights which recall the silicic snowflakes.

The discharge in fluoride of silicon is exempt at all to study if the distances of the electrified surfaces attain several millimetres, because the luminous points, well separated, show that the successive discharges take place under the form of little luminous cylinders joined to small phosphorescent sheets with circular outlines; so that if the two cylinders are concentric, the central tube seems to be plastered on its exterior surface with regular luminous lines, equidistant, and terminated at the other tube, the whole recalling a mop with luminous tags. If the two cylinders are not concentric, the discharge only passes between the nearest walls, allowing the phenomenon to be studied on the edges. The space seems traversed by a shower of fire, as in the apparatus of M. du Moncel.

A diminution of pressure of the fluoride of silicon does not change the general characters of the discharge; but, in withdrawing the tubes of electrified glass, it can be readily proved that each luminous line is swollen at the ends. With low pressures the luminous drops, instead of designing themselves on a black background, seem hid in a violet mist. At the same time their contours loose their definition. A maximum of splendour is seen in the discharges which occur in the plane passing through the observer and the axis of the apparatus. The cylindrical lines, if dilated in rarefied gases, preserve, nevertheless, a lively splendour when the eye looks along them.

For pressures below 760 millimetres the general illumination masks the shower of fire almost completely—the drops seem to be deep in the mist.

Nitrogen is, after fluoride of silicon, the gas which gives the finest rain of fire. At ordinary pressure the globules—of a pale reddish hue—are very small and very close. The phenomenon of nitrogen to what supports the gas in air. We only obtain a luminous sheet of homogeneous appearance at pressures below 0·050 metres.

Hydrogen exhibits also this form of discharge. At atmospheric pressure the phenomenon in colour is almost identical with that observed in fluoride of silicon at low pressures.

The same appearances are observable with chlorine. The luminous drops are greyish, and much less brilliant than those of fluoride of silicon. This gas, under ordinary pressures, opposes a very great resistance to the passage of electricity. Thick electrified surfaces ought to be very near, for if they are at 0·005 metres, for example, the luminous lines, without having the character of a spark, resemble it in luminous intensity. This small number of luminous lines and the brilliant effects which appear on the surfaces of the walls of the tube, unifying amongst them the successive lines situated sometimes more than a centimetre from each other.

In oxygen the discharge is hardly visible, the gas becomes very slightly luminous, or rather phosphorescent. Nevertheless, on the surface of the concentric tubes, with a magnifying glass, a granulation the gas has not too feeble a tension, the distinct luminous globules can be detected.

The constitution of the milky white lights produced by the alternating discharge in carbonic acid recalls the lights observed in oxygen, but the analysis of them is easier.

These discharges are only silent, in all gases at feeble pressures. They are silent also in hydrogen at atmospheric pressure. The rain of fire is accompanied in other gases by a rustling sound.

Discharge tubes, such as are constructed by M. Abreguiat, will show the rain of fire under its various aspects in different gases under different pressures.

du rayon, nous sommes obligés de donner *à priori* l'une de ces deux variables, si nous voulons que l'action transmise au poste récepteur ait un sens.

Or, l'intensité est déterminée par la source lumineuse elle-même, et nous ne pouvons disposer que du point du circuit où nous placerons l'organe sensible. Nous sommes ainsi forcés de décomposer la lumière en couleurs simples, de transmettre celles-ci individuellement et de les recomposer ensuite...

Maintenant, dans quelle voie peut-on espérer trouver la solution directe de ce problème, que nous avons énoncé sous forme de désidératum?... Ce sera l'objet d'un prochain travail.

Paris, le 2 novembre 1880.

MAURICE LEBLANC,
Ancien élève de l'École polytechnique.

REVUE DES TRAVAUX

RÉCENTS EN ÉLECTRICITÉ

De la Polarisation électrolytique.

M. Exner, dont nous avons analysé plusieurs mémoires, se pose décidément un réformateur de tous les principes physiques admis, et il se trouve actuellement en opposition avec presque tous les physiciens.

Nous avons vu qu'il a nié la force *électro-motrice de contact*, malgré tous les travaux importants faits dans ces derniers temps dans cet ordre d'idées. Nous avons vu encore que les couranx thermo-électriques ne sont pour lui que des courants résultant d'actions chimiques, hypothèse qui a été facilement renversée par les expériences de M. Young, et voilà maintenant que les effets de polarisation électrolytique ne sont plus le résultat d'une force électro-motrice secondaire, créée à la suite des réactions des produits de la décomposition. La encore il se trouve attaqué par M. Fitz-Gérald, et non sans raison. Nous savons bien que les effets de polarisation ont diverses causes, mais il est bien difficile d'admettre qu'avec sa manière de voir on puisse les expliquer d'une manière générale.

Pour qu'on puisse comprendre la théorie de M. Exner, il faut savoir que, suivant lui, il ne peut y avoir de force électro-motrice de produite dans un générateur électrique, qu'autant qu'il s'y manifeste une action chimique, et que l'importance de cette force *dépend de la chaleur qui est alors développée*. Or, si les produits décomposés par suite de l'action électrolytique se combinent de manière à constituer d'autres corps, il doit y avoir une quantité de chaleur absorbée, et cette quantité de chaleur étant empruntée à la chaleur primitivement dégagée, abaisse d'autant la valeur de la force électro-motrice primitive, et détermine par conséquent l'affaiblissement du courant qui en est la conséquence. Voilà, suivant M. Exner, *ce qui constitue les effets de polarisation, et son la création d'une force électro-motrice contraire* sur les électrodes où se produisent les décompositions primitives.

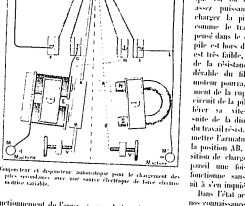
M. Desmond G. Fitz-Gerald fait remarquer que cette déduction de M. Exner conduit à des résultats tout à fait contraires à ceux de l'expérience, et voici ce qu'il dit à cet égard dans l'*Electrician* du 9 octobre 1880 :

« Si, ainsi que l'admet M. Exner, l'on électrolyse est décomposée dans un élément Bunsen ou Grove, ou dans un élément de Smée, il est certain qu'avec les premières piles, l'eau décomposée est reconstituée aux dépens de l'acide nitrique par oxydation, tandis que, dans la dernière pile, l'hydrogène se dévelope entièrement sans reconstitution antiséquente. Or, d'après le principe de M. Exner, la chaleur due, dans le premier cas, à la combinaison de l'hydrogène avec l'oxygène de l'acide nitrique, devrait être soustraite de celle résultant de l'oxydation du zinc et de celle déconnitée par suite de la solution de l'oxyde formé dans l'acide nitrique dilué, pour obtenir la force électro-motrice du couple de Grove ou de Bunsen. Dans le cas de la pile de Smée, cette force électro-motrice serait simplement accrue par la chaleur développée dans les deux dernières actions mentionnées précédemment, sans aucune soustraction; d'où il résulterait que la force électro-motrice d'un élément de Smée serait beaucoup plus grande que celle d'un élément Bunsen ou Grove, et que le développement libre d'un corps électro-positif énergique tel que l'hydrogène, serait le résultat d'un grand accroissement de force,

« Ce qui démontre encore que la thèse soutenue par M. Exner n'est pas exacte, c'est que, dans une autre partie de son mémoire, il est en contradiction complète avec ce qu'il annonce au commencement, et pose des principes contraires aux lois électro-chimiques qui servent de base au développement de la force électro-motrice dans un couple voltaïque : « Dans une pile de Daniell, dit-il, dont la force « électro-motrice est prise comme unité d'oxydation d'un « équivalent de zinc, il se développe jusqu'à 24,300 calo- « ries (1), et cette chaleur donne la force électro-motrice de « cet élément. Dans un autre élément, celui de Smée, par « exemple, les actions chimiques sont un peu différentes : « le zinc se combine avec l'oxygène de l'eau, et l'oxyde de « zinc ainsi formé se combine avec l'acide sulfurique. Or « ces deux actions chimiques développent 32,370 calories « par équivalent de zinc. Si, par conséquent, il n'y avait pas « d'autres actions chimiques développées dans un élément « de Smée, les forces électro-motrices de cet élément et de « celui de Daniell seraient entre elles comme 24,300 : 32,370. « soit comme 1 : 2,24. Mais l'eau se trouve décomposée et « cette décomposition représente une perte de chaleur de « 34,170 (24,180) calories par équivalent; de sorte que la « perte effective de chaleur n'est que de 17,800 calories, et le « véritable rapport entre les éléments Daniell et Smée est « comme 24,300 : 17,800 ou comme 1 : 0,732. Si on « expérimente, on ne trouve pas d'abord ce rapport, car « au commencement, l'élément de Smée est toujours plus

(1) L'oxydation de l'équivalent de zinc (32,7 grams) dégagerait 2 pen près 23 100 calories.

combiné, il n'y a plus *consommation*, mais au contraire *dépense* d'électricité : la pile se décharge dans la machine pour aider son mouvement, dépense inutilement la charge primitivement accumulée et exposant ainsi la pile secondaire à se trouver complétement déchargée au moment même où l'on a besoin de ses services. Pour remédier à cet inconvénient, nous intercalons dans le circuit qui relie la pile secondaire à la machine, l'appareil représenté ci-dessous, et qui est un disjoncteur et conjoncteur automatique. Il a pour effet de couper le circuit lorsque la machine ne tourne plus assez vite pour charger la pile et de rétablir lorsque la force électromotrice de la machine, par suite d'une augmentation de vitesse, est redevenue assez grande pour réfléchir de nouveau le chargement.



Coupe-fort et disjoncteur automatique pour le chargement des piles secondaires avec une source électrique de force électromotrice variable.

L'appareil se compose d'un électro-aimant E, devant lequel se meut comme un pendule une armature AB, dont les vis V, V limitent la course.

La tige de suspension porte un bouton d'ivoire B, qui dans la position AB, établit un contact en C, et dans la position A'B' établit un contact en C'. L'électro-aimant E porte deux fils, un fil gros et court formant le circuit MEGCFM, un fil fin et long formant le circuit MEHCLM'.

La machine est reliée aux bornes M et M', la pile secondaire aux bornes P et P'.

Voyons maintenant le fonctionnement de l'appareil.

Supposons que la machine tourne à une vitesse normale, et que l'armature soit en AB. Le courant de la machine arrivant en M traversera le gros fil de l'électro-aimant, le contact C, la pile secondaire placée entre P et P' et retournera à la machine par P'F et le second fil attaché à la borne M'.

Le courant étant assez intense pour charger la pile, maintiendra l'armature AB en place. Si la machine se ralentit, le courant de charge diminuera, et lorsqu'il sera devenu nul, l'armature AB sera lâchée, retombera et se placera dans la position A'B' sous l'action du petit aimant permanent NS. Dans cette position, le contact C sera ouvert et le circuit de la pile secondaire et de la machine rompu en ce point, mais le contact C' sera fermé par le même mouvement. Le courant de la machine traversera donc le *fil fin*, les bans HC' et C'L, et retournera à la machine par HM. Il en résultera une aimantation de l'électro-aimant E, aimantation qui dépendra de la force électromotrice de la source. En réglant l'appareil à l'aide de la vis V et de l'aimant permanent NS, qu'on peut changer ou rapprocher à volonté, de telle sorte que l'électro-aimant attire l'armature AB lorsque la force électromotrice du courant fourni par la machine est assez grande pour charger la pile secondaire, l'armature quittera la position A'B' pour prendre la position AB à ce moment même, et remettra la pile dans le circuit de la machine, et ainsi de suite. L'appareil se met donc automatiquement dans la position AB ou dans la position A'B', suivant que la source électrique est ou n'est pas assez puissante pour charger la pile. Mais comme le travail dépensé dans le cas où la pile est hors du circuit est très faible, à cause de la résistance considérable du fil fin, le moteur pourra, au moment de la rupture du circuit de la pile, accélérer sa vitesse par suite de la diminution du travail résistant exercé par l'armature dans la position AB, ou par suition de charge. L'appareil une fois réglé fonctionne sans qu'on ait à s'en inquiéter.

Tel est l'état actuel de nos connaissances, l'acumulation du travail par la pile secondaire de M. Planté et l'utilisation des forces naturelles par l'électricité, pour recevoir des applications dont le nombre s'accroîtra de jour en jour, à mesure qu'on augmentera la capacité spécifique de l'accumulateur.

Le moteur électrique est la plus simple des machines motrices : il suffit de deux fils pour les amener le courant qui l'actionne; un simple commutateur suffit pour le manœuvrer. Il y a donc là une série d'avantages que l'on appréciera bien, le jour où, par une disposition rationnelle de distribution et d'accumulation de l'électricité à domicile, on amènera chez chacun la lumière et la force motrice.

E. HOSPITALIER.

19 Nov 1880

CONCENTRATING OR STORING UP ELECTRICITY.

Several years ago M. G. Planté, of France, made a secondary electrical battery, in which the electrical power of several ordinary cells could be concentrated or stored up within one cell, and the electrical force so gathered could be used when wanted. This battery consisted of two electrodes made of sheet lead, separated by strings of rubber, and placed in dilute sulphuric acid.

To charge this battery the poles were connected with an ordinary Bunsen or Daniell cell. During the operation of charging, one of the electrodes oxidizes, a brown coating of peroxide of lead soon showing itself thereon, and the metallic appearance disappears entirely; the other electrode also changes in appearance, its surface becoming covered with a powdery gray coating. When thus charged the secondary battery was capable of delivering an electric current of very much greater force than an ordinary cell of same size. This secondary battery is capable of charge and discharge indefinitely. M. Planté has lately improved upon the Planté battery, by pasting the lead sheets with red lead. Simple as the improvement is, the resulting effects are quite remarkable, the storing capacity and delivery of the battery being greatly increased. The chemical action that takes place in subsequently the same as in the original Planté battery.

It is stated that one of M. Planté's secondary batteries, weighing 165 pounds, is capable of delivering a force equal to one horse power during a period of one hour. If this is so it would bring the weight of an electrometor and battery of one horse power within a gross weight of 200 pounds, and suggests, as one of the possibilities of the new discovery, the production of a carriage propelled by electricity, convenient and economical in use.

For the benefit of those who desire to try this interesting electrical contrivance, we give on another page an illustration in explanation of some recent ingenious experiments on the subject lately made in our office. Any intelligent person who has at hand a few sheets of lead may readily construct the new battery.

Professor Sir William Thomson, of Glasgow University, who has lately experimented with these new batteries, mentions the use of one of the cells, weighing 18 pounds, which Professor George Buchanan took with him in his carriage and successfully employed in removing a tumor from a child's tongue by heating a platinum wire. The bureau published the same effect by the ordinary electrical means would have required the putting in of several voltaic cells, and involved much inconvenience. Professor Thomson anticipates that this method of storing electricity will have many practical uses. He sums as follows:

"The largest useful application is waiting just now for the Faure battery, and I hope that a very minimum time will be allotted to pass until the battery comes into daily application is to do for electric light what a water cistern in

is house does for an inconstant water supply. A little battery of several dozen cells is to give the brush-comes to the Swan or Edison lights to the extent of one hundred candles for six hours without any perceptible diminution of brilliancy. Thus, instead of needing a gas engine or steam engine to be kept at work as long as the light is wanted, with the liability of the light failing at any moment through the slipping of the belt or any other breakdown or stoppage of the machinery, and instead of the wasteful inactivity during the hours of the day or night when the light is not needed, the engine may be kept going all day and stopped at night, or it may be kept going day and night, which undoubtedly will be the most economical plan when the electric light comes into general enough use.

"Another very important application of the accumulator is for the electric lighting of steamships. A dynamo-electric machine of very moderate magnitude and weight, driven by a belt from a drum on the main shaft, working through the twenty-four hours, will keep a Faure accumulator full, and thus, notwithstanding the irregularities of the speed of the engine at sea, or the occasional stoppages, the supply of electricity will always be ready to feed the Swan or Edison lamps in the engine rooms and cabins, or are fields for the mast-head, and red and green side lamps, with more certainty and regularity than have yet been achieved in the gas supply for any house on *terra firmæ*."

English Mechanic Sept 24th 1880

[44937.]—**The Faure Battery.** The current given out is of course proportional to the current which is put in. We also involve a consideration of time. But the question as to cells ought to no greater than that of time. Thus, a cell using two ounces of zinc for charging is doubtless more efficient than one using more cells in series than will give the same current the electro-motive force of the secondary cell itself. Question 3 cannot be answered, because the answer in any case depends on the conditions. The proper thing to do is to insert in the connections a galvanometer, an ammeter, and study its readings. As the charge goes on the galvanometer will show diminishing current, and when it is zero the continuous current ceases, and shows the charge is complete. If an overpowerful generator is used, the continuous current may be large, because decomposition will go on, producing oxygen and hydrogen gases, which escape and be wasted. The acid must not be put strong; in fact, it cannot, because the mass of solution, if strong, will corrode metals, and the cost of the acid will be an object. There will be local action, and great loss of charge, unless other people get better results than I have.—EDITOR.

Chief Asst Prof

Notre Sujet Le Chemin de Fer Supplement.

A TRIAL OF THE ELECTRIC LIGHT AT CLERKENWELL.—A correspondent, residing in the neighborhood, sends us the following:—"The Fine Arts and Industrial Exhibition, which will be held in Corlitt during the next two months, was duly opened on Friday last by the Mayor of the town. The exhibition is in the Drill Hall—a very large and elegant structure. Among the many objects of special interest, for the public, one of the most attractive features of the display, and, as a matter of course, great things were expected. Of the use of the electric light, and the effect of a large number, the fittings of each being elaborated and rendered very beautiful in appearance. The electric lights inside the hall were most brilliant and pleasant so long as they kept in working order. About nine o'clock, however, they became suddenly extinguished; and refused to be resuscitated, to the disappointment of many friends and admirers. In this unlooked-for crisis, the despised gas was called in, and intended should be discarded for this amplifier of modern, but it was soon found that the failure of the electric fluid, during character, immediately restored to the position it once occupied. many objects of interest, which, through the failure of the electric light, had been so peremptorily shrouded in darkness. For illuminating purposes, gas has to stand on its merits, no relays of candles or oil lamps being at hand to assist it, as was the case at a moments' notice, should a similar failure overtake a gas supply."

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Times, June 9, 1881

ELECTRIC STORAGE OF DYNAMICAL ENERGY.

TO THE EDITOR OF THE TIMES.

Sir,—The marvellous "Lex of electricity" described in a letter to you, which was published in *The Times* of May 16, has been subjected to a variety of trials and measurements in my laboratory for nine days' weeks, and I think it may interest your readers to learn that the results show your correspondent to have been by no means too enthusiastic as to its great practical value. I am continuing my experiments to learn the behaviour of the Faure battery in varied circumstances, and to do what I can towards finding the best way of arranging it for the different kinds of work to which it is to be applied. At the request of the Council of Administration of the Société des Forces et la Lumière, I have gladly undertaken this work, because the subject is one in which I feel intensely interested, seeing in it a realisation of the many ardently and unceasingly felt scientific aspirations of my life—an aspiration which I recently dared to express or to hope to live to see realised.

The problem of converting energy into a preservable and storable form, and of laying it up in store conveniently for allowing it to be used at any time when wanted, is one of the most interesting and important in the whole range of science. It is solved on a small scale in a common watch, in drawing a gun cuplon or steam engine to be kept at work as long as the light is wanted, with the liability of the light failing at any moment through the slipping of a bolt—an accident of too frequent occurrence—or any other breakdown or stoppage of the machinery, instead of the wonderful self-activity during the hours of day or night when the light is not required, the engine may be kept going all day and night, and when, as there may be kept "going day and night," which will undoubtedly be the most economical plan when the electric light comes into general use, it might be the Faure accumulator, always kept charged from the engine by the home supply wire, with a proper automatic stop to check the supply when the accumulator is full, will be always ready at any hour of the day or night to give whatever light is required. Precisely the same advantages in regard to the force will be gained by the accumulator when the electric town supply is, as it surely will be before many years pass, regularly used for turning lathes and other machinery in workshops and sewing machines in private houses.

Another very important application of the accumulator is for the electric lighting of steamships. A dynamo-electric machine of very moderate magnitude and expense, driven by a belt from a drum on the main shaft, working through the 24 hours, will keep a Faure accumulator full, and then, notwithstanding irregularities of the speed of the engines at sea or occasional stoppages, the supply of electricity will always be ready to feed Swan or Edison lamps in the engine-room and cabins, or arc lights for mast-head and red and green side lamps, with more certainty and regularity than have yet been achieved in the gas supply for any house on *terra firma*.

I must apologise for trespassing so largely on your space. My apology is that the subject is exciting great interest among the public, and that even so slight an instalment of information and suggestions as I venture to offer in this letter may be acceptable to some of your readers.

I remain your obedient servant,

WILLIAM THOMSON.

The University, Glasgow, June 8.

quite certain that it solves the problem of storing electric energy in a manner and on a scale useful for many important practical applications. It has already led in this country one interesting application, of the smallest in respect to dynamical energy used, but not of the smallest in respect to beneficence, of all that may be expected of it. A few days ago my colleagues, Professor George Buchanan, carried away from my laboratory one of the lead cells (weighing about 26lb.) in his carriage, and by it ignited the thick platinum wire of a galvanic *cautere* and bloodlessly removed a mucoid tumour from the tongue of a young boy in about a minute of time. The operation would have occupied over ten minutes if performed by the ordinary chain *cautere*, as it must have been had the Faure cell not been available, because in the circumstances the surgical electrician, with his paraphernalia of voltaic battery to be set up beforehand, would not have been practically admissible.

The largest useful application awaiting just now for the Faure battery—and it is to be hoped that the very minimum of time will be allowed to pass till the battery is supplied for this application—is to do for the electric light what a water cistern in a house does for an intermittent water supply. A little lantern of seven of the boxes described by your correspondent suffices to give the incandescence in Swan or Edison lights to the extent of 100 candles for six hours, without any perceptible diminution of brilliancy. Thus, instead of needing a gas engine or steam engine to be kept at work as long as the light is wanted, with the

ELECTRIC STORAGE OF DYNAMICAL ENERGY.

TO THE EDITOR OF THE TIMES.

Sir,—Although agreeing with every word of Sir William Thomson's letter in *The Times* of to-day, and entirely sympathising with the enthusiasm as regards the marvellous but of electricity, still I feel that it would have been desirable if in pointing out the importance of this new discovery Sir William Thomson had guarded against a very probable misconception of the purport of his letter.

The means of storing and re-storing mechanical energy form the aspiration not only of Sir William, but of every educated mechanic. It is, however, a question of degree—of the amount of energy stored as compared with the weight of the reservoir, the standard of comparison being coal and coal. Looked at in this way, one cannot but ask whether, if this form of storage is to be the realisation of our aspirations, it is not completely disappointing. Large numbers are apt to create a wrong impression until we inquire what is the unit. Eleven million foot pounds of energy is what is stored in 1lb. of ordinary coal. So that in this use, weighing 70lb., there was just as much energy as in 1jac. of coal, which might have been brought from Paris or anywhere else in a waistcoat pocket, or have been sent by letter.

When we come to the question of the actual conveyance of energy for mechanical purposes, this view is of fundamental importance. The weight of the same amount of energy in the new form is 600 times greater than the equivalent amount of coal; and as a matter of economy, supposing that energy in this form might be had at a certain spot and as capital were required for the conversion or storage, and that the energy were directly applicable it could not be carried ten miles—that is to say, such energy cannot be economically useful ten miles from its source, although coal had to be carried 100 miles to the spot. This limit, in truth, falls far short of what has been already attained by other means. By wire waves and by compressed air or steam energy may be economically transmitted from 10 to 20 miles. So that if this is the utmost of what is to be done by means of the storage of electricity this discovery adds another door to those which are heavily closed against the possibility of finding in Niagara or other water power a substitute for our coal, even when the object is native power, and much more for that purpose for which five-sixths of our coal is used—the production of heat.

It is very important that the people of this country should not shut their eyes to the fact that so far from there being a greater prospect of the solution of the problem than when, about 20 years ago, Professor Jevons raised the alarm, the prospect is now much smaller. In the meantime the capabilities of steel rapes, fields in pipes, and electricity along conductors have been not only hinted, guided, but practically tested and found altogether wanting. And now it would seem that the storage of electricity must be added to the list.

I remain, yours obediently,

OSBORNE REYNOLDS.

Owens College, June 9.

Times, June 11, 81

Times, June 13, 1881.

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ELECTRIC TRANSMISSION OF ENERGY.

TO THE EDITOR OF THE TIMES.

Sir,—Your leading article in the *Times* of yesterday on the storage of electricity alludes to my having spoken of Niagara as the natural and proper chief motor for the whole of the North American Continent. I value the allusion too much to let it pass without pointing out that the credit of originating the idea and touching how it is to be practically realized by the electric transmission of energy is due to Mr. C. W. Siemens, who spoke first, I believe, on the subject, in his presidential address to the Iron and Steel Institute in March, 1877. I myself spoke on the subject in support of Mr. Siemens's views at the Institution of Civil Engineers a year later. In May, 1879, in answer to questions put to me by the Select Committee of the House of Commons on Electric Lighting, I gave an estimate of the quantity of copper conductor that would be suitable for the economical transmission of power by electricity to any stated distance; and, taking Niagara as example, I pointed out that, under practically realisable conditions of intensity, a copper wire of half an inch diameter would suffice to take 25,000-horse power from water wheels driven by the Fall, and (*inter alia*) 20 per cent. on the way) to yield 21,000-horse power at a distance of 300 British statute miles; the price cost of the copper amounting to £60,000, or less than £3 per horse power actually yielded at the distant station.

I remain, Sir, your obedient servant,

WILLIAM THOMSON.

The University, Glasgow, June 8.

[In the second sentence of the third paragraph of Sir William Thomson's letter published in *The Times* of June 9, for "in own laboratory letter," substitute "my own laboratory letter."]

TO THE EDITOR OF THE TIMES.

Sir,—Professor Osborne Reynolds's letter in your issue of Saturday, the 11th inst., shows that the first idea that has occurred to him on reading Sir William Thomson's letter on Faure's "electric store" is probably what must have suggested itself to many engineers—viz., that as far from a million foot pounds being a surprisingly large amount of energy to be stored up in a mass of 70lbs., it is really extremely small; and, indeed, while crossing over from Paris at the commencement of last week, I could not help thinking that the passengers were belaging to England literally in the smoke and blacks on their seats far more energy than had ever been imported into this country stored up in Faure's secondary batteries. But although it is perfectly true, as Professor Reynolds says, that 1jac. of coal contains about one million foot pounds of work stored up in it, this is by no means all that has to be taken into account in considering this question; for where is the engine for extracting this million foot pounds of work out of the 1jac. of coal? Indeed, as Professor Reynolds would

himself tell us, we cannot get much more than one-tenth of this amount of work out of the 1½oz. of coal even in our largest steam engines, which burn many pounds of coal per minute, and in which much heat has been wasted in getting up steam. And if we come to the burning of one single 1½oz. of coal, I know of no engine that can obtain from this even one thousand foot pounds of work, or one thousandth of the energy contained in the coal, if no other coal be used in getting up steam or in previously heating the engine.

But if a secondary battery be allowed to drive a magneto-electro-motor or a dynamo-electric machine with separate exciter only even for the short time necessary to develop, say, 30 foot pounds of mechanical work, I anticipate this can be done without using up in the whole process more than about 35 foot pounds of the electric energy stored up in the reservoir, since the experiments of Professor Perry and myself have shown that, when the motor is running at high speeds with a light load, as much as 93 per cent. of the electric energy put into a magneto-electro-motor is given out again as mechanical work measured by an absorption dynamometer.

It may be answered, however, that if a small bit of coal, although containing a vast store of energy, is not of much practical use in producing work in consequence of the absence up to the present time of a proper converter of the coal's energy into mechanical work, at any rate a small galvanic battery (a little Daniell's cell, for example) is not only a vast storehouse of power, but contains a store which we have the means of converting without appreciable loss into electric light or mechanical work. How, then, is a Faure's box a better store of electric energy than a little Daniell's cell? This question has precisely the same answer as "Why is a pinch of dry gunpowder better than a pinch of wet?" Not because the dry gunpowder has more energy in it than the wet, but because the energy stored up in the dry gunpowder can be all, if we wish, used up quickly, and an explosion produced, whereas that in the wet can only be utilized bit by bit. So seven Faure's boxes will illuminate 100 Swan lamps for six hours, while seven Daniell's cells, or, indeed, twice that number, although possessing a store of power millions of times as great as that in the Faure's boxes, will not illuminate a single Swan light.

But while fully recognizing the great advance made in the subject by Planté, and the recent improvements introduced by Faure, I do not wish to give the impression that the problem is by any means completely solved, since, if the attempt that Mr. Perry and myself, no doubt like many other electricians, are making to convert at a low temperature the energy in coal into electric energy meets with even a fairly satisfactory solution, then a fragment of coal, or, it may be, a puff of gas rich in carbon or carbonic oxide, will be a practical store of energy of incomparably greater value than any secondary battery.

W. E. AYRTON.

The City and Guilds of London Technical College, Finsbury.

Eve. Telegr. May 14. 1881.

A MIGHTY POWER.

Compressed Electricity Rivalling the Imprisoned Genie in the Bottle.

VIA FRENCH ATLANTIC CABLE TO THE EVENING TELEGRAM.

LONDON, May 17.—Sir William Thomson, F. R. S., of the University of Glasgow, has received from M. Camille Faure, of Paris, the discoverer, a box of "electric energy." A gentleman writes to the *Times* this morning as follows:—"On Monday last, in Paris, a Faure battery or *pile secondaire* was charged with the electric fluid, direct from an ordinary Grove battery, in my presence. The receptacle consisted of four Faure batteries, each about five inches in diameter and ten inches high, forming a cylindrical leaden vessel and containing alternate sheets of metallic lead and aluminium, wrapped in felt and rolled into spirals wetted with acidulated water, and the whole placed in a square wooden box, measuring about one cubic foot, and weighing some seventy-five pounds. This was protected by a loose wooden cover through which the electrodes in lead protruded and were flattened down for the convenience of transportation. This box of electric energy was handed to me by M. Faure with the object of submitting it to examination and measurement at the hands of Sir William Thomson.

CARRIED TO SCOTLAND INTACT.

"In about seventy-two hours from the time of charging the jar in Paris I had the satisfaction of presenting Faure's rare offering of a box of electricity intact. This is the patent compression within the small space of one cubic foot of a power equivalent to nearly one million feet. The wonderful box is now deposited in the laboratory of Glasgow University and is being submitted to a series of tests and measurements. The results of some of these made Sir William exclaim, 'Why, it's a little giant!' The advantage to science and humanity which this discovery, or rather the perfection of Planté's discovery is destined to afford, are of such transcendent importance that we cannot for the present form any correct estimate of its magnitude. Whatever may be the practical results obtained I have the satisfaction of recording that for the first time to my knowledge in the history of the universe a box of electric energy nearly equivalent to a million feet contained within less than a cubic foot of space, intact and potential, has been transported from France or elsewhere to Great Britain."

The facts about the omnibus, or rather tram-car, recently driven by means of a Faure battery in Paris, are coming out gradually, and they do not improve on a nearer acquaintance. In the first place, the battery, with its 160 accumulators, cost 20,000 francs, or £800, and weighed about one ton and a quarter; and in the second place, it necessarily occupied a considerable space. The cost of charging the battery is not stated, but there is little doubt that it was a trifle more than the board and lodging of the two horses, which could have done the work quite as well. The first cost of two horses in Paris is put down at 2,600 francs, or £104, and their keep at 6 francs per diem, so that the Frenchmen are beginning to perceive that the Society for Supplying Light and Power is not about to introduce a revolution in motive power. The letters of Sir W. Thomson have been severely criticised by M. F. Géraldy, in *L'Electricité*, and he is taunted with the fact that he never wrote letters to the *Times* about Planté's battery, which he has known for many years, and which is little less efficient than the battery which has excited his enthusiasm.

Nature July 14. 1881.

Faure's Secondary Battery

IN your issue of last week you gave an account of the *soirée* held at King's College, London, on the evening of July 2, and in this account it is stated that "the great event of the evening was the exhibition for the *first* time in England of M. Faure's secondary battery."

At the *soirées* given by the Mayor of Nottingham on the evenings of June 30 and July 3 in connection with the opening of the College by H.R.H. Prince Leopold, I had the pleasure of exhibiting to large audiences one of M. Faure's new batteries. Sheets of lead were bent up into the form of shallow trays, one foot square and one inch deep; in each of these was placed a layer of red lead, then a layer of flannel, then a layer of red lead, and lastly another lead plate. These trays to the number of six were then piled one above the other, after being filled with dilute acid. The cells being connected in series, were polarised by a 10-cell battery of Grove's cells, and after twenty minutes' charging, had taken up a very large quantity of electricity. At a short lecture given during the evening the charged Faure battery was connected with a Gramme machine, and drove it round with considerable velocity for some minutes. After thus employing part of the charge the remainder was used for heating several inches of platinum wire, and for driving for a few seconds a ... These experiments ...cal character of M. ... opportunity of ex... ...ventor, I was obliged ...wever a convenient ...ermits the structure ...ce. The enormous ... form of Planté cell

J. A. FLEMING

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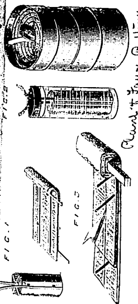

Eng. Mech. & Wld Science July 15 1881

... not be charged by a dynamo machine—only by the ordinary form of battery—so that the stored energy is expensive in first cost. M. Planté, the real inventor of the electrical accumulator, is taking advantage of this fact to show that his device is really more economical than the newer modification, for his battery can be charged by a magneto-electric machine. He is constructing an accumulator on the original form for M. Lissandier, which is to work a small balloon, and which will be exhibited at the forthcoming International Electrical Exhibition. Edison will probably turn his attention to the subject, and with the unrivalled resources of his laboratory we may fairly expect that, before the century is much older, a notable advance in electricity as a motive power will be made. Echo June 18/81

PLANTÉ AND FAURE BATTERIES.

THE annexed illustrations of the secondary batteries, which are exciting so much interest at the present time will, with the accompanying description, enable the reader to understand their construction. At the recent soirée given by the Council and academical staff of King's College, several forms of electric-lighting apparatus were used; but that which attracted most attention was a battery of forty-four accumulators of Faure's design, working twenty of Swan's lamps. The cells were charged in Paris by a Gramme machine, and were arranged in groups of four in cubical boxes, the whole being coupled up in series. The current supplied by this arrangement, shown by a galvanometer in the circuit while the lamps were alight, was about twenty-three webers, and was perfectly steady — the Faure battery yielding an almost equal current during the whole time, until the charge becomes exhausted, when it breaks down suddenly, without any noticeable warning. Mr. Spottiswoode also uses the Faure battery to work Swan and Maxim lamps in his private house. Figs. 1 and 2 represent the Planté cell. The preparation is as follows:—Two sheets of lead (it may be as thin as stout lead-foil) are laid the one on the other, separated by two strips of indiarubber, the whole being rolled up as shown in Fig. 1. The roll having been completed, the cylinder used in its formation is withdrawn, and it is consolidated by a wrapper of guttapercha, and inserted in a glass jar filled with water and 1-10th part acid. An electric current is then made to pass through the cell; oxygen is given off, and produces a thick cushion of peroxide of lead on one sheet; hydrogen is given off at the other sheet. If the current with which the cell has been charged be cut off, and the two sheets are connected, a current will be produced, owing to the presence of the oxygen, which leaves the sheet where it has accumulated and attacks and oxidises the other sheet. This secondary current, which is very small at first, gains strength each time the operation is repeated; in course of time the surfaces of the sheets are changed, the one being covered with a cushion of peroxide of lead, the other with lead reduced to a spongy mass. The cell is then complete, and in a state of electrical accumulation. That was Planté's first successful battery. Subsequently he tried the plan of separating the two sheets of lead by canvas, the cell taking the form of Fig. 2. He then found that it was necessary to leave a small space between the sheets to provide for the escape of the gases which were produced at the end of the charge; subsequently indiarubber bands were employed in preference to canvas. M. Planté also tried carbonate of lead, minium, &c., but without improving upon the results already obtained. The Faure battery is similar to the above:—Two sheets of lead are taken, about 7½in. wide, one about 23in. long and about 1-25th of an inch thick, the other 15in. long and 1-48in. thick. Each of these is furnished with a strong strip of lead at one of its ends. Each sheet has a layer of red-lead spread on its surface, the lead being made into a paste with water, the larger sheet having about 800 grammes on its surface, and the smaller 700 grammes. On each surface a sheet of parchment is laid, and the whole is introduced into a sheathing of thick felt. The sheets are laid one above the other; at the same time several bands of indiarubber are placed in an oblique fashion, as shown in Fig. 3. The roll is placed in a leaden jar, strengthened by copper bands, and covered in the interior with red lead and felt. The cell then presents the appearance shown in Fig. 4. One of the pieces of lead which jut out is curved and soldered to the outer jar, acidulated water is put in, and the battery is ready for work.

We give the above figures as a guide, but there is no special reason for adhering to them, and it may be doubted whether either the parchment or felt is an absolute necessity: for good batteries have been constructed by painting stout lead-foil with red-lead made into paste with water slightly acidified with oil of vitriol, and wrapping the plates in flannel or canvas which has been previously coated with the red-lead paint. The painted surfaces are of course put together. Thin lead is used to keep the weight down as much as possible and to reduce the cost.

himself tell us, we cannot get much more than one-tenth of the amount of work out of the line of coal even in our largest steam engines, which burn many pounds of coal per minute, and in which much heat has been wasted in getting up steam. And if we come to the burning of one single lump, of coal, I know of no engine that can obtain from this even one thousandth part pounds of work, or one thousandth of the energy contained in the coal, if no other coal be used in getting up steam or in previously heating the engine.

But if a secondary battery be allowed to drive a magneto-electro-motor or a dynamo-electric machine with separate exciter only even for the short time necessary to develop, say, 20 foot pounds of mechanical work, I anticipate this can be done without using up in the whole process more than about 25 foot pounds of the electric energy stored up in the reservoir, since the experiments of Professor Ferry and myself have shown that, when the motor is running at high speeds with a light load, as much as 62 per cent. of the electric energy put into a magneto-electromotor is given out again as mechanical work measured by an absorption dynamometer.

It may be answered, however, that if a small bit of coal, although containing a vast store of energy, is not of much practical use in producing work in consequence of the slowness up to the present time of a proper conversion of the coal's energy into mechanical work, at any rate a small galvanic battery is little Daniell's cell, for example) is not only a very inefficient source of power, but contains a store which we have the means of converting without appreciable loss into electric light or mechanical work. How, then, is Mr. Ferry's box a better store of electric energy than a little Daniell's cell? This question has precisely the same answer as "Why is a pitch of dry gunpowder better than a pitch of wet?" Not because the dry gunpowder has more energy in it than the wet, but because the energy stored up in the dry gunpowder can be all, if we wish, used up quickly, and so explosion produced, whereas that in the wet can only be utilized bit by bit. So seven Ferry's boxes will illuminate 100 Swan lamps for six hours, while seven Daniell's cells, or, indeed, twice that number, although possessing a store of power millions of times as great as that in the Ferry boxes, will not illuminate a single Swan light.

But while fully recognising the great advance made in the subject by Planté, and the recent improvements introduced by Faure, I do not wish to give the impression that the problem is by any means completely solved, since, if the attempt that Mr. Ferry and myself, no doubt like many other electricians, are making to convert at a low temperature the energy in coal into electric energy meets with even a fairly satisfactory solution, then a fragment of coal, or, it may be, a puff of gas (or, in nature, of carbonic oxide), will be a practical store of energy of incomparably greater value than secondary batteries.

W. E. AYRTON.

The City and Guilds of London Technical College, Finsbury.

Eve. Telegr. May 19. 1881

A MIGHTY POWER.

Compressed Electricity Rivalling the Supernatural Genie in the Bottle.

VIA FRENCH STATION CALAIS TO THE EVENING TELEGRAPH.

London, May 17.—Sir William Thomson, F.R.S., of the University of Glasgow, has received from M. Camille Faure, of Paris, the discoverer, a box of "electric energy." A gentleman writes to the *Times* this morning as follows:—On Monday last, in Paris, a Faure battery or pile accumulator was charged with the electric fluid, direct from an ordinary Grove battery, in my presence. The receptacle, about inches in diameter and ten fee a cylindrical leaden case, ternate sheets of metallic lea wrapped in felt and rolled in with sulphuric water, and the a square wooden box, measu cubic foot, and weighing a pounds. This was protected b cover through which the electr leaded and were flattened do continuance of transportation. Th tric energy was handed to me b the object of submitting it to e measurement at the hands Thomson.

CABBITO TO SCOTLAND

"In about seventy-two hours charging the jar in Paris I had at of presenting Faure's rare offer electricity intact. This is the sion within the small space of c a power equivalent to nearly a The wonderful box is now depos ratory of Glasgow University; imitted to a series of tests tha The results of some of these m ceptible. "Why, it's a little giar tage to science and humanity covery, or rather the perfection covery is destined to afford a scendent importance that pa present form any correct estima trade. Whatever may be the prac ieldeed I have the satisfaction of for the first time to my knowle tory of the universe a box of nearly equivalent in a million within less than a cubic foot o ned potential, has been transporte or elsewhere to Great Britain."

The facts about the consili car, recently driven by means in Paris, are coming out gra not improve on a recent the first place, the battery ha letors, cost 20,000 francs, or about one ton and a quarter place, it is necessarily occupie space. The cost of charging stated, but there is little doubt more than the board and l horses, which could have done well. The first cost of the put down at 2,500 francs, or $ as 6 francs per diem, so that, th ing Light could have supplied ventilation or motive power f M. Camille Faure, in *L'Electricité*, with the fact, that he recently *Times* at about Planté's battery wi for many years, and which is st than the battery which has ma

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Italian July 14. 1881.

Faure's Secondary Battery

In your issue of last week you gave an account of the *soirée* held at King's College, London, on the evening of July 2, and in this account it is stated that "the great event of the evening was the publication for the first time in England of M. Faure's *secondary* battery."

At the *soirée* given by the Mayor of Nottingham on the evenings of June 30 and July 2 in connection with the opening of the College by H.R.H. Prince Leopold, I had the pleasure of exhibiting to large audiences one of M. Faure's new batteries. Sheets of lead were cast by into the form of shallow trays, one foot square and one inch deep; in each of these was placed a layer of red lead, then a layer of flannel, then a layer of red lead, and lastly another lead plate. These trays to the number of six were then piled one above the other, and the whole filled with dilute acid. The cells being connected in series, were polarized by a 10 cell battery of Grove's cells, and after twenty minutes' charging, had taken up a very large quantity of electricity. At a short interval given during the evening the charged Faure battery was connected with a Gramme machine, and drove it round with great velocity for some minutes. After this employing the rest of the charge the remainder was used for heating several inches of platinum wire, and for driving for a few seconds a simple form of magneto-electric engine. These experiments amply convinced me of the practical character of M. Faure's invention. As I have had also the opportunity of examining one of the original batteries of the inventor, I was obliged to make up this experimental form. It is hoped to be exhibited for lecture-room demonstration, as it permits the construction of the battery to be exhibited to an audience. The enormous superiority of M. Faure's cell over the old form of Planté cell is evident at once on experimenting with it. J. A. FLEMING

The University College, Nottingham, July 10

Elec. Rev. June. 18. 1881

SIR W. THOMSON has been experimenting with M. Faure's accumulator, or secondary battery, and is now enabled to give us some approximate results showing the real value of the invention. A Faure battery weighing about 1920lb will store sufficient energy to give out one hours-power during an hour, or two million foot-pounds. As to the useful effect—the proportion of energy given out as compared with that stored up in the battery—Sir W. Thomson is unable at present to speak positively, but when the accumulator is employed under conditions conducive to economy the loss of energy is less than 10 per cent. Put into a practical form, the calculations show that accumulators weighing three-quarters of a ton would yield a one-horse power during six hours, or if the accumulators weigh only one-quarter of a ton they would yield the same still of a horse-power during six hours. If these estimates are correct, a tramcar could run three hours on one hour by a Faure battery weighing less than eight hundredweight—a result which has not been known, but this point experiment alone can determine, but the great weight of the battery is a serious objection to the new motor. Where the Faure battery system can be adopted it is clear that the Faure battery has a very distinct field for tramway work, at all events. Another disadvantage is that the Faure accumulators can only be charged by a dynamo machine—only by ordinary forms of battery—so that the electrical energy is expensive in first cost. M. Planté, the real inventor of the secondary accumulator, has taking advantage of this fact to show that his device is really more economical than the newer modification; for his battery can be charged by a magneto-electric machine. He is constructing such an accumulator on the original form for M. Lissadelor, which is to work a small balloon, and which will be exhibited at the forthcoming International Electrical Exhibition. Edison will probably turn his attention to the subject, and with the unrivalled resources of his laboratory we may fairly expect that, before the century is out, a reliable storage in electricity as a motive power will be made. *Echo* June 16/81

PLANTÉ AND FAURE BATTERIES.

THE annexed illustrations of the secondary batteries, which are exciting so much interest at the present time will, with the accompanying description, enable the reader to understand their construction. At the recent soirée given by the Council and academical staff of King's College, several forms of electric lighting apparatus were used; but that which attracted most attention was a battery of forty-four accumulators of Faure's design, working twenty of Swan's lamps. These cells were charged in Paris by a Gramme machine, and were arranged in groups of four in cabinet boxes, the whole being coupled up in series. The current supplied by this arrangement, shown by a galvanometer in the circuit while the lamps were alight, was about twenty-seven webers, and was perfectly steady, the Faure battery yielding an almost equal current during the whole time, until the charge became exhausted, when it broke down suddenly, without any perceptible warning. Mr. Spottiswoode also uses the Faure battery to work Swan's incandescent lamps in his private house. Figs. 1 to 3 represent the Planté cell. The preparation is as follows:—Two sheets of lead (it may be as thin as stout lead-foil) are laid the one on the other, separated by two strips of indiarubber, the whole being rolled up as shown in Fig. 1. The roll having been completed, the cylinder is placed in its formation in withdrawn, and it is occasionally by a wrapper of gutta-percha, and inserted in a glass jar filled with water and 1-10th part acid. An electric current is then made to pass through the cell; oxygen is given off, and peroxide of lead is deposited on the surface of the sheet in the left-hand series of cells at the other sheet. The jar is then filled with dilute acid that has been diluted with water, and the two sheets are connected, a current will be produced, owing to the presence of the oxygen, which leaves the sheet where it has accumulated, and attacks and oxidizes the other sheet. This secondary current, which is very small at first, gains strength each time the operation is repeated; in time the surfaces of the sheets are changed, the one being covered with a coating of peroxide of lead, the other with lead reduced to a spongy mass. The cell is then complete, and is in a state of electrical accumulation. This was Planté's first discovery. Subsequently he tried the plan of separating the two sheets of lead by canvas, the cell taking the form of Fig. 2. He then found that it was necessary to have a small space between the sheets to provide for the escape of the gases which were produced at the end of the charge; subsequently indiarubber bands were employed in preference to canvas. M. Planté then tried carbonate of lead, minium, &c., but without answering upon the results already obtained. The Faure battery is made in the form shown:—Two sheets of lead are taken, about 7½in. wide, some 12in. long and about 1-25th of an inch thick, the other 10in. long and 1-16th. thick. Each sheet is covered over with a strong sheet of lead, one of its ends. Each sheet has a layer of red-lead paste on its and is rolled up with a piece of indiarubber, the lead being made into paste with water, the longer sheet having a little more grittiness on its surface, and the smaller 700 grammes. On each surface a sheet of perforated lead, and the whole is introduced into a sheathing of thick felt. The sheets are laid one above the other; at the same time several bands of indiarubber are placed in an oblique fashion, as shown in Fig. 3. The roll is pressed in a broken jar, strengthened by copper bands, and placed in the interior with red lead and felt. They cell then presents the appearance shown in Fig. 4. One of the pieces of lead which jut out is bent and soldered in the outer jar, solidified water is put in, and the battery is ready for work.

We give the above figures as a guide, but there is no special reason for adhering to them, as they may be doubled whether either the paste-coated or felt is an absolute necessity; for equal battery can be made by simply painting the stout lead-foil with red-lead made into paste with water slightly acidified with oil of vitriol, and wrapping the plates in flannel or canvas which has been previously coated with red-lead paint. The painted surfaces are put one to come put together. This lead is used to keep the weight down as much as possible and to reduce the cost.

The storage of electricity is progressing, and we learn now that Mr. Brush has also invented a secondary battery, which is reported to be far superior to the Faure. No details of the invention have yet been published, in which he contends that compressed air is the most economical method of storing force. For locomotive purposes, he says, the results obtained from the storing of electricity do not approach those obtained from the storage of air, in the amount of force actually available for traction or propulsion. For tramways, he declares that the cost of air would be considerably below that of steam, while on such a railway as the Underground, the daily pressure of working by air instead of by steam would be little, if at all, in excess, though the first cost would be greater. If that is true, the directors ought to welcome the air-locomotive, as it will help to free the tunnels of their noxious gases.

The Scientific Mechanic and Patent Record, No. 1.

PORTABLE ELECTRICITY.

By the wonderful invention of M. Camille Faure, of Paris, there is compressed within a portable package of one cubic foot an electric energy equal to a million feet. This package consists of four Faure batteries, each about five inches in diameter and ten inches high, forming a cylindrical leaden vessel, and containing thereon sheets of metallic lead and antimonium, wrapped in felt and rolled into spirals wetted with acidulated water, the whole placed in a square wooden box measuring about one cubic foot, and weighing about seventy-five pounds. It is protected by a loose wooden cover, through which the electrodes in lead protrude. One of these packages was recently sent from Paris to Sir William Thomson, at the Glasgow University. After some seven tests and experiments, Sir William exclaimed, "Why, it is a little giant."

THE ELECTRICIAN, MAY 28, 1881.

THE EFFICIENCY OF SECONDARY BATTERIES.

The performance of secondary batteries comprises two phases, the charge of the accumulator by the action of an external source, and its discharge in the working circuit. Now, each of these operations involves a certain loss of power, and this loss has been recently investigated by M. Emile Reynier, the well-known French electrician.

He considers, first, the case of an incandescent electric lamp, in which the resistance of the circuit is a constant quantity. The elements of the question are as follow:—

E_0 the initial electromotive force of the source.
R_0 resistance of the source.
E electromotive force of the secondary battery.
R resistance of the secondary battery.
E_1 difference of potential between the two extremities of the conductor mixed to incandescence.
R_1 resistance of this conductor.
t the time of the charge.
t_1 the time of the discharge.

The work, T_0, expended in charging will be

$$T_0 = E\,\frac{E_0 - E}{R_0 + R}\,t \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The work, T, utilised in the incandescent conductor will be

$$T = \frac{E_1^2}{R + R_1}\,t_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

To find the ratio of these two works, we must express t_1 as a function of t. This can be done by considering that the quantity of electricity, Q, is the same in the charging and discharging circuits, and that this quantity is proportional to the products of the intensities of the currents by the times; from whence is the equation

$$\frac{E_0 - E}{R_0 + R}\,t = Q = \frac{E_1}{R + R_1}\,t_1$$

and hence

$$t_1 = \frac{E_0 - E}{R_0 + R}\,\frac{R + R_1}{E_1}\,t \quad . \quad . \quad . \quad . \quad . \quad (3)$$

By substituting for t_1 its value in the expression (2), this becomes

$$T = \frac{E_1^2}{R + R_1}\,\frac{E_0 - E}{R_0 + R}\,\frac{R + R_1}{E_1}\,t = E\,\frac{E_0 - E}{R_0 + R}\,t \quad . \quad . \quad . \quad . \quad (4)$$

whence we get the yield of the battery

$$\phi = \frac{T}{T_0} = \frac{E}{E_0} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The efficiency is expressed, therefore, by the ratio between the difference of potential between the two ends of the resistance, which is incandescent, and the initial electromotive force of the electric source. It is independent of the resistances and the values of the times of charge and discharge.

In the foregoing investigation M. Reynier has supposed that the work was done by the discharge in the heating of a wire or conductor; but if the discharge current acts in a circuit which is itself the seat of an electromotive force—say, an electric motor—the expression for the efficiency is not altered. It is then incumbent, however, not to take for the value of E_1 the difference of potential at the two ends of the motor, because E_1 might to express the inverse electromotive force of the motor at the origin of the induction. We ought to arrive at the expression indirectly by putting

$$T_1 = Q\,E_1 \text{ and } T = Q\,E_1,$$

from which we get

$$\phi = \frac{T}{T_0} = \frac{E_1}{E_0} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

These formulæ show how the resistances vanish from the final expression; they give us the relative and respective values of the times of charge and discharge, and show us that if the resistances do not act upon the final yield, they influence the time, and consequently the values, of the work expended and recuperated in unit time.

In practice, the resistances of the circuits ought to be taken into consideration. It is because of its very feeble internal resistance that the secondary battery of M. Faure gives a return of power or efficiency of 90 per cent. under advantageous conditions. In fact, the constants of the Faure battery are, for the small model of 7·5 kilogrammes,

$$E = 2{\cdot}15 \text{ volts},$$
$$R = 0{\cdot}006 \text{ ohm}.$$

Making $E_0 = E_1 + 1 = 3{\cdot}15$ volts,
$E_1 = E_0 - 1 = 2{\cdot}15$ volts,
$R_0 = R = 0{\cdot}006$ ohm,
$R_1 = R = 0{\cdot}006$ ohm.

The work expended during the charge will be

$$\frac{E_0^2}{2\,(R_0 + R)} = 4{\cdot}21 \text{ kilogrammes}$$

per second and per pair, a rule which admits of estimating the battery in time of charging much shorter than usual.

The work recuperated per second and per pair during the discharge will be equal to

$$\frac{E_1^2}{2\,(R + R_1)} = 2{\cdot}3 \text{ kilogrammes}.$$

As to the efficiency, it is, under these conditions, equal to

$$\frac{E_1}{E_0} = \frac{2{\cdot}3}{4{\cdot}21} \text{ or } 81 \text{ per cent}.$$

ELECTRIC RAILWAYS AND TRANSMISSION OF POWER BY ELECTRICITY.*

BY ALEXANDER SIEMENS.

When electricity was first utilised for practical purposes, the cost of producing it precluded its application to anything but giving signals or working small and delicate apparatus, requiring only weak currents to perform their functions; but by the discovery of the dynamo-electric principle, some fourteen years ago, powerful electric currents have been placed at our disposal, at a cost which enables us to transform into commercial processes a number of experiments which, up to that time, served only as illustrations of scientific lectures.

The machines which have caused this revolution in the application of electricity consist essentially of two parts—the fixed electro-magnets, by which a powerful magnetic field is created, and the revolving armature, which is connected with the commutator. When the machine is in action, the rapid motion of the armature through the magnetic field induces an electric current, which leaves the helix by the brushes pressing against the commutator on opposite sides. From the brushes the current passes to the electro-magnets, and afterwards to the outer circuit, where it has to perform the useful work. In traversing the coils of the electro-magnets, it increases the intensity of the magnetic field, which in its turn induces a more powerful current, and this mutual strengthening of current and magnetic field goes on until a balance establishes itself in the manner afterwards described.

The researches of Sir William Thomson, Dr. Hopkinson, Professor Ayrton, and others have proved that such machines, if properly constructed, will render in the form of electrical work up to 90 per cent. of the energy expended upon them in the form of motive power. It may, therefore, be conceded that they are very efficient transformers, and that we can hardly hope to exceed the results already obtained by the best types of dynamo-electric machines. If, instead of using such a machine to generate electricity you send a current into it, the magnetic attraction created between the poles of the electro-magnets and the armature tries to revolve the armature will cause the latter to rotate, and this motion can be communicated to other machinery in the usual ways. A pair of such machines, one for producing electricity and the second for retransforming the current into motive power, can, therefore, be utilised for transmitting power to a distance. In order fully to understand the manner in which this transmission is effected, a large number of experiments were made at the works of Messrs. Siemens and Halske, in Berlin, by Dr. Fröhlich, and the results obtained were laid before the Royal Academy of Science in Berlin by Dr. Werner Siemens on the 18th November, 1880.

The principal conclusions arrived at were the following:—In applying Ohm's law to a magneto-electric machine in motion with permanent magnets we find that the strength of current for a given total resistance is—

$$C = \frac{n \times M \times r}{R} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In this formula C signifies the strength of current; n, the number of convolutions of wire on the armature; r, the number of revolutions per minute; R, the total resistance in circuit; M, the total E.M.F. produced by the permanent magnets and the iron of the armature in one convolution of wire, when $r = 1$; this quantity will afterwards be called "effective magnetism" of the machine.

The same formula holds good for a dynamo-electric machine. In this case, however, the "effective magnetism" M depends on the strength of current (C), and the formula, by substituting $f(C)$ for M, becomes—

$$C = \frac{r\,f(C)}{R} \text{ or } f(C) = \frac{C}{r}\,R \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

In the latter form the very important law is expressed that the strength of the current in a given dynamo-electric machine depends only on the ratio of the number of revolutions per minute to the total resistance in circuit. If we determine, therefore, f (C) for a machine, we can calculate beforehand the strength of current it will produce with a given number of revolutions in a given resistance.

The first series of experiments was made to test the correctness of this conclusion, and the curves I., II., and III., embody the results obtained by working one of the largest "Siemens" dynamo machine (type D_2) through various resistances at different speeds. The total resistance of the machine was, in case (I.), 0·68 S.U.; in case (II.), 7·25 S.U.; and, in case (III.), 7·74 S.U.

By way of comparison, the curve IV. was set out from results published by Messrs. Meyer and Auerbach in "Wiedemann's Annalen," Band 8, p. 491, who had experimented with a "Gramme" dynamo machine. As will be seen, all these curves do not differ materially from a straight line, and, for the limits of practical working, they fully confirm the above theory. There exists, therefore, a curious similarity between magneto-electric and dynamo-electric machines. In both, the strength of current is proportionate to the ratio of revolutions per minute to total resistance, although the magnetism of the magneto machines is a constant quantity, and that of the dynamo machine varies with the strength of current. The important difference between the two kinds of machine is, that magneto machines give a current however slow their motion is, whereas dynamo machines only begin to give a current when the ratio of number of revolutions to total resistance attains a certain magnitude.

The nature of the f (C) was then further examined, and the influence on the magnitude of the "effective magnetism" of the currents set up in the iron of the armature by its quick rotation in a magnetic field, and by the currents traversing the coils of the armature. The results arrived at are represented by the curves V., VI., VII., for the large Siemens machine, and by the curve VIII. for the Gramme machine referred to above. They show that at first the "effective magnetism" increases in proportion to the increase of current, then it deviates more and more until it very gradually reaches a maximum, and for still more powerful currents it decreases again. The latter peculiarity is to be accounted for by the fact that the iron bars of the electro-magnet cannot be magnetised beyond a certain point, whereas the diminishing influence of the currents on the magnetism in the iron of the armature increases continually with the strength of these currents. In practical applications such powerful currents are seldom met with, and it will suffice for the present purpose to assume that the "effective magnetism" gradually approaches a maximum.

When two machines, identical in their construction, are connected to transmit power, the "effective magnetism" in both should be equal, as the same current circulates through both of them. The following equations will, therefore, exist between the various quantities:—

$$E_1 = M\,r_1,$$
$$E_2 = M\,r_2,$$
$$C = \frac{E_1 - E_2}{R} = n\,M\,\frac{r_1 - r_2}{R},$$
$$W_1 = n \times E_1 \times C = n\,C\,R\,\frac{r_1}{r_1 - r_2},$$
$$W_2 = n \times E_2 \times C = n\,C\,R\,\frac{r_2}{r_1 - r_2},$$
$$H = n \times C \times R,$$
$$W_1 = H + W_2,$$
$$N = \frac{W_2}{W_1} = \frac{r_2}{r_1} = \frac{E_2}{E_1}.$$

In these formulæ the index 1 refers to the machine producing the current, and the index 2 to the machine giving out the power; E stands for electromotive force; n, M, r, R, C, signify the same quantities as before; n is a constant depending upon the construction of the machines; H is the heat, generated in the system; W_1 is the work expended upon the primary machine; W_2 is the work given out by the secondary machine; N is the useful effect.

In comparing these formulæ with observations, it is easily seen that they cannot be quite correct. This is most conspicuous with the formula for the useful effect, $N = \frac{r_2}{r_1}$, according to which this should be greatest the more the velocity of the second machine approaches the velocity of the first machine, whereas actual experiments show that N is a maximum for a certain velocity of the second machine, and will decrease for any greater or lower number of revolutions of the secondary machine. The cause of this discrepancy is the influence of the so-called Foucault's currents, which are set up in the iron of the revolving armatures by the proximity of the powerful electro-magnets.

In the primary machine these currents circulate in the same direction as the currents in the covering wire of the armature, weaken the "effective magnetism," increasing the work W_1 expended upon the primary machine. In the secondary machine, however, in which the armature runs in the opposite direction, these Foucault currents circulate in the opposite direction to the currents of the armature wires, and by thus strengthening the effective magnetism and the electromotive force E_2, they diminish the work W_2, given out by the secondary machine.

As our machines are supposed to be of identical construction, the following formula will express the relative proportion of the different quantities relating to the Foucault currents:—

$$M_1 = M - c\,r_1,$$
$$M_2 = M + c\,r_2,$$
$$c_1 = \frac{M_1 - u}{r_1} = \frac{1}{u} - \frac{E_1}{u\,r_1},$$
$$c_2 = \frac{M_2 - u}{r_2} = \frac{1}{u} - \frac{E_2}{u\,r_2}$$

M signifies the effective magnetism, such as it would be if no

* Paper read at the Society of Arts on May 18th.

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Journal Nov 11, 1881.

The Storage of Electricity Accomplished.—Referring to the transmission of a hor, charged with electricity, from Paris to Glasgow, to which we recently alluded, Sir William Thomson, the eminent scientist, writes:—The "million of foot pounds" kept in the box during its 72 hours' journey from Paris to Glasgow was no exaggeration. One of the four cells, after being discharged, was recharged again by its own secondary battery, and then left to itself absolutely undisturbed for ten days. After that it yielded to me 240,000 foot pounds (or a little more than a quarter of a million). This not only confirms M. Reynier's measurements, but seems further to show that the wasteof the stored energy by time is not great, and that for days or weeks, at all events, it may be of practical moment. I have already ascertained enough regarding the Faure battery to make it quite certain that it solves the problem of storing electric energy in a manner and on a scale useful for many important practical applications. The largest useful application waiting just now for the Faure battery—and it is to be hoped that the very minimum of time will be allowed to pass till the battery is supplied for this application—is to do for the electric light what a water cistern in a house does for an intermittent water supply. A little battery of seven or eight Leaden reflects to give the incandescence in Swan or Edison lights to the extent of 100 candles for six hours, without any perceptible diminution of brilliancy. Thus, instead of needing a gas-engine or steam-engine to be kept going as long as the light is wanted, with the liability of the light failing at any moment through the slipping of a belt, the accident of no fireman, steam-raiser or engineer, breakdown or stoppage of the machinery, and instead of the waste of fuel inevitably during the hours of day or night when the light is not required, the engine may be kept going all day and charged at night, or it may be kept going day and night, which will undoubtedly be the most economical plan where the electric light comes into general enough use. The Faure accumulator, always kept charged from the engine by the house-supply when, with a proper automatic stop to check the supply when the accumulator is full, will be always ready at any hour of the day or night to give whatever light is required. Precisely the same advantages in respect of economy will be gained by the accumulator when the electric town supply is, as it surely will be before many years pass, regularly used for turning lathes and other machinery in workshops and sewing-machines in private houses.

William Thomson

Glasgow, Nov. 12.

Nov. 12, 1881.

Electric Vehicles in Paris.

On the 2d of June the application of electricity to locomotives by the system of M. Faure was experimented upon in the courtyard of the great Omnibus Company in Paris, where an omnibus was placed at the service of M. Hufford, the clever mechanical engineer of the Society La Force et la Lumiere. Nothing was changed in the vehicle; the apparatus was placed therein, and worked positively and without accident, the load struck at starting; notwithstanding the road was in bad condition and on a declivity. The experiments were equally satisfactory ascending or descending. In a few days the Company will have permission to run from Place du Trocadero to Passy by way of the Arc de Triomphe. It is thought these experiments will prove conclusively that the system of electric traction offers 20 per cent. economy, and no danger whatever even in crowded streets.

Times Gas Light Journ. July 2. 1881

The Storage of Electricity.

The London *Times* prints the following letter to the editor of that journal:

"SIR:—Although agreeing with every word of Sir William Thomson's letter in the *Times* of to-day, and entirely sympathizing with his enthusiasm as regards the marvellous box of electricity, still I feel that it would have been desirable if in pointing out the importance of this new discovery Sir William Thomson had guarded against a very probable misconstruction of the purport of his letter.

"The means of storing and re-storing mechanical energy form the aspiration of not only Sir William, but of every educated mechanic. It is, however, a question of degrees—of the amount of energy stored as compared with the weight of the reservoir, the standard of comparison being coal and corn. Looked at in this way, one cannot but ask whether, if this form of storage is to be the realization of our aspirations, it is not completely disappointing. Large numbers are apt to create a wrong impression until we inquire what is the unit. Eleven million foot-pounds of energy is what is stored in one pound of ordinary coal. So that in this box, weighing 75 pounds, there was just as much energy as in 1½ ounce of coal, which might have been brought from Paris or anywhere else in a waistcoat pocket, or have been sent by letter.

"When we come to the question of the actual conveyance of energy for mechanical purposes, this view is of fundamental importance. The weight of the same amount of energy in this new form is 800 times greater than the equivalent amount of coal; and as a matter of economy, supposing that energy in this form might be had at a certain spot and no capital were required for its conversion or storage, and that the energy were directly applicable, it could not be carried 10 miles—that is to say, such energy cannot be economically useful 10 miles from its source, although coal had to be carried 100 miles to the spot. Thus limit, in truth, fells far short of what has been already attained by other means. By wire ropes and by compressed air or steam energy may be economically transmitted from ten to twenty miles. So that if this is the utmost of what is to be done by means of the storage of electricity, this discovery adds another door to those which are hopelessly closed against the possibility of finding in Niagara or other water power a substitute for our coal, even when the object is motive power, and much more for that purpose for which free-stalks of our coal is used—the production of heat.

"It is very important that the people of this country should not shut their eyes to the fact that so far from there being a greater prospect of the solution of the problem than when, about twenty years ago, Professor Anyons raised the alarm, the prospect is now much smaller. In the meantime the capabilities of steel ropes, thinks in pipes, and electricity along conductors have been not only investigated, but practically tested and found altogether wanting. And now it would seem that the storage of electricity must be added to the list.

"Owens College, June 8." OSBORNE REYNOLDS.

Times Gas Light Journ. July 2. 1881.

Effect of Electric Light on the Eyes.

An unexplained objection to the electric light arises from its alleged evil effects on the eyes. European observers state that the frequent variations in intensity to which the light is subject give rise to sudden and frequent changes in the pupil, and, consequently, in the "accommodation" of the eye, by which is meant that alternate contraction and dilation of the pupil, by which it suits itself to the variations of light. Such a light, therefore, causes not only muscular fatigue, but also a considerable degree of blurring and indistinctness in the retinal image. The eye suffers both when the light is too dim and when it is too bright. In the former case the object must be brought close to be clearly seen, and an increased accommodative effort is called for, which in most cases results in nearsightedness. In the latter case, the simple intensity of the light produces undue contraction of the pupil, and an increase of tension within the eye.—*Manufacturer and Builder.*

NEW-YORK DAILY TRIBUNE,

NOVEMBER 6, 1881.

In the House of Commons show that politicians of both parties stoutly resents the proposed new arrangements, and that there is a consensus of opinion against a conventional treaty, unless of a much more favourable nature than has as yet been set forth. It would be foolish to run the risk of retaliation on our part, yet we are afraid that a cry for that course of procedure may be raised unless our Commissioners wisely decline to assent to anything of a retrograde nature. To agree to the new duties upon cutlery and other handwares would be to virtually annihilate our trade in them with France, and, if that result is inevitably to follow, it had better be the outcome of the general tariff revision than is witnessed under a special arrangement, whereby which was got nothing and France everything.

THE STORAGE OF ELECTRICITY.

The storage of electricity, in the manner described by Sir William Thomson, whose letter we published, as regards its principal passages, last week, is of such transcendent importance that we need offer no excuse for again referring to the matter. Sir William Thomson, who is one of the highest living authorities, amply confirms the statement that a small box containing 1,000,000 foot-pounds of electric force has been conveyed from Paris to Glasgow. This small box was in reality a Faure secondary battery, in which the electricity can be accumulated and stored until it is regulated for use. By the application of the same kind of battery M Faure has run a bicycle, and has also applied the principle to a small boat which has been successfully tried over Paris. Sir William Thomson has tested this battery, and reports that it does really afford a means of storing electrical force —a fact which is of vital interest and importance to the public. As we have previously pointed out, the great defect of dynamically-created electricity has been its existence only so long as the motive-power was kept running. When the engine stopped the current ceased. Under the new plan this is no longer the case, and, as the eminent scientist named points out, the electric energy may be stored for household or other purposes, just in the same manner as water or gas. In this way we may light our houses, or utilize the electricity as power, under absolute control, and with a minimum of trouble and expense. Such being the case we may expect to witness an enormous development of the electric industry, accompanied, of course, that the Faure battery is capable of indefinite reproduction on a practical scale. There are not wanting those who would dispute the value of the invention, and who ridicule the ideas set forth by Sir William Thomson. Prof. Osborne Reynolds, of Owens College, Manchester, for instance, points out that, after all, 1,000,000 foot-pounds is a very small matter, being in fact just as small "energy" as is cohained in 1¼ oz. of coal. Coal, indeed, is to be our standard, according to Mr. Reynolds, and he predicts the utter failure of the plan for storing electricity. Professor Ayrton also comes forward as a critic, albeit one of a milder type, and admits the truth of the statement that 1¼ oz. of coal contains 1,000,000 foot-pounds of energy, but he very pertinently asks how that force is to be extracted to its full extent. As a matter of fact it is impossible to attain that result, so known engine being capable of working with no minute a quantity of fuel. This is exactly where the difference lies. The coal may contain the power, but it is all latent, and not available without the aid of a much greater force than its own, whereas the electricity is all immediately available, and can be used wholly or partially at will. Besides this the coal once used is done with, whereas the Faure accumulator can be stored anew, and drawn upon as required. This is an essential distinction,

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The National Scientific Journal, Aug. 1st 1881. 33

THE STORAGE OF ELECTRIC ENERGY.—I am continuing my experiments on the Faure accumulator with every-day increasing interest. I find M. Reynier's statement, that a Faure accumulator, weighing seventy-five kilograms (165 pounds) can store and give out again energy to the extent of one hour's work of one-horse power (1,980,000 foot-pounds) amply confirmed. I have not yet succeeded in making the complete measurements necessary to say exactly what proportion of the energy used in the charging is lost in the process of charging and discharging. If the processes are pushed on too fast there is necessarily a great loss of energy, just as there is in driving a small steam-engine so fast that energy is wasted by "wire-drawing" of the steam through the steam pipes and ports. If the processes are carried on too slowly there is inevitably some loss through local action, the spongy lead becoming oxidized, and the peroxide losing some of its oxygen vicariously, that is to say, without doing the proper proportion of electric work in the circuit. I have seen enough, however, to make me feel very confident that in any mode of working the accumulator is not seriously slow, the loss from local action will be very small. I think it most probable that at rates of working which would be perfectly convenient for the ordinary use of fixed accumulators in connection with electric lighting and electric transmission of power for driving machinery, large and small, the loss of energy in charging the accumulator and taking out the charge again for use will be less than ten per cent. of the whole that is spent in charging the accumulator; but to attain such dynamical economy as this, prime cost in lead must not be aimed. I have quite ascertained that accumulators amounting in weight to three-quarters of a ton will suffice to work for six hours from one charge, doing work during the six hours at the uniform rate of one-horse power, and with very high economy. I think it probable that the economy will be as high that as much as ninety per cent. of the energy spent in the engine will be given out in efficient external to the accumulator. When, as in the proposed application to driving tramcars, economy of weight is very important, much less perfect economy of energy need be looked for. Thus, though an eighth of a ton of accumulators would work very economically for six hours at one-sixth of a horse-power, it would work much less economically for one hour at one horse-power; but not so uneconomically as to be practically fatal to the proposed use. It seems indeed very probable that a tramcar arranged to take in, say seventy-five kilograms (one-half hundred weight) of freshly-charged accumulators, on leaving head-quarters for an hour's run, may be driven more economically by the electric energy operating through a dynamo-electric machine than by horses. The question of economy between accumulators carried in the tramcar, as in M. Faure's proposal, and electricity transmitted by an insulated conductor, as in the electric railway at present being tried at Berlin by the Messrs. Siemens, is one that can only be practically settled by experience. In circumstances in which the insulated conductor can be laid, Messrs. Siemens' plan will undoubtedly be the most economical, as it will save the carriage of the weight of the accumulators. But there are many cases in which the insulated conductor is impracticable, and in which M. Faure's plan may prove useful. Whether it be the electric railway or the load-driven tramcar, there is one feature of peculiar scientific interest belonging to electro-dynamic propulsion of road carriages. Whatever work is done by gravity on the carriage going down hill will be laid up in store ready to resist sideroads in drawing the carriage up the hill, provided electric accumulators be used, whether at a fixed driving station or in the carriage itself.

WILLIAM THOMSON *in Nature.*

University, Glasgow, June 13.

The Faure Battery and Incandescent Electric Lighting.

The transmission of power to a distance from its generating point is a subject that has lately been much discussed in the leading newspapers, in consequence of Sir William Thomson's startling communication on the subject of the Faure battery, or "box of energy." It appears from the statements of the Glasgow professor that fifty Joule's equivalents of heat can be obtained at will from a box weighing 75 lbs. According to the figures, a box weighing 50 batteries will keep 20 incandescent electric lamps of 10 to 12 candle power each, in full action for six hours. These batteries will weigh altogether about 2200 lbs., or say 22s cwt., and will require only re-charging at the end of the second day. This, as already announced, will be shortly reduced to 1d., "or even less." Still, taken at the lower named figure, the batteries will cost 4s. 2d. per day for re-charging only. Carriage is not included, but if generating stations are established at intervals of a mile apart, a consumer situated midway between any of these stations will have to deliver and collect his batteries over a distance of at least a mile every day. This duty, with the necessary fixing and dismantling of the apparatus, exclusive of probable damage, will be cheaply done at 1s. 6d., so we have 5s. 6d. as the lowest daily cost of 200 lamps for battery power alone. These lamps are calculated to endure 500 hours' burning, so there would be a constant expense for their renewal even without accidents, which are very common to that style of lamp. Leaving this, however, with all capital charges, in illuminating power to gas at the common union or battwing tip burning under the most favourable circumstances imagined by the friends of the Faure battery of the future, not less than 5s. 6d. per 1000 six hours. An equal amount of light in the common gas-burners before mentioned would be obtainable with a consumption of 600 feet of gas—an average price of 1000 cubic feet, which at 3s. per 1000 an economy of 2s. 6d. for the six hours, as compared with incandescent lamps supplied with the Faure batteries. It should, however, be remembered that the English agent for this apparatus do not hold forth the immediate expectation of a less charge than 2½d. for re-charging a battery, so that for the present the cost of six hours' light, as above, from this source must be taken at 11s. 10d., or £30 of 50 batteries is £300.

Iron, Nov. 11th 1881.

Gas as a Motive Power.

Electricity as a Motive Power.—An interesting lecture has been delivered by Mr. W. Lanchin, C.E., on the "Secondary Battery." Successful results, he premised, had been obtained in lighting a train experimentally with electricity on the Brighton line. Referring to the electric Concorde, he stated that the increase in the Price of electricity in accumulators at a limited less cost per diem than horse-power, irrespective of the capital sunk in the purchase of horses at £40 each. He had worked a sewing machine from an electric accumulator, and he saw no reason why trains should not be run without any locomotive whatever. Mr. Appleyard, fully endorsing the remarks of the lecturer, expressed his opinion that the forthcoming electric exhibition in the Crystal Palace will far excel that held in Paris. Thanks were given to the lecturer for his very able paper. In response to said, he had already been prepared to prevent ignition in balloons.

English Mechanic & World of Science, August 19th 1881.

Nature, July 14th

Brush's Electric Storage Battery.—The

American *Electrician* announces that Mr. Brush has been a long time at work upon an improvement of electric storage, and that he has probably startle the public with a new Swan's lamp. The cells were charged in Paris by a Gramme machine, and were arranged in groups of four in cubical boxes, the whole being coupled up in series. The current supplied by this arrangement, shown by a galvanometer in the circuit while the lamps were alight, was almost twenty-three degrees, and was perfectly steady—the Faure battery yielding an almost equal current during the whole time, until the charge becomes exhausted, when it breaks down suddenly, without any noticeable warning. Mr. Spottiswoode also uses the Faure battery to work Swan

Mechanics' Mag. 7th 1881.

Storage of Electricity for Industrial and Home Use.—A new secondary battery, of greatly enlarged capacity, is now attracting attention in Paris. It is the invention of M. Faure, but is confessedly a development of the well-known secondary battery of M. Plantè, which is formed of sheets of lead immersed in acidulated water. The latter gains in capacity as the process of charging and discharging is repeated, though the resulting thickness of the layer of peroxide of lead that is slowly formed by the current is, M. Faure has conceived the idea of coating the two sets of plates with layers of minium, or the red oxide of lead, and by this means the capacity is greatly increased. The Faure battery is stated to be very lively down the power of accumulation of the Plantè. A battery weighing 75 kilogrammes will develop 75 kilogrammetres, or one horse power, during one hour. As to the nature of the action, the electric current, it appears to change the minium to peroxide on the positive electrode, and to reduced lead on the negative. In discharging, the reduced lead is oxidised, and the peroxidised lead is reduced. The battery was lately exhibited by M. Reyrner to the Society for Encouragement of National Industry. There were 24 couples weighing seven kilogrammes each; connected to a Siemens machine of medium size, they furnished a work of 25 kilogrammetres, which is about a third of M. Hyrtier's figures; but the conditions were unfavourable. Next, a battery of 24 couples, each weighing 12 millimetres thick, and 30 cms. square, separated by two strips of india-rubber, the whole being rolled up as shown in Fig. 1. The roll having been completed, the cylinder used in its formation is withdrawn, and it is consolidated by a wrapper of gutta-percha, and inserted in a glass jar filled with water and 1-10th part acid. An electric current is then made to pass through the cell; oxygen is given off, and produces a thick cushion of peroxide of lead on one sheet; hydrogen is given off at the other sheet. If the current with which the cell has been charged be cut off, and the two sheets are connected, a current will be produced, owing to the presence of the oxygen, which leaves the sheet where it has accumulated and attacks and oxidises the other sheet. This secondary current, which is very small at first, gains strength each time the operation is repeated; in course of time the surfaces of the sheets are changed, the one being covered reduced to a spongy mass. The cell is then complete, and is a state of electrical accumulation. That was the plan of separating the two sheets of lead by canvas, the cell taking the form of Fig. 2. He then found that it was necessary to leave a small space between the sheets to provide for the escape of the gases which were produced at the end of the charge; subsequently india-rubber bands were employed in preference to canvas. M. Faure also tried carbonate of lead, minium, &c., but without improving upon the results already obtained. The

Fig. 1.

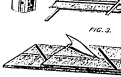

Fig. 2.

Plantè and Faure Batteries.

In annexed illustrations of the secondary batteries, which are exciting so much interest at the present time in, with the accompanying description, enable the reader to understand their construction. At the recent meeting of the King's College, several forms of electric-lighting apparatus were used; but that which attracted most attention was a battery of forty-four accumulators of Faure's design, working twenty of Swan's lamps. The cells were charged in Paris by a Gramme machine, and were arranged in groups of four in cubical boxes, the whole being coupled up in series. The current supplied by this arrangement, shown by a galvanometer in the circuit while the lamps were alight, was almost twenty-three degrees, and was perfectly steady—the Faure battery yielding an almost equal current during the whole time, until the charge becomes exhausted, when it breaks down suddenly, without any noticeable warning. Mr. Spottiswoode also uses the Faure battery to work Swan

Fig. 1.

and Maxim Lamps in his private house. Figs. 1 and 2 show sheets of lead (it may be as thin as stout lead-foil) are laid together, with the other, separated by two strips of india-rubber; the whole being rolled up as shown in Fig. 1. The roll having been completed, the cylinder used in its formation is withdrawn, and it is consolidated by a wrapper of gutta-percha, and inserted in a glass jar filled with water and 1-10th part acid. An electric current is then made to pass through the cell; oxygen is given off, and produces a thick cushion of peroxide of lead on one sheet; hydrogen is given off at the other sheet. If the current with which the cell has been charged be cut off, and the two sheets are connected, a current will be produced, owing to the presence of the oxygen, which leaves the sheet where it has accumulated and attacks and oxidises the other sheet. This secondary current, which is very small at first, gains strength each time the operation is repeated; in course of time the surfaces of the sheets are changed, the one being covered reduced to a spongy mass. The cell is then complete, and is a state of electrical accumulation. That was the plan of separating the two sheets of lead by canvas, the cell taking the form of Fig. 2. He then found that it was necessary to leave a small space between the sheets to provide for the escape of the gases which were produced at the end of the charge; subsequently india-rubber bands were employed in preference to canvas. M. Faure also tried carbonate of lead, minium, &c., but without improving upon the results already obtained. The

has been lately started in Paris by M. Philippart, for obtaining force and light from electricity, the combination of Faure and Faure batteries. M. Hospitalier has pointed out the expensiveness of charging the Faure battery with electricity from ordinary motive.

Mining & Scientific Press June 25, 1881.

Storage of Electricity.

A Wonderful Alleged Discovery.

A correspondent of the London *Times* makes an announcement which, if fully borne out by the facts, is of the highest possible importance. He states that M. Camille Faure, a noted French scientist, has discovered a practical means of storing electricity and rendering it portable. It is almost unnecessary to remark that nothing of the kind has been possible hitherto, and that it has been regarded as being impossible to store up electric energy in a portable condition. At a recent public session of the Academy of Sciences another Frenchman, presided over by the president of the French Academy of Science and surrounded by many leading English scientists, the secret of the discovery is said to have been demonstrated, and the possibility of a doubt. A Faure battery was charged with the electric fluid direct from the ordinary Grove battery. The receptacle con-

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sisted of four Faure batteries, each about five inches diameter and 10 inches high, forming a cylindrical leaden vessel, and containing alternate sheets of metallic lead and minimum wrapped in felt and rolled into a spiral wetted with acidulated water, and the whole placed in a square wooden box, measuring about 1 cubic foot and weighing about 70 lbs. This was protected by a loose wooden cover, through which the electrodes (in lead) protruded, and were fastened down for convenience of transport. This box was handed to the writer of the letter in question, who left Paris on Tuesday night, arrived in London on Wednesday, and finally reached Glasgow, where the box was presented to Sir William Thomson.

That eminent man is now experimenting with the box in the laboratory of the Glasgow University, and will no doubt give the world the benefit of the results of his tests at an early date. Were the matter rests at present, but if all this be true there is no doubt that we are on the eve of changes which will completely revolutionize many of our existing appliances and processes, especially as regards lighting and heating. This small box, measuring about one cu. ft., is said to contain a power equivalent to nearly 1,000,000 foot-pounds—a force, of which we can only speak comparatively, and without adequate knowledge of the resources of the plan on a larger scale. It is plain, however, that if electricity really could be stored and then conveyed from place to place we might look upon the future of illumination, by that means, as being thoroughly and completely assured.

At present the great drawback lies in the circumstance that the generation of the electric force and the production of the light are quite simultaneous. When the machine stops, the light disappears, and stops at once. If, then, means be devised to intercept and store up a portion of the whole of this force for subsequent use, the difficulty would disappear, and electricity will take rank as a handy, manageable and economical means of illumination. The mere supposition opens out a vista which cannot be accurately thought out or described, seeing that, for domestic, railway, mining, manufacturing and scientific purposes, the electric current would indubitably replace gas and all other illuminating media. Before counting these as accomplished facts, however, many economical and other points must be satisfactorily explained. The outcome of Sir Wm. Thomson's investigations will be awaited, therefore, with more than ordinary interest.—*Ironmonger, May 21st.*

Later Advices.

A London special to the New York *Times* of June 7th, and written nearly three weeks after Mr. Thompson's arrival, was first cabled to the outer, says:—The latest advantage of electricity by the use of the Faure battery has attracted the universal attention of the scientific men of Europe. As has been previously stated, William Thompson, the eminent scientist of Glasgow, lately took from Paris to Glasgow a box used to store and transport the electric power. He has already ascertained enough regarding the capacity of the Faure cells to make it quite certain that it solves the problem of storing electric energy in a manner and upon a scale to render it useful in many important practical applications. Among others, enough can be stored to give light in a house for several hours without an additional supply. The reservoir can be moved easily and used where the dynamo-electric machines are unavailable. One great advantage to be found is in the fact that when the energy is supplied from a Faure reservoir it is always steady in delivery, thus preventing fitful oscillations in the light, experienced from the unequal action of the ordinary dynamo machines.

American Omnister, May 1881.

Portable Electricity.

By the wonderful invention of M. Camille Faure, of Paris, there is compressed within a portable package of one cubic foot an electric energy equal to a million feet. This package consists of four Faure batteries, each about five inches in diameter and ten inches high, forming a cylindrical leaden vessel, and containing alternate sheets of metallic lead and minimum, wrapped in felt and rolled into spirals, wetted with acidulated water, the whole placed in a square wooden box measuring about one cubic foot, and weighing about seventy-five pounds. It is protected by a loose wooden cover, through which the electrodes in lead protrude. One of these packages was recently sent from Paris to Sir William Thomson, at the Glasgow University. After some severe tests and experiments, Sir William exclaimed, "Why, it is a little giant."

It would seem most probable that the advantages to science and humanity from this wonderful discovery must be of the most transcendent importance.

Nature, June 30th, 1881.

Storage of Energy

Like many others, I have given much thought to the accumulation of force, and have felt much astonished at the account of Faure's battery, if it is to be a cyclet, although of course such a development was to be expected from the time that Plante made his.

I see that men immediately rush to waterfalls, rivers, and tides to obtain the power for accumulation when they leave coal and wood; my ideas are rather in the direction of wind; and I have often thought our country favored, like that around Zanzibar, with windmills. The wind is not constant, but more so than many of our efficient streams, and it is found at every spot. The power is quite unlimited, and we can moderate the action of the machine by increasing or closing the respective forces. Storage batteries have been required. I have imagined our windmills pumping up water to reservoirs, but we have not yet learned to make reservoirs for water except at an enormous expense and in unexpected valleys (after imagining we have come into many mind), but if we have really true and safe storage, such as described, the wind will become our fire to warm us, our steam to drive us, our gas to light us, and our universal servant. The wind will drive our mills, it will pump when a fog comes, lasting so long that our stores of power fail, with sufficient storage, inconstancy will cease to trouble us, because every valley may have its Niagara and every mountain top its beacon, and darkness will scarcely trouble mankind in the next great world of light. We have heard of the golden servants of Vulcan, and the mechanical slaves of the great Khan. What will be the power which when every mill has its dynamo, by a command can set the lightning at its service by friction, like Aladdin? It seems to me that the wind is the great power that we shall next use, and that France—the power of the air—shall be bound to serve us for at least a thousand years.

The Dutch have long made windmills, but when ever in Holland a few years ago examining a little, I was unable to find the books wanted on the subject.

The fact that our mills be carried will not affect the question if wind is a cel. Wind carries itself. We shall seek our power from the breezes instead of the inferred pile, and a race of healthy, ruddy faces will take the place of the blackened and ill-fed countenances from mines.

I wish to show that we have oceans of power in the wind. Will this storage accumulator, of which I know nothing from personal experience, serve us to keep it for hours and days from a great period. Coal becomes necessary if we accumulate the force of the wind, and Niagara itself will be no longer wanted. Of course we need machines to use the wind-power. At present coals are cheaper with us, but so in all parts of Holland, and enough to solve; do not let us throw cold water on the discoveries of others, or show, as scientific men so often do, our own opinion to be deep beyond the truth among others.

R. A. S.

The Ironmonger, May 21st, 1881.

STORAGE OF ELECTRICITY.

An anonymous correspondent of the *Times*, signing himself "P.E.R.S.," makes an announcement which, if fully borne out by the facts, is of the highest possible importance. He states that M. Camille Faure, a noted French chemist, has discovered a practical means of storing electricity and rendering it portable. It is almost unnecessary to remark that nothing of the kind has been possible hitherto, and that it has been regarded as being impossible to store up electric energy in a practical manner. At a recent public séance of the Société d'Encouragement pour l'Industrie, presided over by the president of the French Academy of Science and attended by many leading English scientists, the success of the discovery is said to have been demonstrated beyond the possibility of doubt. On Monday last, we are told, in Paris, a Faure battery, *or pile secondaire*, was charged with the electric fluid direct from the ordinary Grove battery. The Grove battery, it may be remarked, is a powerful generator of electricity, but it was explained that frictional electricity might have been applied by means of a Gramme or Siemens machine. The receptacle consisted of four Faure batteries, each about 5 inches diameter and 10 inches high, forming a cylindrical leaden vessel, and containing alternate sheets of metallic lead and minium wrapped in felt and rolled into a spiral wetted with acidulated water, and the whole placed in a square wooden box, measuring about 1 cubic foot and weighing some 75 lbs. This was protected by a loose wooden cover, through which the electrodes (in lead) protruded, and were fastened down for convenience of transport. This box was handed to the writer of the letter in question, who left Paris on Tuesday night, arrived in London on Wednesday, and finally reached Glasgow, where the box was presented to Sir William Thomson. That eminent man is now experimenting with the box in the laboratory of the Glasgow University, and will no doubt give the world the benefit of the results of his tests at an early date. There the matter rests at present, but if all this be true there is no doubt that we are on the eve of changes which will completely revolutionize many of our existing appliances and processes, especially as regards lighting and heating. This small box, measuring about 1 cubic foot, is said to contain a power equivalent to nearly 1,000,000 foot-pounds—a force of which we can only speak comparatively and without adequate knowledge of the resources of the plan on a large scale. It is plain, however, that if electricity really could be stored and safely conveyed from place to place we might look upon the future of illumination, by that means, as being thoroughly and completely assured. At present the great drawback lies in the circumstance that the generation of the electric force and the production of the light are quite simultaneous. When the machine stops, the light disappears, and stops at once. If, then, means be devised to intercept and store up a portion of the whole of this force for subsequent use, the difficulty would disappear, and electricity will take rank as a handy, manageable, and economical means of illumination. The mere supposition opens out a vista which cannot be accurately thought out or described, seeing that, for domestic, railway, mining, manufacturing and scientific purposes, the electric current would indubitably replace gas and all other illuminating media. Before counting these as accomplished facts, however, many economical and other points must be satisfactorily explained. The outcome of Sir Wm. Thompson's investigations will be awaited, therefore, with more than ordinary interest.—*Ironmonger, May 21st.*

The Electrician, July 9th, 1881.

STORAGE OF ELECTRICITY.—In our issue of June 18, on page 18, we referred to a letter of Major Scarse to *The Times*. We give herewith the letter and the preliminary comment as it appeared in our daily contemporary :—

"The following letter refers to our recent remarks on a new company called 'La Force et la Lumière.' The explanation while it proves the necessity for our remarks, appears to be fully satisfactory as far as the writer of the letter and Sir William Thomson are concerned :—' Paris, June 14. Sir:—As a director of the 'Société La Force et la Lumière' you have rendered me a great service by your remarks in the *City* article of *The Times* of yesterday. Permit me to thank you for it and to point out that the shares are now being offered to the public are not, properly speaking, an issue by the company, but simply a sale by a private individual, who received them in part payment for the transfer of patent and other rights to the company. You are quite right and justified in explaining that Sir William Thomson is not in any way identified with the financial operations of the company, and I trust you will allow me also to explain my connection with it, which to a great extent is merely the same. I think I am entitled to this, as my letter, printed in *The Times* on the 19th of May last (under my initials and before I was connected with the company) was the first explicit public announcement of the great things to be expected by storing electric energy. Like Sir William Thomson—but in an infinitesimal degree comparatively—I am a man of science and not a financier, and my attention having been drawn to the novelty of M. Faure's discovery, I went into the matter on my *answer*, with the intention of bringing it before Sir William, and discovery of the importance of which you have formed no meagre or erroneous estimate in your leading article of the 20th inst. It was to my friend Sir William Thomson, as a friend and colleague, against any undue use of his name or position as consulting engineer to the company that I consented to accept a seat on the board, and on the express condition that no prospectus or publication of any sort bearing his name should be issued without his previous approval and consent. Unfortunately, I was absent from Paris for over three weeks, and it was only at Vienna, when too late to stop the issue, I learnt that the prospectus you refer to had been put into circulation. I could only telegraph the fact to Sir W. Thomson, offering to withdraw from the company in case he disapproved the contents of the circular. I never saw it until my arrival here a few days ago, and I am, I regret to say, full of misgivings, if necessary, how annoyed and dissatisfied I was at the proceeding. I have only to add and repeat that the prospectus you refer to is not an issue by the company, but a sale of shares for private account; and while I am quite convinced of their value and the great future open to us in the electrical world, I wish it to be distinctly understood from me, as the only Englishman on the Board, that the operations of the parent company 'La Force et la Lumière' in England are to be confined to the transfer of their patent and other rights to an exclusively English company with a board of directors of the highest standing in the electric and financial circles of London, and that the entire control of its future operations will rest in the hands of gentlemen whose names will be a guarantee against a shadow of suspicion.—Yours, &c., F. J. Rebards-Shavery."

IMPROVED ELECTRIC GENERATOR.

A great deal of attention is now given to the relief and cure of diseases without the use of drugs, and electricity is being recognized as one of the important healing agents for accomplishing this very desirable end. Hitherto it has generally been considered the prerogative of a physician to properly apply the electric current to curative purposes; but since it has been discovered that a mild continuous current is effective in the treatment of diseases, it is apparent that any one having the necessary appliances may use the electric current to advantage.

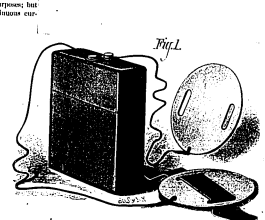
The engraving represents a very simple and compact generator or battery for creating a continuous electric current for curative purposes. It is a modification of the well known Trouvé bluebing paper battery, and is capable of yielding a constant current for a long time.

The inventors of this generator and its accessories state that they have batteries of this class in use yielding a current for over a year without attention, and it may be renewed at the end of that time without trouble or expense.

The rubber case contains two plates, one of zinc, the other of copper, each connected with a clamping screw extending through the cover. Flexible cords connect the binding posts with the electrodes, the latter consisting of two nickel plated disks, each having two slots for receiving a strap by which the electrode may be bound upon the affected part. The generator is carried in a pocket in the inside of one of the garments. This may be done with perfect safety, as the exciting fluid with which the generator is charged is entirely absorbed by the porous filling placed between the zinc and copper plates.

The electrodes are often worn on a belt, one being placed in front of the body, the other at the back. Fig. 2 shows the method of attaching one of the electrodes to a sponge for bathing purposes, and Fig. 3 shows its application to the head when the current is employed to supplement frictional treatment.

There are a number of other methods of applying the current, which need not be described in detail here. Further information in regard to this invention may be obtained by addressing the Constant Current Corporation, 203 Main street, Buffalo, N. Y.



CONSTANT CURRENT ELECTRIC GENERATOR.

Nature, July 21, 1887.

OUR Paris correspondent informs us that Philippart and Sons are preparing to work tramways at Roubaix with improved Faure batteries, and that experiments will also shortly be made in London. Our correspondent adduced some preliminary experiments which he thinks give room for high expectations. One of the most important changes is the substitution of flat for coiled sheets, which produced numerous cracks in the oxidized coating, and had been resorted to in imitation of the old Planté batteries.

Journal of Gas Lighting, &c. Aug. 1887.

THE FAURE BATTERY SCHEME.

THERE is at present an attempt being made to force the Faure secondary electric batteries on the British public, as the foundation for a joint-stock enterprise. To this end a shop has been taken in the Strand, London, where a show is made of some kind of incandescent electric lamps, ostensibly maintained in action by the appliances which Sir W. Thomson is said to have called a "witch," when he first became aware of its peculiarities. Circulars setting forth the advantages of the Faure batteries are being freely distributed, making it appear that sewing-machines, vehicles, boats, and electric lamps can be worked by stored electric energy at a great economy in comparison with existing sources of power. How far these claims are justified in the single matter of electric lighting by incandescence, a "Note" in the present number of the JOURNAL will be found to show. The notice taken in another column of these pretensions might be considered a sufficient exposure of their hollowness; but in the interest of the investing public we here repeat that, according to their own showing, the agents of M. Faure cannot promise any one who may be disposed to sink at least £250 in batteries and lamps, a light at less than something like four and a half times the cost of gas in London. This circumstance is absolutely conclusive as to the chances of the Faure battery superseding any tolerably effective system in which the current is produced from the generators; to say nothing of its pretensions in a competition in which even those latter have failed. It is foreign to our sphere to investigate the claims of the secondary battery for other purposes than lighting, but it sounds strange to hear of four cells, weighing together 200 lbs., being only able to propel a tricycle for six hours. This is scarcely man-power, and unless a very great improvement can be effected somewhere, the apparatus will never supersede a single donkey-engine. The improvement may, of course, be realized in time; but meanwhile the public will probably be chary of embarking capital in support of apparatus which is in its right place only in the experimental laboratory of Sir W. Thomson, or somebody else.

English Mechanic & World of Science 39
Aug. 12. 1887.

ELECTRICAL STORAGE OF DYNAMIC ENERGY, AND THE KENNEDY SYSTEM OF ELECTRIC LIGHTING.

[10677.—On June 10 last a letter appeared in a contemporary written by me, and likewise expressing my views concerning certain notes of the uses and applications of the storage battery, &c.

I will here quote a portion of that letter where I say that "The storage of electricity is the only means by which a uniform current can be obtained for electric lighting, &c. It will be to the electric lamp what a steam-boiler is to the steam-engine. Dynamos, like steam-engines, are irregularity of the speed of the motor that drives it, whether it be in the slip of the driving belt or other causes, variations in the current will occur."

"This difficulty may be overcome entirely by using storage batteries, whether of Faure's or any other equally adapted; and so long as two of these reservoirs are kept supplied by the dynamo machine, one being charged while the other is being used, the battery so automatic action in this supply when the reservoirs are full, and to cut off when they require replenishing, will result, if not entirely at, the defects and objection in electric-lighting being done away with.

"I have set up as patent for this prediction and application, but as regards storage batteries I find many objections to their use, although there are very many ways in which they can and will be used, but the general and most important is their application to electric lighting and motive power. Small, as well as large, electric-motors are now being made expressly to be used with the storage batteries, and will very soon be common on the market. I have used with good effect a storage battery with my motor, but have not been able to obtain one so cheap and efficient as with M. Faure's battery. I fully see a great boon, and efficient as it is, it is only fit for use in a motor, and another yet to come, more potent, and of small weight." &c.

I believe that I am quite right in describing this system, and I am sure that Mr. Kennedy, like myself, is less an appreciation of the uses of storage batteries.

His letter (10633) of Aug. 5 is indeed a repetition in words, and exemplified in works, of what I have previously described in the 10th of June. I can gratulate him for the step he has taken; but at the same time I must say with every respect, remind him that others have been, and others are doing, what he is stated to have done, and what he claims as his exclusive system of electric lighting. There are some things that I could also claim as their system of electric lighting, but I would be the last object of presumption to claim as such. All that I can do, he can do, or others can do, and I make it known that the system of lighting adopted by him, or them, is from the use of storage batteries.—EDS.]

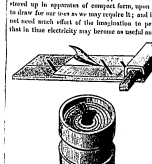
Mr. Kennedy says that the dynamo-electric machines employed would not produce the effect whatever, apart from the accumulators. No doubt the electromotive force of such as he uses is very low; it is, however, quite an easy to change a series of accumulators, as one only, if a dynamo be used having a small greater electromotive force, and with its armature insulated accordingly. Our esteemed friend, Mr. Kennedy, in his letter 4337, there will be local action and great loss of charge unless other people get better results than he has. It is quite true, and the reason is, I think, because the accumulators had not been long enough used. I have found there is great local action at first, which I find gradually lessens as they are used, and after repeated charges and discharges, the local action is very slight indeed, and almost this local action can be overcome. What next? A. The game.

THOMAS SLATER.

10, Leamington-road-villas,
Westbourne Park, W., August 1.

The Faure Secondary Battery.

In a previous issue of this *Journal*, we alluded at some length to the interesting results obtained with the Faure secondary battery in rendering possible the storage of electrical energy in considerable quantity, and its preservation in potential form, without serious waste of energy, for a considerable time, and after the apparatus in which it had been accumulated had been transported from place to place. The possibilities which this interesting result opens, in respect to placing at our disposal electrical energy in some available and serviceable form, have awakened decided interest throughout the scientific world. The hope is certainly warranted that in the near future we shall have at command abundant supplies of electricity stored up in apparatus of compact form, upon which to draw for our uses as we may require it; and it does not need much effort of the imagination to perceive that in time electricity may become as useful and valuable in the Patent. The roll is then placed in a cylindrical lead cell, the outside of which is strengthened with copper bands and the inside covered with red lead and leather, so as to increase the useful surface of the battery. The latter then presents the appearance shown in the sketch, and one of the projecting wires from the lead plates is bent over and soldered to the enclosing cylinder, which is ready for use when it has been filled with water and about 10 per cent of sulphuric acid. The apparatus when charged weighs about 20 pounds. It will be seen that this differs from the Planté secondary battery only in the employment of red lead. The material chiefly employed is the same, the mode of construction is similar, the leather taking the part of the cloth previously used by M. Planté; it has no merit in itself; on the contrary, it is a cause of resistance, and is liable to deterioration, being useful only to keep the red lead in place. It is, in fact, this red lead which constitutes the new feature and gives the special advantage to the apparatus.



The Faure Battery.

veyed a current among civilized people at steam, though it must be confessed that much remains to be accomplished before this state of affairs is reached.

We give in the following a description, with an illustration of the Faure secondary battery, with which the interesting results reported by Sir William Thomson were obtained. The description is abstracted from an ably written article by M. Giraldy in a recent number of *Le Journal Universel d'Electricité*, criticising the comparative merits of the Planté and Faure batteries. The Faure secondary battery is protected by two patents, dated October 20, 1880, and February 9, 1881, respectively. In these patents M. Faure describes principally those batteries composed of lead plates laid on frames covered with red lead, and protected by leather, attached by flexible lead rivets, an arrangement similar to the rectangular batteries of M. Planté. The actual batteries are not so made, being constructed as follows: Two sheets of lead are taken, 7.87 inches wide; one of these plates is 23.62 inches long and 0.31 of an inch thick; the other is 15.75 inches long and 0.02 of an inch thick. Each plate is covered on both faces with a layer of red lead reduced to a paste by water, 1.76 pounds being spread over the larger plate, and 1.54 pounds over the smaller. On each face thus prepared a sheet of parchment paper is placed, and the whole is introduced into a sheath of thin leather. One plate is then put on top of the other and rolled up, strips of rubber being interposed obliquely, as shown

The roll is then placed in a cylindrical lead cell, the outside of which is strengthened with copper bands and the inside covered with red lead and leather, so as to increase the useful surface of the battery. The latter then presents the appearance shown in the sketch, and one of the projecting wires from the lead plates is bent over and soldered to the enclosing cylinder, which is ready for use when it has been filled with water and about 10 per cent of sulphuric acid. The apparatus when charged weighs about 20 pounds. It will be seen that this differs from the Planté secondary battery only in the employment of red lead. The material chiefly employed is the same, the mode of construction is similar, the leather taking the part of the cloth previously used by M. Planté; it has no merit in itself; on the contrary, it is a cause of resistance, and is liable to deterioration, being useful only to keep the red lead in place. It is, in fact, this red lead which constitutes the new feature and gives the special advantage to the apparatus.

According to the inventor, there are two advantages gained. The long and delicate operation necessary to prepare the Planté battery is not required. (This operation consists in passing through the battery an electric current, when oxygen goes to one plate and produces a thin coat of peroxide of lead, and hydrogen goes to the other plate). The second advantage claimed is that the battery has a storage capacity much greater than that of Planté, the proportion, according to M. Reyster, being, as deduced from numerous experiments, forty times greater with equal weights of batteries.

The article from which we glean the above description, then proceeds to criticise the relative merits of the Planté and Faure batteries, a subject with which in this place we are not specially interested.

Captain Richmond's Model Steam
May 13, 1871.

STORAGE OF ELECTRICITY.

A NEW secondary battery, of greatly enlarged capacity, is now occupying attention in Paris. It is the invention of M. Faure, but is confessedly a development of the well-known secondary battery of M. Planté, which is formed of sheets of lead immersed in acidulated water. The latter gains in capacity as the process of charging and discharging is repeated, through increasing thickness of the layer of peroxide of lead that is slowly formed by the current. M. Faure has conceived the idea of using, instead of solid sheets of lead, a mixture, or thin red oxide of lead, and by this means the capacity is greatly increased. The Faure battery is stated to have forty times the power of accumulation of the Planté. A battery weighing 70 kilogrammes will develop 75 kilogrammetres, or one horse-power, during one hour. As to the nature of the work which can be performed by discharging the current generated on this battery, electrotyping, and to reduce lead salts negative. In decomposing the reduced lead is oxidized, and the peroxidized lead is reduced. The battery was lately exhibited by M. Reyster to the Society for encouragement of national industry. There were 21 couples weighing 100 kilogrammes each; connected to a Siemens machine of medium size, these furnished a work of 17 kilogrammetres, or 1.7 horse-power, as M. Reyster's figures; but the process was unfavorable. Next, a band of platinum, 1 millimetre long, 2 millimetres broad, and 1-30th of a millimetre thick was made to glow; then two inches of platinum wire were fused. The superiority to the Planté battery was well demonstrated. Some competent physicists present thought that Faure's battery as a means of distributing electricity to any house or workshop, independently of gas, that may be applied, and from the experiments of a system of installation. The method is also applicable to generating for domestic electric lighting. A current may be added, has been lately started in Paris at 5 francs per hour, including force and light for electricity, for the decoration of the Opéra and Faure batteries. M. Hospitalier has criticised the expensiveness of charging the

view of its many elevating influences, could almost be termed a blessing? To this we answer, "Yes." What we at first require is an acknowledgment from the educated portion of our community that music has a value beyond the mere charm of an accomplishment; that it should be a part of a man's education as much as Latin or geometry.

In all our schools we should have music taught in a thorough and systematic manner. To many it might be an uninteresting study, but to few a useless one; for if they did not in after years continue the actual practice of music, there might still be a possibility of retaining that appreciation of its value which would lead their children to cultivate what they themselves had neglected.

This might be a slow process by which to raise and to create musical standards, but who could doubt of its being a sure one? We cannot sensibly make a musical nation by symphony concerts, regimental bands, and great musical festivals.

At present music is looked upon as such an entirely unnecessary accomplishment that our private schools give it little attention, and allow no extra time to such of their pupils as undertake the study. The consequences is, parents are unwilling to impose upon their often overtasked boys a study which for some years must necessarily be tiresome, and to most children uninteresting. The frequently-adopted plan of waiting to see whether children "have any taste" or "show any love" for music, is a wrong one. No child would prefer practicing scales to playing ball; and few boys, if the cultivation of their tastes depended upon the whims of their ever-flying fancies, would turn them into educated men. They give them the opportunity of forming a taste, and for its development trust to the esthetic element of their nature.

Admitting that music is taught to the best advantage in private lessons only, for by that method the pupil obtains that which is most required—the personal attention of the teacher—it still may be taught to the masses, in schools successfully, but only in a general way. A member of one of our Educational Boards once remarked that "in the musical education of the masses, precepts, maxims, laws of general application, a good taste, methods and habits of study and of practice, and the general principles of the art are mainly to be inculcated." This is, indeed, the case, for in class training it will only be the general powers that are developed, while the thousand and one little peculiarities and traits which indicate an individual capacity and talent will, necessarily, not be seen. In the earliest attempts to develop the minds of children, the musical training should be commenced. There should not only be the ability to *read* well, but to *sing* well. *The power to read musical instruction should begin in in the primary schools.* Numberless foreign examples are constantly before us; for instance, in Germany, known to be the most musical country in the world, vocal music is taught as thoroughly as the alphabet. In most of our cities, vocal music enters considerably into the curriculum of primary instruction; but efficient instruction is but too seldom met with. Vocal music in the school-room has a singularly tranquillizing influence upon the hearts and minds of the children. In Germany there is not a school that does not afford excellent and abundant material for chorusses; and there is no reason why it should not be so with us. Our chief fault is that we allow musical instruction to commence too late in life. Children, with ordinary talent, can very easily learn at six or seven years of age and thus lay the foundation for future excellence. The rudiments of music are readily comprehended by children; and the art of chaining is as attractive to them as the most melodious vocal exercises. Indeed every lesson proves that music has a wonderful power to amuse. Nearly every home boasts of its piano, or some simpler instrument, and it is an undeniable, irrefutable fact, that for these instruments, many whose leisure hours would be spent in disreputable society, or in wretched dissipation, are attracted to that place so dear to all genuine American hearts,—home.

It is unfortunate that so many trashy songs and instrumental pieces hold a prominent place upon the music-stands of most households; but it will not, until public appreciation is raised to a higher standard, cease to be thus. We may be assured that in the future—the early future it is to be hoped—we shall find the very best music a common source of enjoyment in each and every household. There are many unmistakable guide from the mere performance of music. For example: to read the biography of some composer, an analysis of some of his works, and then to hear them performed, alone would be the means of arousing the healthy minds, an interest that would seldom fail to bear good fruit. In addition all that we have predicted and hope for, ever come to pass, would there ever be a want of voices in church choirs, or choruses for oratorios or opera.

The principles we have endeavored to inculcate here, and to impress upon the reader, once recognized, as they are to a very great extent on the Continent of Europe to-day, would, ere many years, insure to music an important place in the education and estimation of every American. Then, and not till then, shall we feel in their full power, those refining and civilizing influences which music, like all beautiful arts, brings to those who award her the place which her votaries hope and believe she will yet hold in the New World as she now does in the Old.

THE STORAGE OF ELECTRICITY.

BY CHARLES MORRIS.

A DISCOVERY, which may prove of considerable future importance, has been lately announced in the English scientific journals, and has been sufficiently detailed in the newspapers to need, perhaps, no further comment, except for the correction of possible false conceptions concerning it. We refer to what has been entitled "The Storage of Electricity." Since scientists, as well as less learned writers, speak of it under this title, and since such a title is apt to give a wrong conception of what the discovery really embraces, it may be well to present a more definite description of the true principle involved, and thus to correct the false idea conveyed by the above phrase.

Electricity cannot be stored, any more than heat can be stored. Not as much, in fact, for heat is slow in its movements, and a stock of it can be made gradually to yield its energy; but electricity is instantaneous in its transfer, and only by its continued reproduction can a continued effect be gained from it. All that is really meant by the misleading phrase, "the storage of electricity," is the preservation of conditions for the spontaneous production of electricity. In fact, there is no discovery here of any scientific principle, as the announcement might indicate, but merely of an application of a principle known almost as long as electricity itself.

In every galvanic battery electricity is stored, in the same sense as in this new arrangement. It is simply a new form of galvanic battery, its only advantage being the peculiar form in which the requisite chemical conditions are produced, its portability, and its electrical power.

To understand this more clearly, it may be well to present a general review of the physical principle concerned in all manifestations of force. We may first consider water as the flow of force down hill, to seek its level below. It is only during this downward flow that available energy is set free, and that work is performed. A weight suspended above the earth is capable of performing work; but it performs work only while it is falling to the earth; and it becomes incapable of performing work when it has reached its lowest level on the earth's surface. So the waters of a lake elevated above the sea level are capable of doing work during their descent to this level. But the work is done neither in the lake nor in the sea, but only in the river down whose bed the water falls from the one to the other.

There are other modes of reaching a level than these, and work is done in them all. Thus the attraction of the moon heaps up certain portions of the ocean waters, and the tidal flow comes *from the effort of* this heaped-up water to regain its level. In like manner *the heat of the* tropic sun, by expanding the waters of the *equatorial oceans, lifts them* above the level of the condensed polar waters. *The effort to regain this* level produces vigorous ocean currents, of which *the Gulf Stream* is a well-known example. Again, *the heat of the sun similarly dis*turbs the level of *the air*; or it would be better *here* to replace the word "level" by "equilibrium," which is a word of more general application. The equilibrium of temperature in the air is disturbed by the solar heat. The atmosphere becomes more rare at one locality than another, and air flows from the dense to the rare region to restore the equilibrium of density. This is the origin of most, and perhaps primarily of all winds.

For the displays of energy here adverted to we are indebted to the action of the sun and the moon. Equilibrium in these particulars, already exists upon the earth's surface; but it is constantly disturbed by the influence of these distant spheres, and in the effort to regain it vigorous work-yielding forces are set free. The solar heat has done more than this; it has produced permanent disturbances of the equilibrium of force. Our coal beds are, in this sense, stores of force, which is capable of being set free under proper conditions. We might speak of the storage of heat in coal, as the storage of electricity is spoken of

PHOTO-MICROGRAPHY.

By DR. CARL SEILER.

All workers in microscopy, doubtless, appreciate the necessity of correctly recording, not only in writing, but also by means of pictures or drawings, many of the appearances seen in the field of the microscope. We can do this by drawing an outline of the objects observed, by the aid of the *camera lucida*; but not only does this require some expertise, but also a considerable amount of time, and even then the resulting picture will not be a correct representation of the field of the microscope, because it will always be tinged more or less by the imagination of the draughtsman, and will be more or less diagrammatical in consequence.

With photography, on the other hand, an exact reproduction of the image thrown upon the screen can be obtained, and in much less time than it takes to make even a moderately simple drawing with the *camera lucida*. It is the object of this chapter to give an idea of the means employed to obtain a photographic picture of a microscope object—means which are in the hands of every microscopist, and which do not require a great outlay of money.

A room with a southern exposure, which can be darkened; a mirror, movable in all directions, outside of the window; an achromatic combination of lenses of from eight to ten inches focal length; a microscope which can be tilted as to be horizontal, and a stand to hold the screen and sensitive plate, are all the apparatus absolutely necessary besides the chemicals used in ordinary photography.

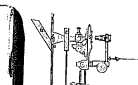


FIG. 1.

These different pieces are disposed of as follows (FIG. 1): The mirror (*a*), which should be eight or ten inches long by about four inches wide, is attached to a board which fits into an opening in the dark shutter of the southern window, and is to be moved by rods from the inside. Instead of this mirror, or in conjunction with it, a heliostat is of great advantage to throw the light of the sun constantly in one direction, for, if once adjusted, it need not be disturbed, and thus a great deal of time is saved. Until recently such an instrument was too costly for the use of students, but of late Mr. Kuebel, of Washington, D. C., has put a heliostat in the market which works very satisfactorily and which is sufficiently low in price to be within the reach of many who desire to work in photo-micrography. The heart in the shutter has in its centre a circular opening containing an combination of a one-fourth portrait photographic lens, horizontal position, so that the axis of the tube is in a line with the axis of the achromatic combination, and about half an inch from the back combination of the tube-stage condenser (*c*). The eye piece is then removed from the microscope, and the tube lined with black velvet, to prevent internal reflection, as far as possible, and the whole apparatus is covered with dark cloth, to prevent stray rays of light entering the darkened room.

This done, the sun's rays are reflected from the mirror outside the window, through the achromatic combination, which acts as a concentrator and throws a powerful light through the condenser, through the object on the stage (*b*), and thus a brightly illuminated image is formed by the objective (*o*) on the screen, which, later, when the negative is to be taken, is replaced by the sensitive plate.

This image, when thus formed, must be focused with the greatest care and accuracy, in order to obtain a sharp negative; and as the screen must be at some distance from the microscope in order to obtain the necessary magnification of the object, it is necessary to have some contrivance for turning the fine adjustment at a distance. For this purpose it will be found that a small pulley, placed alongside of the microscope, having an endless band running over it and the milled head of the fine adjustment, answers the purpose very well, when the axis of the pulley is connected by means of a universal joint to a fishing-rod, which by its sections can be made longer or shorter, thus bringing its end close to the screen.

The tube of the microscope, even when all internal reflection has been obliterated, still remains a drawback, inasmuch as it reduces the size of the image, or rather the disk of light, the more, the longer it is. There are, however, some stands made in which the tube can be entirely removed, such as the old Ross stand, and they are therefore very desirable for photo-micrographic purposes.

Any good objective of wide angular aperture and good definition can be employed for photography, provided monochromatic light is used in making the negative. When such is the case the visual and chemical foci fall in the same plane and a special correction of the objective for photography becomes unnecessary.

Such a light is obtained by passing the rays of the sun through a cell containing a strong solution of ammonio-sulphate of copper (*c*) before they enter the substage condenser. I have found some difficulty in making the cell containing this solution, as the copper salt will dissolve almost any cement, and if exposed to the action of the air, very rapidly becomes decomposed, and the solution is thereby rendered useless for the purpose. I have used with satisfaction a cell made of a brass ring, lined on its inner side with lead or tin, having a thread cut on its outside, to which flanged rings are secured. Upon the edges of the inner ring a ring of rubber tubing is applied, and upon it a disk of plate-glass is laid, which is tightly pressed upon the rubber by the flanged ring. Thus a cell is obtained very similar to the round, flat spirit levels, and which will hold the ammonia sulphate of copper solution for months without change. In filling the cell care should be taken to leave room for a small air bubble, for if the cell is completely filled the heat of the sun's rays will expand the solution sufficiently to cause leakage.

This solution, besides giving monochromatic light, at the same time filters out almost all the heat rays from the light, so much so that an immersion lens may be used for any length of time without the drop of water evaporating.

At the present time, when dry plate photography has been developed to such an extent that it has superseded, in a great measure, the wet process, it has been thought that it would be the most simple, economical and satisfactory method in photo-micrography; but after repeated trials by myself, as well as many others working in the same direction, it has been found that it is not only more expensive, but also takes more time, in the long run. The reason of this is that it is impossible to judge, with any degree of certainty, as to the actinic power of the light forming the image on the screen by merely looking at it, and that a trial plate only will give an idea of the length of exposure necessary for a given day, time of day

objective, and subject, to be photographed. It is true we can expose a dry plate for trial, but then we must develop it immediately, and the time of developing a dry plate is about three times that of developing a wet one, and a dry plate is also about three times as costly as a wet one. Therefore the old wet collodion process is the best.

The collodion to be used should be an old one, and contain some free iodine. I have found that a mixture of "Anthony's red labeled" and "Medalion, glace, half-tone" collodions—both commercial articles—one five or six months old, gives very satisfactory results. The nitrate bath should contain forty grains of crystals of silver to the ounce of water, and should be slightly acidulated with nitric acid. The developer should be a weak one: twelve to fifteen grains of the double salt ammonio-sulphate of iron to the ounce of water, containing a few drops of a solution of gelatin and acetic acid as a restrainer.

After the negative has been fixed in the usual way, with hyposulphite of soda or cyanide of potassium, it is almost always necessary to intensify it, which is easily done by flowing the plate while wet with a watery solution of iodine until the film becomes white; then it is to be washed under the tap and flowed with a solution of sulphide of ammonium, which imparts to the negative a dark brown color, and thus strengthens its printing quality.

The object to be photographed should be as thin as possible, because the lens will depict only one plane of it, and is should present as much contrast and differentiation of its elements as possible; this is especially the case in animal tissues, and when high powers are used, the focus should be taken with the greatest care *for one particular point to be brought out*; a general focus not particularly sharp in any one point, will not give a satisfactory negative.

The screen upon which the image is formed should be of plate glass, having an extremely fine ground surface on one side—the side next to the object. Such a surface can easily be prepared by flowing the glass plate with a good negative varnish, and when this is set but not yet dry, lightly breathing on it, when an extremely fine and even frosting of the surface will show itself, sufficient to arrest and reflect the rays of light forming the image.

In photo-micrography, as well as in ordinary microscopy, proper illumination of the objects is of the greatest importance, and frequently a poor objective will show a better definition in the hands of a skilled manipulator than the best objective can when the light is not properly managed. In this one point lies the difficulty of photo-micrography, and it is the stumbling block over which so many fall who undertake to photograph microscopic objects.

As a general rule the best light is obtained when the back lens of the sub-stage condenser is about half an inch beyond the burning focus of the large condenser in the shutter, that is about eight and a half inches from this condenser, and when the light is *absolutely central*. But this distance cannot be strictly adhered to, inasmuch as different objectives require different illumination. In practice, I find that in order to obtain the proper distance of the condenser for a particular objective, it is best to put a blood-slide, upon which the corpuscles are in one layer only, on the stage, and project the image on the screen, moving the condenser backward and forward until, when sharply focused, no concentric rings are seen in the disks. The object to be photographed can then be substituted for the blood-slide, and the light will be found to be all that is desired. (*Compendium of Microscopical Technology.*)

PROFESSOR HELMHOLTZ will issue a collection of his scattered scientific memoirs in the autumn.

PLANTÉ AND FAURE BATTERIES.

THE annexed illustrations of the secondary batteries, which are exciting so much interest at the present time will, with the accompanying description, enable the readers to understand their construction. At the recent soirée given by the Council and academical staff of King's College, several forms of electric lighting apparatus were used; but that which attracted most attention was a battery of forty-four accumulators of Planté's design, working twenty-four Swan's lamps. The cells were charged in Paris by a Gramme machine, and were arranged in a series of four in cabinet boxes, the sets being coupled up in series. The current supplied by this arrangement, shown by a galvanometer in the circuit while the lamps were alight, was about twenty-three webers, and was perfectly steady. The Faure battery yielding an almost equal current during the whole time, until the charge became exhausted, when it broke down suddenly, without any noticeable warning. Mr. Spottiswoode also uses the Faure battery to work Swan

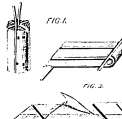


FIG. 1.

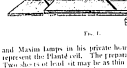


FIG. 2.

and Maxim lamps in his private house. Figs. 1 and 2 represent the Planté cell. The preparation is as follows: Two sheets of lead of any be as thin as six at least will be used for one on the cells, separated by two strips of india-rubber, the whole being held up as shown in Fig. 1. The lead being first carefully cleaned, the cylinder now in position is half filled with a solution of one part of sulphuric acid and sixteen parts of water. An electric current is then made to pass through the cell; oxygen is then made to pass through the cell; oxygen is given off, and produces a thick cushion of peroxide of lead on one sheet; hydrogen is given off at the other sheet. If the current with which the cell has been charged be cut off, and the two sheets are connected, a current is produced, owing to the presence of the oxygen and hydrogen in separate contact with the surfaces of the sheets are charged, the cell being covered with a cushion of peroxide of lead; the other with lead reduced to a spongy mass. The cell is then complete, and in a state of electrical accumulation. This was Planté's first secondary battery. Subsequently he used the plan of separating the two sheets of lead by causing the cell taking the form of Fig. 2. He has found that it was necessary to have a small piece between the sheets to provide for the escape of the gases which were produced at the end of the charge; subsequently indiarubber beads were employed in preference to canvas. M. Planté also tried carbonate of lead, minium, &c., but without improving upon the results already obtained. The

with its 80,000 volts, and supply it by secondary 200-volt
dynamos or 100-volt dynamos, through proper distributing
wires, to the houses and factories and shops where it is to
be used for electric lighting, and sewing machines, and
lathes, and lifts, or whatever other mechanism wants
living power. Now the thing is to be done much more
economically, I hope, and certainly with much greater
simplicity and regularity, by keeping a Faure battery of
50,000 cells always being charged direct from the electric
main, and applying a methodical system of removing sets
of 50, and plugging on the town-supply circuits, while
other sets of 50 are being regularly introduced into the
great battery that is being charged, so as to keep its num-
ber always within 50 of the proper number, which would
be about 40,000 if the potential at the emitting end of the
main is 80,000 volts.

ON THE ARRESTATION OF INFUSORIAL LIFE.*

By Prof. Tyndall.

Three years ago I brought with me to the Alps a
number of flasks charged with animal and vegetable in-
fusions. The flasks had been boiled from three to five
minutes in London, and hermetically sealed during ebul-
lition. Two years ago I had sent to me to Switzerland a
[illegible] of similar flasks containing other infusions. On
[illegible]ore this year 120 of these flasks lay upon the
[illegible]ber little library. Though eminently putre-
[illegible]imal and vegetable juices had remained as
[illegible]ear as when they were prepared in London.
[illegible]part taking up one of the flasks containing an
[illegible]fect or removed infantile organisms it
[illegible]ed with organisms. He would find it more
[illegible]ded throughout, with massive flocculi moving
[illegible]he liquid. Exposure of the flask for a minute
[illegible]tercurrin water would cause both turbidity and
[illegible]ulation; and render the infusion as clear as
[illegible] distilled water. The turbidity and flocculi
are simply due to the coagulation of the liquid to a jelly.
This fact is some guarantee for the strength of the in-
fusions. I took advantage of the clear weather this year
to investigate the action of solar light on the development
of life in these infusions, being prompted thereto by the
interesting observations brought before the Royal Society
by Dr. Downs and Mr. Blunt, in 1877. The sealed ends
of the flasks being broken off, they were infected in port
by the water of an adjacent brook, and in part by an in-
fusion well charged with organisms. Hung up in rows
upon a board, half the flasks of each row were securely
shaded from the sun, the other half being exposed to the
light. In some cases, moreover, flasks were placed in a
darkened room within the house, while their companions
were exposed in the sunshine outside. The clear result
of these experiments, of which a considerable number
were made, is that by some constituent or constuents of
the solar radiation an influence is exercised inimical to
the development of the lowest infusoria. Twenty-four
hours usually sufficed to cause the shaded flasks to pass
from clearness to turbidity, while three this time left the
exposed ones without sensible damage to their transpar-
ency. This result is not due to mere differences of tem-
perature between the infusions. On many occasions the
temperature of the exposed flasks was far more favorable
to the development of life than that of the shaded ones.
The energy which in the cases here referred to prevented
putrefaction was energy in the radiant form. In no case
have I found the flasks sterilized by insolation, for on re-
moving the exposed ones from the open air to a warm
kitchen they infallibly changed from clearness to turbidity.
Four and twenty hours were in most cases sufficient to pro-
duce this change. Life is, therefore, prevented from devel-
oping itself in the infusions as long as they are exposed to
the solar light, and the paralysis thus produced endures
them to pass through the night time without alteration.
If it is, however, a suspension, not a destruction, of the
germinal power, for, as before stated, when placed in a
warm room life was invariably developed. Had I had
the requisite materials I should like to have determined
by means of colored media, or otherwise, the particular
constituents of the solar radiation which are concerned
in this result. The rays, moreover, which thus interfere
with life must be absorbed by the liquid or by its germinal
matter. It would therefore be interesting to ascertain
whether, after transmission through a layer of any in-
fusion, the radiation still possessed the power of arresting
the development of life in the same infusion. It would
also be interesting to examine how far insolation may be
employed in the preservation of meat from putrefaction.
I would not be understood to say that it is impossible to
sterilize an infusion by insolation, but merely to indicate
that I have thus far noticed no case of the kind.

* British Association, 1881.

PLANTÉ'S RHEOSTATIC MACHINE.*

Translated from the French by the Marchioness Clara Lanza.

Ruhmkorff's electric induction machine has proved in the most satisfactory manner that by the intermediary of inductive action, we can transform voltaic electricity into electricity of high tension. M. Bichat has likewise shown that by the same means, currents of high tension can be changed to currents of quantity, analogous to voltaic currents. M. Planté, with his secondary pile, has rendered this demonstration still more emphatic, and as his experiments demanded a greater tension than he was able to produce with his batteries, he undertook the manufacture of an apparatus by which he could obtain very notable discharges of static electricity, capable of forming at will, long thread-like sparks, or short, thick ones. In this way he was induced to make the battery of which we are about to speak, and which he calls the *rheostatic machine*.

Although this apparatus (fig. 1) was presented to the Academy of Sciences and exhibited to most of the physicians who witnessed M. Planté's fine experiments, it is as yet, but little known. Why this should be the case we are at a loss to understand, for it is one of the most perfect machines that can be employed in experiments of static electricity. Had the apparatus borne a foreign name, we are confident it would have attracted considerable attention long ago. It is much to be regretted that we are so constituted in France, that whatever is invented by an unknown man, a *savant* who does not rejoice in an established position or who is not a member of some scientific coterie originating from a celebrated school, is looked upon entirely as a matter of subordinate interest. "It is only an amateur's work," we hear on all sides for awhile and then the subject is dropped forever. In England it is quite different. Amateurs such as Grove, Gassiot, Warren, Delarue, Spottiswoode, Lords, Rees, Lindsay, Raleigh, Elphinstone and many others, find their efforts are appreciated as they deserve to be, and no one ever thinks of inquiring whether they are *savants* patented by the government or not.

M. Planté therefore, not being among the last-mentioned, was forced to meet with indifference which he forcibly overcame later by the fine work he performed with his accumulators. He was not so successful, unfortunately, with his rheostatic machine, and for this reason we shall dwell a little upon the important results it has afforded us.

M. Planté's machine consists of a series of condensers with mica plates, parallel one with the other and capable of being charged and discharged in a manner similar to the secondary batteries without any other alimentary electric source than these latter.

The various pieces composing the apparatus must be

* *La Lumière Électrique*, August 6th, 1881.

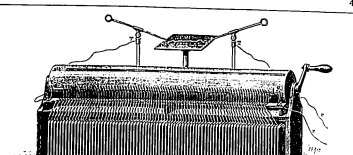


Fig. 1.

taken apart with great care. The commutator is formed of a long cylinder made of hard rubber. It is furnished with longitudinal metallic bands destined to connect the surface condensers, and crossed by pieces of copper wire bent at the ends, the object of the latter being to unite the condensers of tension. To this end, metallic wires, fashioned like springs, rest upon the cylinder and are associated with the two armatures of each condenser by very fine copper wires covered with gutta-percha. They are attached to an ebonite plaque on each side of the cylinder, and the latter can be made to rotate rapidly and continuously by means of a set of wheels. The final springs are separated considerably from those preceding them, in order to prevent the electric sparks from dis-

Fig. 2.

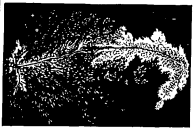


Fig. 3.

charging between the tension poles of the rheostatic machine and those of the secondary battery.

The mica plates in the condensers are 0m 18 in length and 0m 14 in breadth. The armatures are made of tinfoil. The edges of the condensers are rendered adherent by frames or simple ebonite plaques. These give them more rigidity and cause them more readily to maintain a vertical position, one beside the other, without coming in contact.

When the cylinder is so turned that the longitudinal metallic bands come in juxtaposition with the springs, the armatures in an even range with all the condensers unite on one side, while those in an uneven range are joined on the other, forming a single condenser of large surface. The armatures discharge by causing the right hand boundaries, which can be easily distinguished in the figure, to communicate with the poles of the battery.

When, on the contrary, the cylinder is so turned that its transversal pins are presented to the springs, all the charged condensers are connected in a series or in tension. The armature of the farthest condenser on the left, communicates with the last spring on the other side of the cylinder and ends at branch T of the excitant. The armature of the final condenser on the right communicates with the spring next to the last, and this spring unites with the last metallic pin traversing the cylinder. The last spring placed in the opposite side of the cylinder communicates with the other branch T of

the excitant. While the condensers are thus connected, the pole, or battery, which charges the apparatus, is entirely beyond the circuit.

M. Planté has constructed rheostatic machines of different sizes. The one here represented is supplied with eighty condensers. The commutative cylinder is 1m one meter long and 0m.15 in diameter.

When this cylinder is put in motion and the machine connected with the battery of four secondary couples, we perceive, as the charge begins to act upon the commutator, long lines of sparks at those points where the metallic contact is effected. It becomes a tube of sparkling light and the effect is equally apparent when the discharge in tension occurs. At the same time we obtain a long spark at the excitant T T.

Engineering News.
Oct. 8th 1881.

THE STORAGE OF ELECTRICITY.*

BY SIR WILLIAM THOMSON.

The first and most obvious use of Faure's accumulator was stated by the author to be the production of electric energy at the most convenient time, and to keep it in store until it could be most conveniently used; but its largest use in electric lighting would be to allow steam or other motive power and the dynamo to work economically all day, or throughout the twenty-four hours when the communications were such as to render that economical, and then storing up the energy so that it might be available when the light was required. There was also a very valuable use of the accumulator in its application as an adjunct to the dynamo, in order to fulfill the first condition of giving greater regularity to the light-giving current and storing up an excess of surplus in such a manner that the stoppage of the engine would not stop the light, but only reduce it slightly, and so also that there would always be a good residue of two or three hours' supply of full lighting power after the driving machine was stopped, or a supply of light for eight or ten hours for a diminished

* Abstract of paper read in Section A, British Association, Southport.

number of lamps. It was obvious that great economy and important practical results were to be obtained by the use of such a system, provided that the expense of the storing material and the magnitude and the lasting power of the apparatus that it involved were not prohibitory—were not such as run away with whatever gain there might be in the principle. The subject was altogether in its infancy, and we must wait a fuller information, both as to its practical and its economic sides. So far as estimating electrical quantities was concerned, we must hold our hands until, along with the incandescent lamps given us, there was a statement that they would continue in action, giving out so many candles' power approximately, when so many volts were applied to them, and during such and such a time.

England, Mechanics & Trade of Commerce
Oct. 8, 1881.

THE DE MERITENS SECONDARY BATTERY.

A MONGST the interesting exhibits at Paris is a secondary battery, the invention of Gaston Planté, de Meritens, which, it is said, is superior to the Faure. In its first form it consists of a sheet of lead 7mm. (.275in. nearly) thick, folded and rolled on itself in such a way that the sheet at each end is constant, and a series of triangles are made. These triangles are entirely filled by sheets of lead 2mm. (.078in. nearly) thick, and placed in contact with each other and the bounding sides. The leaves of lead foil are soldered to the sides, the ends, and a bigger, left in front, a "pole," and the bottom are placed in an ebonite box, perforated and covered with glass by a space of 9 mm. (.354in.) at the Exhibition in a battery of 50 elements, each 0m. (2·95in.) high, and 0m. 25 (9·84in.) thick. The bath consists of dilute sulphuric acid, 1 part of acid to 9 of water, and requires no renewing for months of clock or fuel enveloped, while the peculiarity of the construction leaves the leaves by a current very little altered, and is, moreover, from the arrangement of the plates, very little liable to become disturbed. M. de Méritens has also observed that the folded plate is of very little use, and that it is found necessary to employ plates of lead 1mm. thick, the thin ones 2mm. thick, being nearly all burnt away. The density of the current will now be much 1·5cm. wide. Several thousands of the thin leaves 0·005in. thick) will be placed upon one another in such a way as to form a vertical parallelopiped, one of the wider faces of which will be covered with the solder, and the strips formed by the leaves will be connected to it. In this way the weight will be considerably reduced, and the efficient surface largely increased. When once properly formed the battery is said to have a very large storage capacity compared with its weight, and it must be acknowledged that it is the simplest form of secondary that has yet been devised.

[September 9, 1881.]

THE ENGLISH MECHANIC
AND WORLD OF SCIENCE.

THE STORAGE AND TRANSMISSION OF POWER.

MURRIE is abundant evidence in the proceedings at the meeting of the British Association to show that we are on the eve of a great revolution in our methods of utilising the available sources of energy. Sir W. Thomson, in the Section of Physics, and Sir W. G. Armstrong, in the Section of Mechanics, both addressed themselves to an elucidation of questions which are just now attracting the attention of mechanical engineers and physicists; and the modern developments of electric science warrant the boss of confident anticipation in which the two presidents spoke of their respective sections. A few years ago it was pointed out by a distinguished savant that the economy of steam-power had made considerable progress in the preceding decade, and as the advance towards perfection was still proceeding, it was not impossible that in another ten years we might reach a limit beyond which it would be hopeless to expect much progress. Events have not altogether borne out that expectation, and it is now recognised that the advance has been smaller in the last than it was in the preceding decade. Engineers are not at the present day in a hurry to write the word "finality" on their designs, but they are compelled by experience the fact that they are rapidly approaching the limit beyond which they cannot hope to progress. Just as they approach that limit, however, a new field opens to view, and the possibilities of advance in other directions attract their attention. The results obtained with the modern forms of dynamo-machines, the capabilities of Faure's installation of the comparatively old form of Plantè's storage battery, and the suggestion of Dr. Siemens that it is possible to utilise the immense power such a waterfall as that at Niagara, have given rise to speculations which, in the immediate future, may play a very important part, and the recent exhibition in Paris will direct the attention of many minds to a subject of growing interest. Sir W. Thomson, in his address to Section A, reviewed the sources of energy which man can utilise, and dwelt with special emphasis on the value of wind and water-power in combination with the artificial production of electricity. Sir W. Armstrong, in his address to Section G, drew attention to the fact that we have nearly reached the limit of possible development of the steam-engine, for, as he pointed out, the advantage to be derived by increasing the range of temperature is seriously discounted by the enormous waste of heat in the escaping gases and by radiation, while introducing mechanical difficulties and dangers that it would be better to avoid if possible. Mere increase of pressure is not an altogether unalloyed gain, and even if we can improve the steam-engine to the utmost extent at present deemed possible, it would still be a wasteful though undoubtedly a valuable servant. The steam-engine, which is really a heat-engine, acts by expansion of volume—a principle which is known to be essentially wasteful, whereas electricity operates by, for want of more explicit terms, what we call attraction and repulsion, thus producing motion in a manner which is subject to no greater loss of effect than attends the motive action of gravity. If we could produce electricity with the same facility and economy as we can produce heat, the gain would be enormous, and the question then arises whether we cannot actuate dynamo-machines by natural forces, and save our coal for other purposes. As a secondary motor, the dynamo-machine has already been utilised in several ways, and if we can actuate it by some power which is at present allowed to run to waste, the gain will be just the value of the coal and the interest of the capital that would otherwise be expended in laying down motive-power engines. Of the available sources of energy, the other than fuel, we have wind-power, water-power, and tidal-power; but, so far as the latter is concerned, it is, as Sir W. Thomson has shown, somewhat comparatively insignificant. In wind-power and water-power we have agents which cost nothing, and though, so far as the latter is concerned, in this country we have little more than the power of running water, the former may possibly, with the aid of recent inventions, be turned to good account. Sir W. Armstrong, in his address, reviewing the known means of obtaining electricity, pointed out that, until we can make the combination of coal with oxygen directly available for the development of electric energy, there seems to be no probability of obtaining the current from chemical action at such a cost as would supplant heat as a motive agent. Coal, and the other hydrocarbons, are the only abundant and cheap bodies which have their chemical affinities unsatisfied, and are, therefore, capable of evolving energy when combining with oxygen; and, although a method of storage would enable us to use water and wind-power for the production of electric currents our dynamo-machines will probably, for some years to come, depend mainly on coal as their prime mover. It is not impossible that with some form of gas-battery we may be able to use coal directly in the production of the electric current, and it is probable that future developments of the thermo-electric pile may place us in a position to obtain sufficiency of current by a direct application of heat; but at present the former idea is only in the laboratory stage, and the thermopile is rather more wasteful than the steam-engine. As Sir W. Armstrong put it, however, the vice of the steam-engine lies in its inability to utilise heat of comparatively low grade, while it wastes an enormous quantity up the flue of the furnace. If we could utilise that waste and the energy of the engine itself by a supplemental machine acting on the principle of the thermo-electric battery, we should approach very near to the possible theoretical economy. By whatever means obtained, however, it is certain that electricity will play an important part in the world of mechanics as a motive power, though for some time it may be in a subordinate character, as a sort of handmaid to the steam-engine. Sir W. Armstrong has himself drawn down a small but very useful illustration of the manner in which electrical appliances, to transmit its energy to a considerable distance, and there are many places where natural forces are available for producing power to be transmitted to situations in which it can be conveniently utilised. We give elsewhere some notes by Sir W. Thomson on the possibility of distributing the gigantic power of the falls of Niagara, the scheme depending for its success mainly on the practical utility of Faure's accumulator; but the idea is one that in different shapes has occurred to many investigators and experimentalists. If we can store in an economical manner the current produced by our dynamo-machines, we see then and there ready to take a large step in advance, and even if the storage should prove to be a rather costly operation, there are still many instances in which it could be employed with advantage. Mr. Stone has tested Faure's accumulator in connection with an installation of his lamps, and has expressed the opinion that it is the very thing wanted to make electric lighting all that was needed, while, as our readers will remember, Mr. Rankin Kennedy has explained in our columns the method in which he utilises it for a similar purpose (pp. 284, 308, Vol. XXXIII.). By means of the accumulator, electric energy, generated by a

THE AMERICAN ENGINEER. 157

THE CAVETT & McKNIGHT SHEAR

A visit to the Siemens-Anderson Steel Works at Pittsburgh, would give the reader an opportunity of witnessing the operation of a gigantic shear, recently put there, and which has attracted considerable attention. It is said to be the largest shear in the United States and weighs some 70 tons. It is designed to cut steel blooms eight by eight inches, or plates 36 inches by 1 inches, but. It does the work with the greatest ease and alacrity, and has already cut blooms seven inches by eleven inches.

This beautiful piece of machinery is about sixteen feet in height, while the body of the shear is nine feet and a half wide. These figures give but a faint idea of the grand proportions of the machine. The roller table attached to it is 22 feet wide. The shear is driven by continuous gear, and the crank or punch is thrown off by an independent steam cylinder. The fact that the gear wheel by itself weighs exactly four tons, gives one some conception of the immense power of the machine and how it accomplishes the feat of cutting blooms of the proportions mentioned above. The top shaft is 12 inches in diameter, of steel, with a wrought-iron eccentric of a weight of 1,500 pounds. The whole is driven by an 8x by 16 vertical engine. It is considered one of the great curiosities in the line of steel mill machinery to be seen in Pittsburgh at the present day.

Messrs. Cavett, McKnight & Co. manufacture this and a great piece of machinery, whose works are at 32 to 40 Penn avenue, Pittsburgh, are pushing an enviable reputation for large work, and we are pleased to be able to present an illustration of this, their latest addition to the examples of the progress in mechanics of the United States.

The machine was designed by Mr. David Shaw, of the Siemens-Anderson Steel Works. See illustration, page 156.

THE STORAGE OF ELECTRICAL ENERGY.

As the question of the storage of electrical energy is receiving so much attention in the discussion of the features of the Faure secondary battery, we venture to reprint extracts from the two leading engineering papers of London, on this subject. We begin with the following from the *Engineer;*

"A great deal has been written and said on the subject of the storage of electricity by means of Faure's secondary battery. That M. Faure has succeeded in improving upon the Plantè pile has been known for some time to scientific circles, but no undue importance was attached to the fact. Of late, however, most extraordinary stories have been set on foot; and the columns of the daily press have announced that storage is a fait accompli, and that before the close of gas-lighting is all but over, and that the ship of the immediate future will be propelled by electricity. We have contented ourselves up to this moment with an announcement of the nature of M. Faure's invention, and we have refrained from doing more lest we should inadvertently lend the invention a notoriety it does not deserve. M. Faure has been known for years in France, and there is good reason to believe that a company to work patents has already been formed in Paris, and that an attempt to form a similar company in this country will soon be made. The most exaggerated claims have been put forward for the invention—claims so exaggerated that there was reason to think that no one could be fools enough to believe them. Unfortunately, however, Sir William Thomson unwittingly wrote a letter to the *Times*, which appeared on the 26th inst., and which might easily be used with great effect by the promoters of a company. Sir William Thomson told the world that he had carried a million foot-pounds with him stored in a space of one cubic foot. This sounds very large, and the daily press in certain cases became more enthusiastic than ever. But large as "a million foot pounds" sounds, it is really very little, and Sir W. Thomson has, we feel certain, been misunderstood, and his incautious words have been made to imply what he never meant them to convey. Before going further we may explain that the force stored up in Sir W. Thomson's "unit of electricity" would not drive a 1-horse power dynamo-machine for more than half an hour, even if all the energy it represented could be made available by employing mechanical work. The latter expedient is not as a matter of fact there is no electricity available, over stored up in the form of mechanical energy, for the purpose of actual galvanic battery, the duration of release action is but short.

As the colons of the Faure battery to notice as a money-making invention we are bound to say we presume to explain what it is a property of, and in language—language which will not, perhaps, please the electrician, but will, nevertheless, convey to the reader who knows nothing of electricity a very good idea of the action of this wonderful box, about which so much is being said. Imagine a box of any convenient size, and which we much be better pleased in a weak acid solution, and kept from touching each other by means of cotton or cotton wool, or some such substance. If, however, a wire be used to connect the two plates, what is called galvanic action takes place. A current of electricity passes through the wire, and the zinc becomes rapidly oxidized. After a time the zinc will all be oxidized, save a small portion behind, which is protected by the oxide from contact with the acid. When this happens, the action of the battery ceases. Now let us suppose that a powerful current of electricity from another battery is driven in an opposite direction through the first-mentioned battery; the effect would be to undo what had been done, the zinc would be deoxidized and ready for work again, and if metallic contact were prevented, the battery might be kept ready for use for a considerable period. In practice the result we have indicated cannot be secured with zinc and copper, for reasons which we need not stop to explain. We have stated that it would, because the statement conveys a clear idea of what takes place in the Faure battery; for although deoxidation of zinc cannot be effected practically in the way indicated, it is possible so to act on an oxide of lead as to produce an analogous effect. The Faure battery consists of a strip of lead covered with red lead Pb_3O_4, the red lead, which is an oxide or rust of the metal, being kept in place by a sheet of felt. Two such lead plates having been prepared, they are rolled up together like the spring of a watch. This couple is then immersed in an acid bath and a current of electricity from a dynamo machine is driven through it. After two or three repetitions of the process, it is found that the red lead coatings on the two plates have undergone chemical change, one plate having been converted into peroxide of lead PbO_2, while the other is converted into metallic lead. By establishing conditions under which the peroxide loses some of its oxygen and the metallic lead gains some, a current of electricity can be obtained at once. Such, in few words, is the principle of the Faure secondary battery. It contains no electricity, but its parts are in a condition to produce a certain quantity of electricity at will, just like any other battery. The peculiarity of the Faure battery, it is said, that the current produced is powerful, very large in quantity, and high in potential. But this may be said of many other batteries.

"As to the value of such a battery as a mechanical agent, we have to bear in mind first that it creates nothing. It can only give back a portion of the energy expended in producing the chemical change in the red lead, and there is every reason to believe that if employed to turn the best dynamo-electric motor to be had, and more than 50 per cent. of the original energy would be given back. Thus, instead of 1,000,000 foot pounds in a box of one cubic foot capacity, we should have but 500,000 foot-pounds effective. But the great drain persistently urged for this Faure battery is levied in the idea that it represents vast concentrated energy—that nothing in parallel in this respect is to be found in the whole world. Thanks are due to Professor Ayrton, Professor Perry, of Dawn's College, who lead no time in replying to Sir W. Thomson's statements. The means of storing and re-storing mechanical energy," writes Professor Reynolds, "form the equivalent not only of Sir William, but of every educated mechanic. It is, however, a question of degree—of the amount of energy stored in a certain weight of the energy-storing device. The lowest possible efficiency in electricity is 50 per cent., and the highest is probably 90 per cent. Looked at in this way, one cannot but ask whether, if this form of storage is to be the realization of our aspirations, it is not enough to multiply by two pounds of energy, to supply a young impression until we inquire what is a unit. Eleven million foot-pounds of energy is what is stored in one pound of ordinary coal. A unit of electricity, weighing 75 lbs., there was just as much energy as in 1¼ oz. of coal, which might have been brought from Paris or anywhere else in a waistcoat pocket, or, better still, in a cigar-case by letter.'

"Professor Reynolds here hits the precise point which required hitting. The Faure battery is not a form of energy, but a convenient form of storage up of energy, that its powers are really very insignificant as compared with other arrangements. For example, a cubic foot of water weighs 62½ lbs., and so is 12.5 lbs. heavier than the Faure battery which contains the equivalent of a million foot-pounds. To impart 1,000,000 foot-pounds of energy to a cubic foot of water is only necessary to raise its temperature 20.7 degs. Fahr. Now, it is obvious we may say that the work cannot be rendered available for the production of useful effect, and he is in a sense quite right; but so far as the bare statement that the Faure battery contains a million foot-pounds of energy in a small space is concerned, the assertion that a cubic foot of water when heated 20.25 deg. hotter than it was before, contains 1,000,000 more foot-pounds of energy, is equally true. Again, a cubic foot of air at a pressure of 300 lbs. on the square inch, and atmospheres, contains very nearly 250,000 foot-pounds of energy, and this in a more available form than the energy stored up in a cubic foot of air in a finely-concentrated state into a liquid. The solution of gelatine, say be accomplished in many ways. The simplest would be the compression of air, but as much as the Faure battery. It is true that a vessel of four cubic feet capacity would be required to carry 1,000,000 foot-pounds in this way, but the engine and reservoir taken together need not be larger than the Faure battery and its containing vessel taken together. We might, were it necessary, easily extend this list, and show that the Faure battery has really no claim to be expanded in its present form as much more than an interesting scientific toy. Twenty feet of coal gas will produce an indicated horse power per hour in a small engine. There is no trouble whatever in compressing 20 cubic feet into a space of 1 cubic foot. If anyone will take the trouble to carry a cubic foot of gas thus compressed from Paris to Scotland, he will be in a position to boast that he has done just four times as much as Sir William Thomson. But 20 cubic feet of gas at 300 lbs. pressure will produce a horse power hour; but 20 cubic feet of gas condensed twenty times represents 2,000,000 foot-pounds. Let us now, however, compare Sir William Thomson and his with the Faure battery. We have no coal gas. We do not know what it costs to charge a Faure battery, but we know that coal gas can be had very much cheaper."

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poured quickly at the neck, and the gates cut, so as to whirl the iron and keep all dirt in the centre of the ingot, which is then allowed to cool.

When the mould cools, the cast iron in the ingot-end until the neck is about to freeze up. When you see it put it in, then with a sledge-hammer, so as to cause a pressure on the contracting shell, which would be liable to crack. When feeling, break the real slowly. It is better to make the gates as hot as possible, by howling them in the sand, as the iron will be closer and make a sounder casting. Ingots of 2 tons and upwards are poured against a cold, dry casting, the mould being about level, the pressure will be equal all around. Wherever there is a check or crack, you may depend that it is caused by unequal pressure of the confined liquid metal against the contracting shell.

THE DE MERITENS SECONDARY BATTERY.

AMONGST the interesting exhibits at Paris is a secondary battery or accumulator, devised by M. A. de Meritens, which is said to be superior to the Faure. In its first form it consists of a sheet of lead 2mm. (·078in. nearly) thick, rolled and relabled on itself in such a way that the sheet is in the form of a cylinder with a number of perforations. Over this brought a number of thin sheets of lead 2mm. (·078in. nearly) thick, and placed in contact with each other and with the cylinder. The leaves of lead foil are soldered together on one side, and a tongue is left to form a "pole." Two sections are placed in an ebonite box, separated from each other by a space of 2 cm. (·787in.), and from the bottom by a space of 5 cm. (1·968in.). The space between the forming a battery at the Exhibition is very small indeed, being but 10mm. (·393in.) long, and 5cm. (1·968in.) high. The battery has both coasts of dilute sulphuric acid. The battery is entirely of lead, and therefore the protection in the form of cloth or felt envelopes, while the material formed between the leaves by the current, is very firmly adhered, and is, moreover, from the porosity of the lead, very light. The inventor, M. de Meritens, is a professor of medicine at the Brussels Veterinary School, and the fabled plate is of very little use in the battery, and is scarcely more than a dead weight, the thin leaves, 2mm. thick, doing nearly all the useful work. Four pole of aluminum will now be made simply of 8cm2 strips of lead 2mm. thick, and 5cm. (1·968in.) wide, soldered to a strip of lead (·393in. thick) and 5cm. (1·968in.) wide, which is then soldered to the aluminum pole. The battery is very light, and is said to be very powerful. It is not clear what is the exact capacity of the battery, but it is stated that it is simply proportional to the number of leaves of lead foil employed, and that the capacity is 1 ampère hour per kilogramme of lead. The internal resistance of the battery is very low, and it is said that it is retained by stops which prevent the lead foil from touching. The battery is said to be very durable, and to stand any rate of charge or discharge that may be desired, and to be very efficient, only more nearly than one half of the energy put in is realized.

Dried feces of gelatine, thus prepared, dissolve with great readiness in water. On the completion of the process the gelatine is to completely dehydrated that it will absorb from the air only 2 or 3 per cent. of moisture. The presence of water is a problem, as it will known, it always attended with changes, as it is the source of many undesirable chemical treatment, to avoid such consequences, whether it unit fortuitous or not is extremely fortunate in the value in the arts. Once the greatest difficulties in the way of the use of gelatine in photography have to do the fact that dissolved in water it undergoes the changes in the temperature and hygroscopic condition of the atmosphere, and chemico-physical conditions are rendered valuables by such sudden and unconstitutable changes. The process of dehydration is entirely independent of atmospheric conditions, and may be so nice that its moisture is not absorbed by the air. The process of dehydration has already been referred to. Of the material used it is only necessary to state that, as the process is very rapidly carried on, and as the solution is not exposed to such an extent as it is when the gelatine is prepared, the operations are employed, there is no opportunity for the most foreign substances to become intermixed with the gelatine present. While the process is very simple, the difficulty of treating all gelatine solution, from whatever source they may be derived, it is peculiarly fitted for the purpose, as it is free from the mineral jellies or hydrocarbons obtained from fish-skins, silted or fresh, and also from other fish tissues.

SCIENTIFIC NEWS.

NOTHER comet is announced, this time by Mr. Denning, who first saw it on October 4, at about 10h. 30m. sidereal time, in the constellation Leo and Coma Berenices. The following are approximate positions on October 4, 10h. 30m. A.S. 174m. 3s. Dec. 21. Daily motion, 1m. 30s. eastward. Bright central condensation. Dim. Eight degrees. The first orbit of the original telegram has been received from the Astronomer Royal; but it is not clear whether that was a repeat of Denning's, or whether the comet was also discovered at Greenwich.

Mr. Wesley, of 28, Essex-street, Strand, sends us Part I. and the Introduction of Hilaire's "Excessive Pictures of the Moon." Mr. Gravatt, R.E., has published six gelatine plates of the Moon at different phases, which are being reproduced by photo-engraving. The introduction, which we have not yet had time to study, describes the Moon fully, in clear, and descriptive given in the beginning understand that the other pictures will respectively illustrate the Moon's first quarter, Sunset at Copernicus, and "the Earth-like on the surface in shadow" of the Moon. The publication of these plates will doubtless meet with a favourable reception in the de-cavern.

The International Geological Congress meeting at Bologna, adopted on the 20th ult., a resolution in favour of combining the collection of a general geological map of the world to a scale of one millionth of seven sheets, and has appointed to be Germans, and the other five to be Italians, from England, France, Spain, Austria, and Russia severally. The scale of the map is to be 11,000,000, and the nations of the work to be performed in Berlin.

The Institution of Civil Engineers has issued a circular inviting communications on the following subjects:—1. The best method of furnishing the same amount of water as the Manchester Corporation supply. By simply turning off the handle of a committee, the circuit was closed for the screaming current. It is suggested that there should be a central generator of electricity for furnishing as current at any time in case of fire, as well as for lighting purposes; and facilities should be given to enable promptly the electrical machine with the conducting materials (2) will be noticed that the figures are rather unfamiliar, and it would be interesting to know how much the pump really did. (3.)

DRIED GELATINE FOAM.

A METHOD of preparing gelatine in the state of foam—a state in which it can be indefinitely preserved, or in which it can be readily dissolved in water, is described by Mr. R. Brooks, of Hockley, Essex.

The gelatine is first dissolved in water, but it is subjected to violent agitation, or to violent agitation, or to the action of air-currents under pressure, whereby air is mechanically held in the solution, and it becomes foamy; and, second, by evaporating the water from the solution, and the foam by subjecting it to the action of cold, dry air. The evaporation may be by the mere circulation of air in a finely-comminuted state into a liquid solution of gelatine, say be accomplished in many ways. The simplest would be the compression of air, and is as much as the Faure battery. It is true that a vessel of four cubic feet capacity would be required to carry 1,000,000 foot-pounds in this way, but the engine and reservoir taken together need not be larger than the Faure battery and its containing vessel taken together. We might, were it necessary, easily extend this list, and show that the Faure battery has really no claim to be expanded in its present form as much more than an interesting scientific toy. Twenty feet of coal gas will produce an indicated horse power per hour in a small engine. There is no trouble whatever in compressing 20 cubic feet into a space of 1 cubic foot. If anyone will take the trouble to carry a cubic foot of gas thus compressed from Paris to Scotland, he will be in a position to boast that he has done just four times as much as Sir William Thomson. But 20 cubic feet of gas at 300 lbs. pressure will produce a horse power hour; but 20 cubic feet of gas condensed twenty times represents 2,000,000 foot-pounds. Let us now, however, compare Sir William Thomson and his with the Faure battery. We have no coal gas. We do not know what it costs to charge a Faure battery, but we know that coal gas can be had very much cheaper."

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like period preceding. At the twenty-two clearing-houses outside of New York, the exchanges were larger in June than ever before in any month, and in the last quarter, half-year, and year, were larger than in any previous corresponding period in the history of the country."

PROGRESS IN SCIENCE AND THE ARTS.

Shipment of Railroad Iron by the Mississippi River.—The shipment of 9000 tons of railroad iron from Wales to Des Moines, Iowa, by way of New Orleans and the Mississippi River to St. Louis, is a notable event, says the *Railway Age*, especially as it is future, as stated, that it is delivered at Des Moines at $6 a ton less than the rail would have been by way of New York and thence by rail. What the rate would have been any other way over the canal and lake route from New York is a question. As long as steamers carrying grain to Europe from the ports of New York can secure return cargoes of railroad iron, they can afford to make low rates; and the demand for railroad iron in such large quantities must be deemed upon permanently, and the question then will be whether New Orleans can hold out sufficient inducements as a place of import to make it profitable for the steamers.

Gold Mining in Australia.—The statistics furnished in the report of Mr. Hayter, Statist to the Government of Victoria, continues to exhibit a most remarkable decline. The quantity raised in all these colonies since deposits of that metal were first discovered in 1851 is estimated at 60,000,000 ounces, valued at $1,250,000,000. By far the largest proportion has come from Victoria, where the gold-fields in 1859 produced only 758,-342 ounces, which is less than half the average annual yield of the same colony during 1870–73.

This Little Earth.—A writer in *Belgravia* kindly furnishes us with a few hints—a sort of rude measuring-rod that may be of use when our sense of our planetary importance becomes oppressive. It is only, he says, when we regard our globe as a member of the planetary system, and that system in turn as a unit among systems, that we feel how infinitesimal are its conformand how relatively insignificant it is. We may, for practical purposes, treat the orbit of Neptune as the circumference of our planetary system, and state the diameter of it therefore as about 5,480,000,000 miles. But if we could suppose all this vast plane converted into a solid disk, instead of being, as now, for the most part empty space, and if it were then given, by some means or other, a slightly luminous surface, it would appear to an observer upon the very nearest fixed star no more pretentious than a new shilling glittering in the sunshine would appear to an observer at a distance somewhat over a hundred yards. In other words, it would want fairly [illegible] of all.—We may [illegible] sphere, [illegible] sun-[illegible] ircumference of [illegible] elimate of

ENGINEERING AND MINING JOURNAL.
[JULY 9, 1881.

The "Box of Electricity."—The following letter from Professor Tyndall appeared in the *London Times* of June 17th. The letter has a special interest, apart from the clear description of a "secondary battery," because it gives the honor of the discovery to its rightful owner, and removes the perplexity occasioned by the use of the term "storage of electricity" and "box of electricity."

"SIR: Would you permit me to say a word or two on a subject of great public interest and of considerable public perplexity—I refer to the so-called 'storage of electricity'? The usual condition for the production of a voltaic current is known to be the immersion of two different metals in a liquid called an electrolyte. When two pieces of metal thus immersed are connected with a galvanometer, the existence of a current is declared by the deflection of the needle of that instrument. Substituting for the two metals two clean plates of platinum and connecting them with the galvanometer, the needle remains unmoved. The platinum plates being homogeneous, there is no reason why the current should start from one of them through the liquid rather than from the other. If such currents started, they would be equal and opposite, and, would, therefore, neutralize each other. In other words, with the two homogeneous plates of platinum we have no current.

"But let the platinum plates, after immersion, be detached from the galvanometer and joined, even for a moment, to a voltaic battery, the current which would destroy the homogeneity of the plates, for example, by oxidizing the octahydrated water, that liquid will be decomposed, a film of hydrogen covering one plate of the platinum, and a film of oxygen covering the other. These two films play the part of two different metals in the ordinary voltaic battery; and if the plates of platinum should be connected with the galvanometer, the current produced will be strong enough to dash the needle violently aside.

"The experiment may be varied in fifty or five hundred ways, and when, instead of the films of gas, solid layers of depolarized electrolyte on one or the other of the homogeneous plates, the duration of the current is prolonged. Several cells thus rendered active, through the agency of an extraneous current, constitute what is known as a 'secondary battery.'

"The discoverer of this battery was a man who, without pecuniary reward, or even the hope of such reward, almost sacrificed his existence in the investigation which resulted in the discovery. The name of this man was Ritter, a native of the small German village of Lieguitz. He died in Munich, penniless, exhausted by restless labor, poverty, and disorderly living. A public subscription was started to save his name and services ought not to be ignored at the present time. Other men labored and we have entered into their labors. Employing homogeneous plates of lead and rendering them non-homogeneous—that is, converting them, in fact, virtually into different plates—by the action of a voltaic current, M. Planté greatly intensified the effects obtained by Ritter. Faure has followed and improved upon M. Planté. Converting the plates of lead with minium, with the aid of the currents now [illegible] battery of great power and of considerable promise from a practical point of view."

"But I think scientific men have a right to demur to the phraseology in which M. Faure's extension of the discovery of Ritter has been intro-

hardened, and the two cones ground well together. The small screw which is fitted into the stem to keep the pulley up to its bearing is better if it is tight enough in its place without going home to a shoulder, as it can be adjusted more easily.

To finish this tool the front part into which the drills are fitted is all that has to be done; this is also made from a piece of round steel, and should be made as short as possible, in order that as little vibration as possible may arise. When screwed and fitted to its place, the small stem should be held in a chuck made to the babr, the instrument put together and driven from the over-head motion to drill the hole in the front where the drills fit. This is an important matter, as it is most essential that it should be quite true. It will be seen that the front is thin hexagon where it goes against the face of the pulley; this is to facilitate the removing of it when necessary. The drills also should be turned in their pieces in the same way as ordinary ornamental drills.

I am quite convinced that this addition will be duly appreciated by those who try it. I have had the pleasure of making a great many, and they have always given satisfaction. A careful inspection of the original would help materially, and I shall be glad to show it, or lend it to anyone for that purpose. In conclusion, I hope that these details, though somewhat lengthened, may be of as much service as many others have, judging from the correspondence I have received relative to them.

HOW TO MAKE A 2IN. ASTRONOMICAL TELESCOPE.

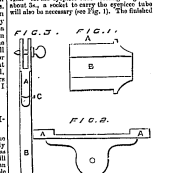
I WAS very glad to see the subject of the "effectiveness of a 2in. telescope" so ably dealt with by Mr. Dridle. There are doubtless many of your more fortunate readers who will smile at the fervour displayed over so small an aperture; but they should remember that as splendid work has been done with telescopes no larger than this; and also, that with a great many would-be students, the desire lies simply between the purchase of that size or none at all. The way in which I am acquainted with many of the new amateurs is considerably progress in practical astronomy, and who would certainly never have been tempted to provide themselves with telescopes had they not been able to gratify their tastes for star-gazing at a very reasonable rate, much lower in fact than the usual retail price of even such modest instruments. My object, in writing, therefore, is to describe how I, and others, who may be similarly situated, how they may very easily put together a thoroughly reliable 2in. achromatic telescope with two powers, brass tube, and which mounted on a tripod-stand, and still have some change out of a sovereign.

But, though I am desirous of showing how to the luxury of an astronomical telescope may be indulged in for so small a sum, I should be sorry to raise false hopes in the minds of those who by means have small be attempted. There must, for example, many of our readers to whom the highest prices for such a telescope would be just a mere trifle, but who would no less be keenly alive to the pleasure they would derive from the thought that it was to a successful issue of their own endeavors, rather than to the accidental possession of a long purse, that they were enabled to penetrate into the far depths of space. Nor is this all, for the experience gained in the manufacture will be of benefit, and cannot fail to be of value in the future selection and management of any other instrument they may hereafter possess.

As regards the choice of materials, I shall also like to say a few words. A great deal has been written about the necessary expense required by the use of "polished satisfactory and cheap" in both the microscope and telescope; but I may say I have yet to be convinced that either a tin tube or a roll of brown paper is at all suitable for the purpose. If a telescope is worth making at all, it is surely worth while to lay out an extra couple of shillings to give it a decent appearance, to say nothing of the superior solidity or of the convenience in getting a tube of just the right size, ready for immediate use at the nearest metal-merchant's.

The selection of the O. G. will first engage the attention of the operator. This should be of not less than 30 inches focus (solar), and should throw a clear-cut image of a pea or needle-frame without blur or haze at the edges. In testing the glass, the nearer the focus is to the object, the more the focus is to be less, the longer the focus will appear to be; some allowance should be made, therefore, for this peculiarity if the testing takes place, as it very likely will do, in the crowded interior of an optician's shop, and a still further allowance of about 3 inches must be made for the difference of focus between artificial and terrestrial objects; indeed, taking it altogether, an amateur would act on the safe side if, under the circumstances, he allowed a margin of 6 inches. The price of such an O. G. of Paris make, should not exceed 7s. or 8s.

The next step will be to procure a length (corresponding to the focus of the O. G.) of 2in. rolled tubing: 6 inches of 2in. and 12 inches of 1in.—for the eyepiece tube—cooling slipcaller sheet 5s., a socket to carry the eyepiece tube will also be necessary (see Fig. 1). The finished



socket, it must be remembered, should fit tightly into the 2-in. tube at A, and be just of sufficient size at B to allow the eye-tube to pass easily through. The pattern for this will have to be made by a turner, who must be warned to make the necessary allowance for the shrinking and swelling of the brass casting. The portion of the telescope is, perhaps, the most particular and difficult of the whole affair, so, to save trouble and expense to such as do not possess a lathe of their own, I shall be glad to forward a rough casting—chucked for the inner tube—on receipt of 1s. 6d. in stamps. The casting, as shown at A, Fig. 2, may be sunk into a piece of hard rubbing, and should fit sufficiently free to allow of an easy sliding motion. A safety pin and groove may be placed at C, if thought necessary.

The parts of the telescope are now ready for the lathe, and here I may say that the beginning may safely be left to the discretion of the amateur, or since it is, as regards its efficiency, quite a work of supererogation, he may if he much care enter with it altogether, or try its definition first and deal with it afterwards according to its merits.

Aldebaran.

(To be continued.)

THE TOMMASI SECONDARY BATTERY.

THE annexed illustrations show the construction of the Tommasi secondary batteries which have been patented by the Société Universelle d'Electricité Tommasi, of Paris. One of the modifications described is especially interesting, but the practical value of the invention obviously depends on its cost in actual working. It has been found by experience that

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leather more than a year ago that firm, believing their workmen possessed a large amount of the inventive faculty which remained latent for want of sufficient encouragement to bring it out, offered small money rewards for improvements in any of the machines or processes carried on in their works and shops; and they instituted the awarding of these to a committee, who have recently formed their second annual list. Practically, this report is the first since the scheme has been in working order, and from it we feel that the committee have had under their consideration no fewer than thirty-four claims. The whole of these claims, we may take it, had some ground, though possibly in some cases those who made it, or had a slightly exaggerated idea of their importance. Nevertheless, they all represented some inventive work—whether successful or not was left to the committee to decide; and out of the thirty-four only eight have been rejected as unworthy of reward, while four remain for further consideration. We then find that during 1881, in one establishment, no fewer than twenty-two improvements have been made which are judged worthy of being rewarded by sums ranging from £2 to £5—sums which are practically acknowledged to be moderate as rewards. The committee, in fact, are now, we learn, empowered to grant sums of money exceeding £10, and also to give larger amounts than those which have been hitherto granted for improvements of the same degree of merit. Further, some of the improvements made are of so important a character, that provisions have been made for giving assistance in procuring patent rights; so that we may fairly say the scheme has been as successful as to have realised the anticipations of the firm. A large proportion of the improvements made by the workmen are in connection with the woodworking machines, some of which have been so modified that they now have a large variety of work, while others have been so contrived that they are used for many different kinds of work, besides the one for which they were designed. Other machines again, have been so improved that they do the same kind of work with greater safety, while sundry new processes and new methods have received awards from the committee. The results obtained in the short time reported on by the committee are highly encouraging, proving as they do in the most practical manner that there is a good deal of inventive tal-ent amongst our mechanics and artizans, and that if—as human in the majority of cases lessons there is no little encouragement for its exercise. We have always held that a Patent Law which encouraged inventors by putting protection within the reach of the poorest workman would lead to a great increase in the number of inventions brought to the Patent Office, and been to the United States, and the results of the experiment made by the Messrs. Denny are convincing proof that there are lots of inventive skill in the rank and file of workshops. Many of the improvements made by Messrs. Denny's workmen are in themselves of small importance, but still of importance in the workshop; it is clear, however, that the improvements which made machine capable of being manipulated by a boy of work on different patterns, but under circumstances would have not been patented and published for the benefit of other inventors.

NEW STORAGE BATTERIES.

THE UTILITY of the secondary battery or accumulator in any system of electric lighting appears to have been widely recognised, if we may judge from the number of inventions, patented and otherwise, which have come into existence within the past twelve months. Besides those already described and illustrated in our columns, there are at least three whose experimental trial is looked forward to with much interest, viz., those of Edison, Swan, and Brush—the latter, it is stated, being on quite a novel principle. Until a demand was created for these secondary batteries, no one thought of improving Plantè's simple device of two plates of sheet lead; but since the discovery of the value of red lead as a coating, which was made by M. Faure, many experiments have been at work, and these will probably shortly be as many different accumulators as there are inventors proper—that is, batteries in actual use, for the variation in Voltaic cell known and described are nearly numerous than is generally supposed. At a recent meeting of the Society of Telegraph Engineers and Electricians, Mr. Cromwell F. Varley, gave some curious instances of the manner in which inventions lie dormant or practically unutilised for want of a sphere of labour. It seems that as far back as 1861, in Patent No. 2555, he described forms of cells which have actually been re-patented three times—viz., by Sir C. Wheatstone, Mr. Smith and Mr. Varley. The battery first described in his specification is a modification of the Daniell; but Mr. Varley also inserted a description of the sulphate of mercury cell, in connection with the patent, chloride of lime as of insulation surfaces for storing up electricity. These latter devices were at the time well-known condensers composed of laminæ of tinfoil separated by sheets of some non-conducting substance, and connected at alternate ends to the pole of the battery. It is not unlikely that in the forgotten documents at the Patent Office there may be some other inventions which more nearly resemble the electrical accumulators we know of to-day; but it is obvious that the "earliest of the Patent will be the natural result, and the fittest will, no doubt, be that one which is cheapest. From this point of view it might be supposed that the secondary battery devised by M. J. Jacques, in which he employs a sheet of palladium as the negative element, would be of little practical utility; but with a sheet of lead as the positive pole, the battery is very powerful, even when of small dimensions, and notwithstanding the cost of the metal, it is not impossible that other circumstances may combine to render the use of palladium commercially possible. Three grains is said to absorb 900 times its volume of hydrogen; but as a sheet of this iron, with ammonium sulphate as the solution, absorbs still more, and as the cost of the latter may be found more advantageous. The positive plate of Mr. Rosser employs a cylinder of ferro-manganese for the positive, and steel iron as the negative element. Modifications of Plantè's secondary battery appear to have more attraction for inventors, probably because they are cheap and are cheaply constructed. On p. 613, Vol. XXXIII., we gave a description of one of these modifications, made by Mr. Dyer, who, working with M. Carpentier, has lately made further improvements. In one strip of lead, rolled into small tube by half a metre (say, 20in.) long, and of any suitable thickness—which probably means as thin as can be handled and worked—which he passes between the rollers of a corrugating machine, so arranged as to make the corrugations in an oblique direction. Each of these strips he folds in two, with a porous separator between, and scales the ends together. The corrugations are obviously to afford a passage for the escape of gases, and they are so arranged as regards the alternate position of positive and negative plates that they all point upwards. The soldered ends of the plates are at the top.

[From the "Journal of the Society of Arts."]

The Storage of Electricity.

By SYLVANUS P. THOMPSON, B.A., D.Sc., Professor of Experimental Physics in University College, Bristol.

[Continued from page 31.]

APPLICATION OF PLANTÈ'S ACCUMULATORS TO ELECTRIC LIGHTING BY INCANDESCENCE.

Faure's cells have already done good work in providing an efficient means of working incandescent lamps, such as those of Swan and Maxim, for domestic purposes. I have the pleasure of showing you to-night the result of passing through two chandeliers of Edison's little incandescent lamps the current generated by forty of Faure's accumulators. Here are also some of the incandescent lamps of Swan and of Maxim, lit up by the same means. I have to thank the representatives of the various companies for the courtesy that has put at my disposal these means of illustrating my discourse.

Careful and precise measurements have been made by Sir William Thomson and Mr. J. T. Bottomley, using from 29 to 30 Faure cells as a source of current to illuminate 24 of Swans lamps. These measurements have shown that the efficiency is very considerable, and that where from 35 to 50 such cells are available, the light produced by one lamp may range from 300 to 400 candles per horse power, the latter being measured as actually consumed in the lamp.

Swan Lamps, No. 1.

Number of cells.	Volts.	Watts.	Volts × watts = total energy in kilogrammetres.	Horse power.	Candles.	Candles per horse power.
1	2·6	55·9	1·21	6·88	·093	11·6	125
2	5·2	65·5	1·46	9·56	·129	25	194
3	7·7	67·2	1·46	11·51	·156	42	269
4	10·3	71·8	1·74	12·48	·170	58	341
5	12·9	74·1	1·81	13·42	·181	81	450
6	15·5	76·1	1·82	13·86	·187	55	294
7	18·0	78·6	1·89	14·83	·200	63	315
8	20·7	80·3	2·06	16·54	·223	95	426
9	23·2	81·3	2·06	16·88	·228	76	333
10	25·9	81·6	2·06	17·45	·235	87	340
11	28·4	82·0	2·06	18·27	·247	102	412
12	31·0	82·9	2·17	19·72	·267	120	450
13	33·5	82·9	2·13	19·72	·266	80	300
14	36·1	83·2	2·27	21·91	·296	114	385

Carbon of lamp broke with small power, immediately after the measurement of the light was completed.

The foregoing statistics of one series of experiments are taken from the paper read by Sir William Thomson at the meeting of the British Association at York, September, 1881. From these experiments it appears that a high degree of economy in lighting by incandescent lamps is really attained. Should the accumulator be further improved, to reduce the percentage of waste between charging and discharging, accumulators will play a very important part in future installations, provided they can be constructed at a prime cost, lower than the present figures.

At the Paris Exhibition of Electricity, Faure's batteries have been doing excellent work. The following details of the separate installations will give an idea as to how many cells are required for a given number of Swan's lamps:

	Swan Lights.	Faure Cells.
Vestibule	23	
Kitchen	4	56
Bathroom	1	
Telephone room (No. 7)	17	29
Telephone room (No. 8)	18	30
Hall of the Compagnie Le Forez and Le Lumières	24	56

THEORETICAL APPLICATIONS OF ACCUMULATORS.

In an article on electrical storage, which appeared in *Nature* on June 2, 1881, I pointed out the usefulness of accumulators, in the following words:

"The uses for such secondary batteries may be of three kinds:—1. They may serve as portable supplies of electricity to be left and called for to exchange when *charged*. 2. They may serve to accumulate supplies of electricity from dynamo-electric machines, and store them until required for furnishing electric light or motive power on a small scale. 3. They may serve as equalizers of electric currents in a system in which the supply is liable to fluctuations. Suppose, for example, a dynamo-electric machine is employed to produce electric light. Any least thing which alters the speed of the machine, even for an instant, makes the light flicker and change in intensity; while the breakage of the engine-strap would at once cause total darkness. But if a secondary battery of suitable dimensions and power were inserted across the circuit between the dynamo machine and the lamp, the inequalities of the current would be greatly modified. When the light was not in use the battery would store up the current. If the engine failed the battery would at once put forth its power. It is probably in this direction that the secondary battery will find its unimportant field of useful-ness."

Of the first and second of these purposes you have an illustration to night. The modified Plantè cell and these Faure cells having been brought to this room charged, for the purpose of showing you their powers. The third possible use has been also emphasized by Sir William Thomson, who, at the Bath-usher meeting of the British Association, gave details of a science of automatic adjustments to make and break the circuit between the dynamo machine and the secondary battery, so as to guard the former from damage and the latter from waste.

As to portability, for such purposes as domestic lighting, the cost and risk of carting the heavy cells to and fro is probably prohibitory. For special purposes, such as those of gelenco-cautery already mentioned, the Plantè accumulator is certainly superior to the Faure, since it is lighter, and at the same time gives up its charge more rapidly, though in storage power for cells of equal bulk is less than that of the Faure.

MAXIMUM TEMPERATURE ATTAINABLE BY A CELL.

In connection with the subject of obtaining a high temperature by means of a cell, it may not be out of place to point out that the very high electromotive force of three accumulators (about 2·2 volts), exceeding that of my single cell of any other kind, carries with it the possibility of obtaining with such a cell a lower electromotive force. This discovery is due to Lovera, of Copenhagen, who, in a remarkable paper published (in "Wiedemann's Annalen") in August last, upon the relation between the conducting power of metals for heat and for electricity, has shown that the highest possible temperature to which a cell can raise any part of its circuit is proportional to its electromotive force. The highest point to which a Daniell's cell, however large, can raise a platinum wire according to Lovera is 3,237° above the zero of the Centigrade scale. The limited temperature for a Plantè or a Faure cell is 6,927°.

APPLICATION TO BLASTING AND TORPEDO FIRING.

The great calorific power of these accumulators, due as much to their small internal resistance as to their high electromotive force, is doubtless of great importance in the application to the firing of blasts and mines in great numbers. The old galvanic batteries now used might economically be replaced by one or two storage cells provided with a charging battery of half a dozen Daniell's cells, whose slight internal resistance would be thus accumulated.

APPLICATION TO PERFECTION OF THE TELEPHONE.

Another application of the secondary battery which has occurred to me, and which, on a small scale, I have tried with success, is in connection with telephonic transmitters. The problem is still room for improvement in the telephone; at the best, the speech it transmits is neither so loud, nor so distinct, nor so free from extraneous sounds, as might be desired. The fault lies almost wholly with the transmitters. They will not transmit loud sounds distinctly. The strength of the currents generated by the Bell telephone, used as a transmitter, is limited by conditions which are wholly inherent in it. Hence the possible strength of the currents transmitted from those which fall into the mouthpiece of a "microphone" or "carbon transmitter." My remarks must be understood as applying to the latter kind of instrument. If you put a very strong current on to a microphone, so as to make it, as you think, speak more loudly, the end is not attained. The points of contact are worn, there is a wildering and wheezing heard at the receiving end, and the speech degenerates into confusion. There is, then, a practical limit to which the strength of the current flowing through a microphonic current can be carried. Some of the transmitters in use employ three or four pairs of contacts, the current being carried through these either in series or in parallel. In the first of these two cases the resistance is only pushed beyond a certain limit, one only of the contacts usually does work by one stage. In the latter case, one only of the contacts is least. I the real work of transmitting—namely, that whose resistance is least. I propose to increase the power of a transmitter by employing a multiple microphone, so arranged that a fairly strong current shall pass through each point of contact, and that the current through each contact shall be independent of that through the rest. I therefore arrange all the individual microphones in parallel arc, in the line circuit, but provide each with its own battery. A hundred microphones thus united, and simultaneously acted upon by the voice, will each add its own quantum to the total effect in the circuit, and the result will be loud and distinct speech. But a hun-

American Gas Light Journal.
Feb. 2, 1882.

Electricity as a Motive Power.

An interesting lecture has been given by Mr. W. Leahine, C.E., on the "Secondary Battery." Successful results, he promised, had been obtained in lighting a train experimentally with electricity on the Brighton line. Referring to the electric railway at Berlin, and the electric tram car in the Place de la Concorde, he stated that tram cars could be propelled by electricity in accumulators at one-third less cost per diem than horse power, irrespective of the capital sunk in the purchase of horses at £40 each. He had worked a sewing machine from an electric accumulator, and he saw no reason why trains should not be run by the same force on the Underground Railway without any locomotive whatever. Mr. Appleyard, fully indorsing the remarks of the lecturer, expressed his opinion that the forthcoming electric exhibition at the Crystal Palace will far excel that held in Paris. Thanks were given to the lecturer for his very able paper. In response he said that cells had already been prepared to prevent gyration in balloons.—*Times.*

The Storage of Electricity.

By Silvanus P. Thompson, B.A., D.Sc., Professor of Experimental Physics in University College, Bristol.

Introductory.

Science has of late made two advances, the ultimate importance of which it would be difficult to overestimate. Not many months before he was seized with the mortal illness which robbed us too soon of his rare and unique genius, Prof. Clerk Maxwell was asked by a distinguished living man of science what was the greatest scientific discovery of the last twenty-five years. His reply was: "That the Gramme machine is reversible." His far-reaching and philosophic mind had perceived that in this phenomenon, which to so many had seemed little more than a curious scientific experiment, lay the principle which, if rightly developed, would render possible the electric transmission of power, and, in the solution of this practical problem, bring about social and economic changes, the importance of which but few of us have even yet begun to realize.

If we could to-night summon up the noble spirit of the philosopher and ask him to tell us what recent scientific discovery came next in importance to this, I think we should receive the reply "that a voltaic battery is reversible." The reversibility in the action of the voltaic cell is the counterpart and complement of the reversibility of the Gramme machine; for while the one has solved for us the problem of *the electric transmission of power*, the other has solved for us the problem of the *electric storage of energy*.

The storage of electricity in such a form that it shall be available for producing electric currents, and for the electric transmission of power, is a fact of so great importance, both in science and in commerce, that no apology is needed for bringing the subject before the Society of Arts. *But the ogre is needed for bringing the subject before the Society of Arts. But the electric storage of energy, which is the end attained, must not be mistaken for the storage of that subtle agent, electricity itself.* A century ago it was thought that the Leyden jar provided a means of bottling up electricity itself. In one sense this may be true, though the fact remains that the more carefully we hunt for the charge of electricity condensed in the jar, the more difficult does it become to realize that there is anything there; and *it is doubly difficult to find, in the electric accumulator or storage cell, anything which can be called stored electricity.* In electric accumulators, such as those of Planté and Faure, electric currents are made to do a certain kind of work, which store of work can again yield us current of electricity. But, as a matter of fact, the particular kind of work done is, as we shall see, quite as much chemical as electrical. Just as in Sir William Armstrong's hydraulic accumulators, water forced into a vessel with a great pressure furnishes a means of storing mechanical power under such conditions that when we let it down it can do work for us, so in the electric accumulator, by which we want to store electric currents, we use a chemical storage, and the chemical work so stored can itself, as it runs down, set up electric currents in our wires, and do electrical work for us.

Before dealing with the various systems of electric storage that have been suggested, I purpose to lay down two important general principles. They are as follows:

Firstly, that no kind of storage of energy, mechanical or electrical, is possible, except by doing work in overcoming some force which itself opposes the process.

Secondly, that the action in which work is thus done must be one that is reversible; that is to say, to which there is an equal and opposite reaction.

ELECTRICAL ACTION AND REACTION.

"To every action there is an equal and contrary reaction." In these words Newton laid down the great fundamental principle of mechanical science. Its application is not limited to such mechanical reactions as the recoil of a gun, the return of a bent spring, or the mutual attractions of the planets, but reaches down into other departments of science. To Newton himself we owe the simple experiment in which he proved the extension of the principle to magnetic forces. He found the magnet to be drawn toward a piece of iron with a force precisely equal to that with which it drew the iron to itself. It was left to Newton's great contemporary, Robert Boyle, to demonstrate that the same law held good also for the force of electric attractions; an electrified body drawing a non-electrified one toward itself and being itself attracted with an equal and oppositely directed force.

But Newton himself showed that there existed another and deeper meaning to the law of action and reaction, when he laid down the famous comment* which, though forgotten until unearthed by Sir William Thomson, virtually anticipated the nineteenth century discovery of the conservation of energy. As understood in the light of modern dynamics, any "action"

* ("Postles on Nat. Phil.," Chap., II., Art. 20):—"Work done on any system of bodies has its equivalent in work done against friction, molecular forces, or gravity, if there be no acceleration; but if there be acceleration, part of the work is expended in overcoming the resistance to acceleration, and the kinetic energy developed is equivalent to the work so spent."

is which energy is spent and work done is found to have its corresponding "reaction" in the possibility of the energy thus stored being at some later time set free. That particular "action" of an agent to which Newton told us there was still an equal "reaction," when the action was measured by the product of its momentum into its velocity, was in fact nothing other than its *capacity for doing work*.

If you lift a pound of iron to a certain height against the pull of gravitation, the action implies the expenditure of a certain amount of energy, the equivalent of the work done. Precisely an equal amount of work (saving a trifling proportion converted into unuseful work of another kind—namely, heat) can the mass of iron do in falling back again; for by its fall it may do the work of raising another pound to the same height.

In the science of electricity and in magnetism the same fundamental principal holds good. Suppose, for example, energy to be spent in the following action: Let a heavy weight descend over a pulley, and in its descent cause the dino of a Holtz's electric machine to rotate; the work done in this case is electric work, the energy being expended not in moving matter against gravitation or any similar force, but in moving electricity against those electric forces which are continually urging it to run down to the dead level of equal and uniform potential. But our supply of electricity thus furnished can itself be made to do work, because it can thus run down and give out in another form the energy expended on it. Only let it be led by wires into the terminal poles of another Holtz machine, and it will drive it round, and by driving it round may be made to lift a weight. The reaction here is the converse of the action, and would be equal but for inevitable waste by friction and dissipation of the electric charges.

Another instance of electric action and reaction is afforded by the reversibility of dynamo-electric machines, such as that of Gramme, as mentioned at the outset. The Gramme machine can be used either as a generator or as a motor. If driven by the power of a steam engine or a gas engine, or by wind power or water power or hand power—in short, by any mechanical means whatever—it generates powerful currents of electricity, which may be used for producing electric lights, or any other kind of work that an electric current can do; the currents of electricity being due to the rapid movements of coils of wire fixed upon a rotating armature across a field of magnetic force, excited by the currents themselves in the same machine. If, on the other hand, currents furnished by any suitable source are led by wires into the coils of a Gramme machine, those currents will drive it round, and will expend their energy in producing mechanical rotation, causing the machine to be used as a motor.

Here I may remark, in passing, that the reversibility of the Gramme machine affords a means of electric, or rather of electro-mechanical storage. Suppose we want to store electric currents. Set them to drive a Gramme machine, and let the Gramme machine, by means of a pully, gradually wind up a very heavy weight. If, subsequently, we let the weight descend, it will drive the Gramme machine, and will generate currents as it runs down.

ACTION AND REACTION IN VOLTAIC CELLS.

We now pass to the more immediately important case of the reversibility of the voltaic cell, as of its chemical and electrical actions.

In the ordinary voltaic cells, currents of electricity are produced as the expense of a certain consumption of zinc and of acid. These materials may be regarded as the fuels of electric currents, just as coke and coal are the fuels of steam power. Like those fuels, they represent a store of energy. Everybody knows that when two bodies attract one another (as for instance the earth attracting a stone), and we do work in separating them, they possess the power of rushing together again, and of doing work; and, therefore the power of rushing together again, and of doing work; and, therefore, when so separated, may be said to represent a store of potential energy.

This is equally true in the case where we do work against the atomic attractions known as chemical affinity. Zinc has a certain chemical affinity for oxygen. To separate an atom of zinc from one of oxygen requires that we should do work, and then they have the chance of energy to be expended. When thus separated they have the chance of doing work in resulting, this work generally appearing in the form of heat. When a piece of coal is burned—that is to say, is permitted to unite chemically with oxygen—it *is* a store of energy *come down*, and manifests itself in the form of heat. A piece of coal represents a store of energy. So does a portion of food. A piece of zinc, for zinc can burn directly and bag of hydrogen gas; so does a piece of zinc, for zinc can burn directly and give out heat, or may burn indirectly by being dissolved in sulphuric acid, also giving out heat. A Daniell's battery represents a store of energy. A pinch of gunpowder also represents a store of energy. The amounts differ, it is true; and the rate at which some of these stores can be made available for use also differs widely in the different cases.

An ounce of coal represents an amount of energy which, if entirely expended in doing work, would raise 600,000 pounds one foot high against the force of gravity, or would do 600,000 foot-pounds of work. An ounce of gunpowder is stored about 10,000 foot-pounds of energy. An ounce of zinc represents a store of only 132,000 foot-pounds. An ounce of copper

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ARTICLES.

THE TRANSMISSION OF POWER TO A DISTANCE.

ONE of the most valuable papers read at the recent meeting of the Institution of Mechanical Engineers, was that by M. Arthur Achard, of Geneva, on the various modes of transmitting power to a distance. The recent developments of dynamo-electric machines have, as will be remembered, drawn renewed attention to the subject, and the power wasted at such a place as Niagara Falls has been a favourite text for the lecturer. M. Achard has been studying the question for several years, and has now combined the results of his operations with an account of sundry practical experiments in a paper which, in the future, will be frequently referred to. The application of transmitting power have been the hydraulic, the compressed air, and the wire-rope, and each experience as has been gained in the former is not likely to recommend it to the attention of engineers. We do not, of course, refer to the use of a hydraulic power distributed over a factory or a railway goods yard, and for the use of a large waterfall as a source of power for the factories which may be established in its vicinity. M. Achard has already described (in a paper published in 1877) the application of hydraulic power to a number of factories at Schaffhausen, Fribourg, and Bellegarde. The water-power running to waste in Europe is sufficient to form a most feature looping for a little of it near his own factory, and as we have the photographs of the Mont Cenis tunnel turned all available falls to account when carrying out that gross and arduous undertaking. At Schaffhausen, however, where everything seemed favourable for permanently utilising and transmitting hydraulic power, the profits on the cutlay of capital has been very small indeed, in spite too, of suitable conditions, rapid extension of working, and careful management. At Fribourg and Bellegarde, where the conditions are not quite so suitable, the manufactories failed after a short and profitless existence, showing very clearly that cheap motive power is not in itself sufficient to create industries. Wire-ropes, for transmitting power to a distance, are simply a modification of the rope system, the only advance being the material of which the ropes are constructed. It is only on a par with the usual treatment of scientific subjects by French and foreign writers that the invention of wire-wire ropes for power transmission attributed to a resident of Ohio, although in reality no form or another, they were well known, but in this country and in America, practically before the alleged inventor had left school.

The principle on which this transmission of power is carried out are well known, being simply an extension of those on which ordinary hemp ropes are applied. The transmission of power by means of ropes requires that a shaft friction much greater than does transmission by toothed wheels; but ropes adapt themselves to conditions where gearing is out of the question, and by the use of large

pulleys, the friction is much reduced, the effect of the stiffness of the rope being also then comparatively insignificant. Where the distance is considerable, the transmission is divided into "relays" with a separate rope for each, and the relays are separated by "stations." Each station is provided with a horizontal shaft, and a double-grooved wheel, which is the driven pulley as regards the relay which terminates there, and the driving pulley as regards the succeeding relay. The power has to be distributed at intervals along the line, it is taken off at the stations, the rope there being adapted for the purpose. Sometimes a single rope is used, but where the power limit is placed at 500H., and the most length adopted in practice is about 4,921. The diameter of the pulleys generally employed ranges from 11, to 16ft., and with their shafts they weigh from 7½lb. to 11,233lb. in the case of single-grooved, and from 1,151lb. to 8,257lb. in the double-grooved pulleys. The slope of the grooves is a V rounded off at bottom and having a double-curve. The cases in which pieces of leather are secured to the grooves, which, in such a case, about three years, but wears out most rapidly on unsuitable pulleys which simply carry the rope and revolve at very rapid rates, the loss corresponding 4H. The speed of the ropes may, without inconvenience, be 1,000ft. per minute. At Schaffhausen, the ropes last on an average about a year, but it must be understood that the engineers do not wait for a rope to break before renewing it. Hence it is not unlikely that the life of a rope might be considerably greater, if, as soon as it commenced to fail, the work could be tolerated. Short life is a great fault in the transmitting power system by wire ropes, but they afford unquestionably a simple, and, for existing plant, often where other devices would be unsuitable or at a inexpensive. No little skill is needed to obtain the maximum amount of work and of durability, and though M. Achard gives formulæ, they require modification according to varying conditions which he specifies. When power has to be transmitted to the top of a very steep hill, instead of a relay station exactly at the top, it is better to have two intermediate pulleys, and to put the further away on the level. This at Bellegarde, where a height of 1126. has to be surmounted; this plan has been found best in transmitting the power of a couple of turbines. For the formulæ and details we must refer those interested to the paper itself, which will be published in the next issue of the Proceedings of the Institution of Mechanical Engineers.

Transmission of power by compressed air has, since the experiments made at the Alps during the long tunnels through the Alps became known, been a subject of discussion amongst engineers. Except for use in mines and for the purpose above mentioned it is not come into extensive use. Work of this kind, having been for inserting experiments, necessitates the use of air at high pressure, and hence results in much expansion; but the question of efficiency is for cases of the kind put in the background by the engineer, in consequence of the great advantages presented by the cheap power workings. It is, perhaps, not too much to say that the long tunnels through the Alps could not have been excavated at twice their cost, without the use of compressed air machines, which served a double purpose. As a means of transmitting power, however, the question of efficiency becomes of the first importance, and M. Achard says that the ultimate efficiency is the product of three partial efficiencies, (1) that of the air-compressing machine; (2) that of the pipes by which the air is conveyed, and (3) that of the machine which the air is to do the work. The essential condition required in an air-compressor is, that the temperature of the air during compression should be as far as possible constant; and, according to M. Achard, the most efficient method of accomplishing this is the one of the Col de Gothard machines was M. Colladon's suggestion, to inject a very fine spray of water into the pump-barrel, and thus bring it into intimate contact with the air to be acted. These machines, he says, had an efficiency of 78 to 82 per cent., but no subsequent tests appear to have been made. M. Achard has, however, made a number of facts bearing on the question, and his contribution will be read with attention. Just as water is used to cool the air during compression, so it is employed to heat it during expansion; and M. Achard describes Schaffhausen's compressed-air engines for tramways in the city of that name. The air-engine in this engine-tube on its way to the cylinder passes through a pipe double-grooves. This stove is heated by coke, and, after, at a small expenditure of fuel, is enabled to work expansively without serious loss from cooling. Referring to the transmission of power to a distance, M. Achard described the well-known Schmidt hydraulic engine, which resembles an oscillating steam-engine, and a turbine on Girard's system, in the setting of both these machines varies greatly with the surrounding conditions, and they scarcely afford a solution of the problem. Turning to the use of electricity as a motive power, M. Achard had little that was new to tell the Institution, and in the summary he stated that transmission of power by ropes furnishes the most economical result, and that where where wide distribution of the power is required, it is the only one to be preferred. As a kind of preface to a description of his system, M. Achard's Archimedean paper will be valuable; but at present there is no data, or at least not sufficient, to enable us to arrive at very definite conclusions. Electricians will naturally hail by electricity, and, so far as we can see, that promises to solve the problem in a very satisfactory manner; but the question belongs to the future, when competitive experiments may have elicited the attention of engineers on the lines which will lead to the greatest amount of success. Electricity has been applied to the transmission of power, and in a few cases has answered admirably; how far it can be economically employed in other cases there are no useful data available in forming the estimate. We know what has been done by Mr. W. Armstrong and by Dr. Siemens, and we look to a continuation in the unsettled country like the United States to supply us with useful information on the subject. In Switzerland water-power is extensively used, but, as we have already established, there is little likelihood that electricity will make experiments with dynamo-electric machines; hence it is only where waterfalls are available that the experiments we want are likely to be made, and only there when a demand for power is created. Manufacturers, as a rule, will not settle in districts where cheap power is the only attraction, and if the cheap power is only transmitted to their premises they will gladly do so. In the course of the discussion which followed the reading of the paper, Mr. Siemens was generally pledged, and some useful suggestions were made which mechanical engineers will keep in mind. Mr. Schönjander mentioned that his attention had been drawn to another means of transmitting power to a distance, by means of steam in properly perforated pipes—a method which is just now talked about in the United States, but which is scarcely within the compass of the question. What is wanted is a successful method of utilising waste power—that of waterfalls, of running rivers,

THE STORAGE OF ELECTRICITY.

At a recent meeting of the Newcastle-upon-Tyne Chemical Society, Mr. J. W. Swan read the following paper:—

"Before I commence," he said, "the term "voltaic accumulation" to him also. But more than this, we owe to Plante the rich results of a life devoted almost entirely to the subject of its connection with it the name by which he employs the phrase "voltaic accumulation" in a double sense—as meaning a thing stronger, and to signify cumulative effect. It is in this last sense that the term is generally used by M. Plante, and it is, or to which I shall confine myself. Now, M. Plante has chiefly directed his attention. One of his principal objects has been to construct a battery which should combine with high tension effects usually obtained from the fricational discharge of an insulating plate machine, the continuous and comparatively late electricity and of fricational electricity were so widely different. Voltaic electricity, he says, is essentially that of the perception of the law governing the phenomenon were never known, and which we employ in the Bell Telephone, and which, fed by naked wires, operated so quietly in causing the undulations of the diaphragm that the slightest articulation, could be the same whilst, bursting all bounds, rushed with the force of a thunderbolt.

When the platinum terminals of a voltaic battery come in contact for a few seconds, or even for a few minutes, the corrosive fumes spurned from them. If the same platinum be put in a pellet, and the same solution, be charged for a few minutes from the patently but powerfully working battery, and put into a glass cell, the platinum will be undissolved by the solution, a large electrical machine of the fricational type, you may hold the pellet in the hand for hours without feeling the electricity that would maintain a continuous stream of fire, and, if you touch the platinum with the tongue, you will not taste it. Moreover, the voltaic cells which decomposed the water in the voltameter so slowly, nor the charge so small, but the smallest measurable space of air; while the chemical effects of the fricational discharge are most violent, more terribly and fast its spark through several inches of air.

M. Plante has devoted the history of the voltaic battery. It was known that by connecting the zinc and the platinum with the terminals of a voltameter, by electricity, M. Achard had little that was new to tell the Institution, and in the summary he stated that transmission of power by ropes furnishes the most economical result, and that where where wide distribution of the power is required, it is the only one to be preferred. As a kind of preface to a description of his system, M. Achard's Archimedean paper will be valuable; but at present there is no data, or at least not sufficient, to enable us to arrive at very definite conclusions. Electricians will naturally hail by electricity, and, so far as we can see, that promises to solve the problem in a very satisfactory manner; but the question belongs to the future, when competitive experiments may have elicited the attention of engineers on the lines which will lead to the greatest amount of success. Electricity has been applied to the transmission of power, and in a few cases has answered admirably; how far it can be economically employed in other cases there are no useful data available in forming the estimate. We know what has been done by Mr. W. Armstrong and by Dr. Siemens, and we look to a continuation in the unsettled country like the United States to supply us with useful information on the subject. In Switzerland water-power is extensively used, but, as we have already established, there is little likelihood that electricity will make experiments with dynamo-electric machines; hence it is only where waterfalls are available that the experiments we want are likely to be made, and only there when a demand for power is created. Manufacturers, as a rule, will not settle in districts where cheap power is the only attraction, and if the cheap power is only transmitted to their premises they will gladly do so. In the course of the discussion which followed the reading of the paper, Mr. Siemens was generally pledged, and some useful suggestions were made which mechanical engineers will keep in mind. Mr. Schönjander mentioned that his attention had been drawn to another means of transmitting power to a distance, by means of steam in properly perforated pipes—a method which is just now talked about in the United States, but which is scarcely within the compass of the question. What is wanted is a successful method of utilising waste power—that of waterfalls, of running rivers,

PACIFIC AMERICAN SUPPLEMENT, No. 839.

The next day it is discharged and then recharged for two hours in the opposite direction, then again in the previous way, and so on. Each time it is recharged and discharged the quantity of electricity present is not found sensibly to increase, but the electromotive force of the battery is found to increase from 2 to 2.5 volts after a succession of actions little by little weaker, and have no longer the power to charge the electrolytic cell, and to discharge through the interior of the lead plates.

The secondary couple is then laid out for twenty-four hours, and at the end of that time is recharged in the opposite direction. It then gives upon discharge as far as this operation that day a fresh alteration in the direction of the primary current.

"Then the interval of rest is extended little by little to a fortnight, one month, two months, etc., and every time the discharge is found ingo on continually increasing. It has, in fact, in the course of nine months reached 1,000 hours. The positive plate, if it is thin, finishes by being almost entirely transformed into peroxide of lead, and is in a very delicate texture; and the negative plate becomes formed by a thick and compact layer of spongy metallic lead, covered with a layer of sulphate of lead.

"It is not always necessary to employ the electric evolution corresponding to the maximum of energy, as for as this operation transformation of the physical and chemical nature of the plates. Thus, one sometimes gains by discharging with a greater resistance and take more time to charge them.

"Sometimes the plates yield a current of sufficient duration for the purposes for which one wants them, it is no longer necessary to recharge them, and one can employ them as primary couples. Thus, for example, the electricity of lead peroxide and spongy lead when the positive plate would indicate a tension of several ounces. A definite direction is therefore adopted, in which the secondary couple is then more powerful, but this is not always charged."

"The plates obtainable—more especially in view of the fact that one can employ them for a time given on, of as to accumulator which will be available for a very long time, and last time to which practically no limit can be put—if possible, to avoid this tedious process of preparation, as briefly described by M. Plante. No doubt it answers the purpose quite well when industrial applications are not to be considered, but practical accumulators, such as must be used in connection with a central system of electric lighting, and which would possibly be required to be set at work at any hour, are very little suitable—more especially in view of the advantages and give to Plante's cells a greater capacity of storage, that I made the experiments that will be described in connection with the modification of Plante's cell, which I used in the Paris Exhibition.

"Here are some of the results obtained in action. The idea of this modification

MARCH 10, 1882.

THE STORAGE OF ENERGY.

LAST week, Prof. W. E. Ayrton delivered a lecture at the London Institution on the "Storage of Energy," which he referred to the various appliances in use for that purpose, but especially to Faure's accumulator. Among the illustrations shown, the lecture-theatre was lighted, in the first instance, by a dynamo for raising heavy weights by means of electric energy which has been stored the previous day in Faure's accumulators, and conveyed to the lecture-room. The total quantity of energy was 50,000,000 foot-pounds—a small thing rather than a large one—as a matter of fact, a small thing indeed, as it refers to matters well understood, and to be compared with the results to which Prof. Ayrton has arrived in the theoretical construction of the Faure battery; and which, when having the plates near together, the latter have a large surface, in order to store much electric energy. And the way to give the plate a large surface, without making it inconveniently large, is to make it of a corrugated form, and to put the two groups half plates near together. Now, Plante made groups had plates that were flat, and were the mere sheets of ordinary lead in sheet acid, and sent a current from cast to the other. This produced, however, peroxide of lead on one plate, and liberated hydrogen at the other. After a while the cell would be exhausted, showing it to only be itself a current through an external circuit. The effect of this was to reduce the peroxide of the spongy lead and to oxidise the other plate, an action which was continued by again sending a current through the cell in the opposite direction to only to have the same action as at first was set. Hence currents were sent out in succession for longer and longer times, the cell being reversed between the sending of each, that is, after long or longer periods, until at length, after some months, when the cell "gave up the ghost," as the old electricians used to phrase it when received, a current is not strong enough to decompose the water, and a return current is produced when the cell discharges.

In 1880 M. Faure thought of the plan of putting a thick layer of red lead on one of the plates, a substance which can easily be reduced to spongy lead by a small charge of a current. Then, after being coated over with red-lead, was then wrapped in flannel, jacket, and the two plates were placed in alternate plan, and the whole rolled together so as to practically form two plates with very large surfaces very near together. To charge this battery the currents are sent somewhat in the same way that Plante's are, but the time is much shorter, and with the exception that the charge is only, and not months, are required in the former case. The battery, when available is reduced to a spongy condition which is gradually lost very slightly oxidised on the other side. It is reduced to the spongy condition on this side by sending a current in the direction of the first, and the last current is on one side. The cell is then ready for discharge, on the other side to an even more extensive action, and so on. Each time there is an extension of the spongy lead, the spongy lead becomes again slightly more oxidised than it was before, and so on until the cell is worn out. A small quantity of oxygen which travels back towards and forms a film of peroxide on the plate. Hence, How does a cell store electricity? No! emphatically no! When a cell is charged so much electricity passes out as passes in, so, when discharging it, just as much electricity passes in as passes out, so that a cell is not a reservoir of electricity, but absorbs energy. The pith then of Faure's discovery was, that instead of using a cell of lead on its inactive oxide, the presence of which layer of lead will oxidise, he reduced it to a fair layer, instead of repelling as much as from the spongy lead is electrically formed out of the oxide, and thus increased the rapidity of passage of electric waves of force.

The next point to consider is—let, the storing capacity of such accumulator; 2nd, its efficiency; 3rd, its durability. Let us take a cell as you have hereby refers to the point, Professor Perry and me to collect a large series of experiments on this subject.

Let us take a single example of the storing capacity. A certain cell, containing 25lb. of lead and red-lead, was charged and then discharged, discharge being eighteen hours—six hours in three successive days; and it was found that the total discharge represented an amount of electric energy equivalent to 1,140,000 foot-pounds of work; energy is the term now in use from-power for time—practice of an hour. 1,140,000 foot-pounds of work stored per pound weight of lead and red-lead. On the second day we made it give out energy more rapidly than on the first, and on the third more rapidly than on the second—of being done, of course, by diminishing the time the current is clients. During the last day we were discharging with a current of about 25 amperes. But in connection with the storing power there is a very curious phenomenon to which I think not much attention has been directed, and that is the loss of the storing power of a Faure's cell. When a cell has been charged and discharged, charged, and is left for a few hours by itself, it appears to have obtained a new charge. For example after the 18 hours' discharge just referred to, although there apparently was an electric energy in the battery cell, it was found that after a few hours' rest on the accumulator small given a current of over 50 amperes, and discharged it down, large flashes of fire. The phenomenon was wonderfully like the invigorating action of sleep. In our case, during our experiments with an extremely rapid and powerful discharge, we found that after several charges and discharges after the cell threw out the same as much energy as it did in the first discharge after charging. This recuperative power has doubtless explained many people who have possibly discharged Faure's cell very rapidly, into under-estimating its storing capacity. Not getting out, after a time, as much energy in the first discharge, they have hastily concluded that a considerable portion of the energy put in was lost. But in fact nothing was wrending there in the cell; the experiments were carried out carefully enough to allow it to come out. This recantilling power may be due to the rest after very short periods of rest, is of great importance when a large amount of energy is required for a short time, as, for example in starting a tramcar after such stoppages, which is common on the horse. Secondly, as regards efficiency. The efficiency of an electric accumulator—that it, the ratio of energy out, take it to the watt given in and discharge on the speed with which it is charged and discharged, or discharged. The latter, of course, is the more important. Thirdly, a certain amount of power will be wasted, or "lost" as the term is, whenever a current passes through a body, some heat is developed, and the greater the current the greater the heat, the latter, however, increasing much more rapidly than the current. Now, it is found that in a Faure's cell not a little energy is wasted in the form of heat, and the greater the current the more rapidly does the current waste by heated discharging. Secondly, it is also possible to find out how much of the energy put into the cell is wasted in heating the cell, and how much is stored up in the cell in chemical disintegration. In the experiments shown first, a certain fixed quantity was, experiments with a current of 17 amperes, the loss in charging and discharging combined, was found to be 40 per cent.; indeed, in some cases, for very slow discharges, we have found it not to exceed 10 per cent. Now, in the Faure's cells, some of the most valuable researches were conducted by Professor Fleeming Jenkin, and published members of Professor Perry and myself, we have found that a current of only 17 amperes can be obtained by discharging a single cell; since, of course, the internal resistance is low; indeed, I shall show you a current of 50 amperes, or about 25 amperes presently. In speaking of the number 17, I merely mean to say that with the current mentioned in the experiments on the efficiency above referred to were made.

We have said that a cell containing 25lb. of lead and red-lead stored 1,140,000 foot-pounds of work. Now, consider what this means. It represents all the energy required to be expended to pull a tramcar containing 40 passengers up a hill 1,000 feet high, supposing the car to weigh 2 tons, and allowing for the electrical arrangements. The electric-motor would have more than about 2000lb. to produce about two horse-power. We have therefore this wonderful combination of a cell which is a source of energy, and all the machinery necessary for over two tons of weight, and 40 passengers with it powered in the tramcar running at 1 or 2 miles an hour, and then after several periods of rest, is capable of recuperation

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remembered, was not so enthusiastic when addressing the British Association at York and it would be interesting to learn by what means it is proposed to get hold of the tidal energy. The dynamo-machine enables us to transform and transmit this energy, and the secondary battery enables us to store the current and utilise it as required in a steady flow of power; but by what means is the tidal energy to be grasped and compelled to turn the armature of the electrical machine. No doubt, as Prof. Thompson says, the accumulator of to-day may become as large as the gasometer of a city gas-works; but we are afraid he advances tremendously when he says that "many months will not elapse" before the fertile atmosphere of the underground railways is replaced by a pleasant and salubrious sanitarium in fragrant ozone!

THE PROBLEM OF THE SCREW PROPELLER.

THE problem of the screw-propeller is one of the few questions which have taxed the highest intellects without being solved, and though for forty years or so it has been a subject of discussion amongst mechanics and engineers, it is no nearer solution, apparently, than it was years ago. And yet the problem is very simple, and apparently so easy: it is nothing more than, What is the best form of propeller for a ship of given size, and with so much engine power? There are some other conditions—such as draught of water, construction of the ship's counter, and many other details—but the main question is easily elucidated. With forty years' experience we should be in a position to state clearly what sort of screw—whether quick or slow pitch—should give the best results in a vessel whose dimensions and engine-power are known; but the fact is, that there are not most intimately acquainted with the subject would be the first to acknowledge that they really know very little about it; they have little more than experience or rule of thumb to guide them, and though to their practice has been fairly successful they would be the last to say that—it was altogether so satisfactory as they could wish. Experiments innumerable have been carried out by the Government, but though so far as the particular ship has been concerned, the best available propeller has ultimately been adopted, no data have been laid down by which a shipbuilder could determine without fear of error, the best possible propeller he could use for a given vessel. In engineering circles, the man who claimed to have discovered the "secret" of the propeller was, and still is, looked upon with recently, however, the perpetual-motion inventor, and it may be that because so little attention has been paid to the views of the enthusiast, nothing, or next to nothing, has been done towards solving the problem. Of late years, however, thanks to severe competition, new lines have had a chance of being practically tried, and some of them builders are not disinclined to get out of the beaten tracks when they see the promise, at least, of improvement. One or two of these novel lines have contained from time to time brief notes of new ideas in screw propulsion, and, on occasion required, more lengthy descriptions; it is for this reason that we draw attention to the somewhat remarkable paper recently read by Mr. J. R. Rost

Cassier's Magazine

FAURE'S SECONDARY BATTERY.

THE following is the substance of a letter addressed to *The Times* over the signature "G. L. R. S." On Monday last, May 9, in Paris, a great battery, or *pile secondaire*, was charged with electricity which was sent from the ordinary Gramme battery in my presence. It may be more economically done, but I was anxious to see the operation. The receptacle consisted of fifty-four lead lattices, each about 12in. diameter and 16in. long, forming a cylindrical leaden vessel, and containing alternate sheets of metallic lead and minium (peroxide of lead) rolled into a spiral united with metallic lead, and the whole placed in a square wooden case. Without any other preparation but lead weighing some 5,000lbs. was packed by a lead weighing some 5,000lbs. was packed by a four wooden cover, through which the ends of the plates loosely protruded, and were followed down for convenience of transport. The lead or "electro" was then put into a bath of dilute sulphuric acid, mixed with the object of rendering it for extraneous matters, and connected to four cubical elements, for which Thomson, F.R.S., at the University of Glasgow, has lately got me to work through the journey from Paris to Dundee (distance increasing a few hours' delay at Calais. I arrived at Glasgow-street at 11 a.m. on Wednesday, after running the gauntlet of customs and police examinations, and was suspiciously looked at, and seemed to doubt my statement that my box only held "condensers for experiments in electricity." The information at the Glasgow terminus of the Midland Railway was also disliked and disobliging. But I was not to lose on the journey I noted the face of the battery charge and found it to have well maintained its full charge from London to Glasgow and Dundee, a number of hours, and finally, in about 72 hours from the time it was charged in Paris, I had the satisfaction of proceeding with William Thomson, M. Faure's care-calling of a "lecture" on the latest and purest battery in existence without that small spherical one cubic foot a power equivalent to nearly one million of foot-pounds! This wonderful box is now deposited in the laboratory of the Glasgow University, and I am told by the able director, and being submitted to a series of tests and measurements, which will be duly reported. But I must, myself, say that I was struck by the simplicity of the whole arrangement, and by the doubtless he himself will give to the public through the proper channels. But I must, myself, say that I was struck by the simplicity of the whole arrangement, and by the absence of any complicated apparatus. The cost of such transcendent importance that the cost per horse-power is certain as its stored force is practically almost infinite as its even bright light. But, whatever may be the practical results obtained, I have the satisfaction of recording that for the first time to my knowledge in the history of the universe has a box of electric energy accurately equivalent to a million of foot-pounds contained within less than a cubic foot of space, latent and potential, been transported from France or elsewhere to Great Britain.

ELECTRICAL ACCUMULATORS, OR SECONDARY BATTERIES.*

By Prof. Oliver J. Lodge, D.Sc.

THE distinction between a primary and a secondary battery lies in so subtle an important one when we are considering either as the producer of electricity, and we may have in our minds a cell with zinc, or, as I prefer, Zn (lambit, just as soon as we consider the working of theoretical reasons.

I shall use the term "element" in preference to "element," as being more general. I define an element, but may also be a compound, such as Zn, Cu, Fe, Ag, Hg, Pb, Sn, Sb, Bi, Au, Pt, Ir, Os, Rh, Ru, Pd, Ni, Co, Mn, Al, Mg, Ca, Sr, Ba, Li, K, Na, Si, B, Ti, Zr, Th, Ce, La, Di, Y, Er, Tb, Cl, Br, I, F, O, S, Se, Te, N, P, As, V, Nb, Ta, W, Mo, U, C, H, and probably others, but so is the group NO, or NO$_2$. A radical is any compound which plays the part of an element in forming combination with another group. Chemists have invented names for many of these radicles into electro-positive and electro-negative, or "basylous" and "chlorous," but these terms have been slow to recognise the full physical meaning of this distinction. They have also, on the other hand, been misused, that, lead, nitrate, and the like, and without entering into the disputed question whether such substances are fixed or variable, it is obviously best to use a definite compound, and when released to call it by its elementary name, whether as an acid, alkali or metal, as the case may be.

It is necessary, however, that radicles can exist temporarily in the free state, when they are said to be *nascent*. Thus when many liquids—as a speak of gases—undergo a number of such dissociated molecules, the molecules are supposed to pass from one to another as well as to the surface of the liquid, and being on the average pretty constant—like the air we breathe—they are equally distributed through the whole

* Condensed slightly from the *Electrician*.

liquid, and if some are left by means removed, more will at once be formed to take their place. Now, if we put any radicle such as NO_3 into a long dissociated—there is, no doubt, a constant tendency—but the average number dissociated at any moment is probably very small.

Now, if we put a metal, such as copper, into a solution which is charged with electricity—half of them with positive and half with negative—the negative ones will, if the metal nascent, a definite reaction—half of them with negative, called therefore electro-negative or chlorous. This is shown by Faraday that the charge possessed by the radicle is constant, though it may differ in sign; and the charge is carried by the latter, the atomic charge, and so on. The resistances of these charges are certain from the facts of electro-chemistry, and the electrical charge appears to be the essential condition for the existence of any radicle or of a free radicle. It further appears that when two opposite radicles combine their charges neutralise one another, and by proximity; and that before two radicles of the same kind can unite into a molecule their charges must be given up to some third body, or body which possesses such dissociated and oppositely charged molecules, remaining about in a *Sea-specific* condition, being decomposed by electrical means, and it is from such a sea that the radicles which have not yet combined to form molecules are not electrolytes, and will not conduct electricity. Electrolytes conduct electricity by a bodily transfer in opposite directions of the charged radicles; they obey Ohm's law of the fact, as a convection current, or rather perhaps of two seas, of dissociated molecules moving in the positive radicles the other of the negative. The resistance of the liquid depends upon the slow clearing away from the sea of radicles by a process chiefly analogous to diffusion, for it is chiefly only assisted or directed by electricity in the immediate—molecular—vicinity of the discharging electrodes.

What now these electrodes? They are conductors introduced into the liquid, with the property of depositing upon the charged radicles in their immediate neighbourhood uncharged, or else opposite, charges. Thus, suppose they are two plates at present connected with a battery, so that one plate is charged with positive and the other with negative electricity. The positive plate will oxygen-electro-positives are attracted by it; they deliver up their charges to it, and uniting into molecules, rise as gas. Their places are taken by others from the slightly more remote regions, and so on, a virtual procession of oxygen atoms continually taking place towards the positive plate, each carrying its charge with it. The same thing happens on the hydrogen side, only that twice as many hydrogen atoms start in the action, the charge of each being only half that of an oxygen atom.

This, then, appears to be the state of things in ordinary electro-chemical decomposition. Gaseous radicles dissipated on the surface of the electrode will combine with it, if in any way possible, instead of merely combining with each other and escaping free. Thus the hydrogen alloys itself as it were with the platinum; and the oxygen, if it finds any copper or other less noble metal on the surface of the electrode, combines with it, and with it, the ordinary chemical affinities being enhanced by the electrical attractions.

But now, instead of two apparently charged plates of the same material, let us immerse in the liquid two plates of zinc and a plate of copper, or any two metals of which have a different affinity for oxygen, and let us connect the copper plate and one of the zinc plates as they were to the positive plate, but apparently by a chemist, not an electrical, force. It may be possible ultimately to reduce chemical forces to electrical ones, or *vice versâ*; but at present it seems necessary to draw a distinction between the attraction for the oxygen in an iodure, only 1·5 volt, and that in a sulphate, which is more than a telescopic distance of the plate. The replenishment of the oxygen into this region is chiefly carried on by diffusion and fresh dissociation. The copper on the other side pulls the oxygen too, but as it is pulled on both sides it does not gain much motion; and very slow assimilation, however, is all that takes place. Hydrogen, on the other hand, appears, provided the plates are not homogeneous, to test the levelling of the negatively charged oxygen atoms, they are equally distributed through the whole liquid, and the charge of electricity to the copper as soon as they are connected by a wire.

The copper so connected, being now negatively charged, attracts the hydrogen atoms, and they are deposited upon it. Now this hydrogen is not ordinary hydrogen. We now therefore have the conditions for an accumulator—namely, the copper plate connected by one wire, and neutralising by their charges the hydrogen atoms on its surface, and the zinc, partially giving up negative electricity to it; the zinc plate connected by another wire, hydrogenising it to some extent, but soon giving up their positive charges to the hydrogen atoms which are present in the liquid. A constant current will therefore flow in flowing along the connecting wire, of negative electricity from the zinc to the copper, or positive from the copper to the zinc.

The electrodes are thus of the same metal, say zinc, but one or both lead, not connected with any battery, but with the two poles of a source of electrical condition—say one coated with hydrogen, the other with oxygen. Plainly the same process of action can go on. The oxygen atoms will be attracting the hydrogen like the copper, or like the zinc, and any charged plate connected with the pole of a battery; the hydrogenised plate will behave like the zinc, and the oxygenised like the copper. The current will flow in the wire from the oxidised plate to the hydrogen-coated one.

We have thus a battery which will maintain a current as long as the plates continue coated or oxidised, and the two gases; but the action of the current is to tend to destroy the coatings and restore the plates to a condition of equality. A battery may be made, then, either of two different metals, or of two plates of the same metal, where the other—the case we will not now further consider because it is not practical—the two metals are connected into the other or one more hydrogenised than the other, by the action of some chemical or other disturbance. Take, for instance, two plates of lead and immerse them in dilute sulphuric acid: but one be bright and metallic, the other rusted over with a coat of oxide of lead. As soon as electric connection is made between the two plates, a current of electricity continually flows along it from the rusted to the bright plate, the bright plate becoming gradually oxidised, and the other becoming gradually reduced. If the plate has been oxidised by exposure to hot air, or by ordinary chemical means, such a battery would be but a primary one; if the coat of oxide has been produced by passing through the cell an electric current from some independent source, then the battery is called a secondary one.

ELECTRICAL ACCUMULATORS OR SECONDARY BATTERIES.*

By Prof. OLIVER J. LODGE, D.Sc.

(Continued from page 37.)

I NOW proceed to the complete investigation of the most advantageous conditions when charging a set of similar secondary batteries with a steam dynamo driven at a constant speed.

Let P be the horse-power actually applied to the driving of the dynamo when it is in full action, at the given speed, as determined by a dynamometer.

Let P' be the power supplied to drive the dynamo at the same speed when it is not allowed to produce any current whatever; that is, the power required to overcome the friction and the resistance of the air, &c. So that $P-P'$ is the whole horse-power available for electrical purposes, and of this some will be expended in heating the armature and field magnet wires.

Let A be the resistance of the armature wire in ohms.

B the resistance of the wire on the field magnets.

R the resistance of the leading wires conveying the current to the cells.

r the resistance of each of the cells.

Let N be equal to the number of cells being charged, and n any fraction which expresses the maximum electromotive force in each cell opposing the charging current in it.

c the current flowing through each cell in parallel.

C the current flowing through the field magnet coil, and C' in the leading wires.

E the difference of potential between the terminals of the dynamo when it is in action charging the cells.

Of three quantities it is essential that E shall be greater than $n\,r$ if the cells are to be charged at all. If $n\,r$ is the greatest they absolutely can be, and if E is equal to $n\,r$, then no current will flow through the dynamo and no charging will be effected. If E is greater than $n\,r$ by a little, and as soon as a current is driven through the dynamo, the engine instead of the engine will begin to drive the engine away at a speed depending on E. If the tuning at the engine of the now driving engine will be in the same direction as when it was charging.

The following relations hold among the above quantities:—

$$E = n\,r + c + n\,R\,r. \qquad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$C = E/B. \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$2\,K\,(P-P') = E\,(c+C) + A\,(c+C)^2. \qquad \ldots\ldots (3)$$

$$2 = A\,n\,r + n\,r\,(c+C) + n\,R\,(c+C). \qquad \ldots\ldots (4)$$

The last being a statement that the energy of the motive force generated by the reversed electromotive force of the current flowing round the circuit, is equal to the work that a function is depends upon the construction of the machine, and especially upon how near that machine is to saturation. If it is saturated the function is a constant; if it is nowhere near saturation, the function is proportional. It can be determined by experiment and plotted.

Of all the above quantities,

P has a fixed value determined by the speed required, and unfortunately by cloud-and-sunspots;

n and r may also be taken as fixed and known quantities, for the size of the cell is a matter of convenience, and n is determined by it, while r is a function of the material used in the cells, and for Plasted or Faure cells is fixed.

B is easily altered, and can be made as small as convenient.

A and R are also easily measurable, and though not necessarily constant, may be considered fixed for a particular dynamo.

* From the *Engineer*.

The remaining four of the above quantities, viz., c, C, and E, are dependent variables, and are given in terms of the others by the preceding four equations.

The number of thermal units (water-grammes-degree-centigrade) produced every second is—

$$\text{At the bearings and in the air churned by the machine, } (P-P')\,J.$$

$$\text{in the armature } \frac{A}{J}\,(c+C)^2.$$

$$\text{in the field magnet } \frac{B}{J}\,C^2.$$

$$\text{in the cells } \frac{r}{J}\,N\,c^2.$$

$$\text{in the leading wire } \frac{R}{J}\,(c+C)^2.$$

The energy utilised as chemical work is $N\,n\,r\,c$.

What we want of course is to make this last term as great as possible in comparison with the preceding five terms. Now it gives without saying that the smaller P and R can be got the better. It also appears from the second and third of the above terms that it is good to have A small and B large. Now that about $N^2 \cdot 3$ appears as less easily in the leading wires than in the cells, and hence it must be advantageous to make R small. But then N combines two factors n and r, and the second of these appears second to two of the above less terms; hence, though it is good to have n as great as possible, it is quite a question how big r should be. We find, however, by a little consideration, that r ought to be large as compared with the other terms, that is to make the ratio of useful work to waste a maximum, we must have—

$$\frac{n}{r} = \left(r + \frac{n}{N}\right)$$

$$\frac{A+B}{(p\,(A+B)+2\,A\,B)\,r + B^2\,(A+R)} = \frac{1}{c^2}. \qquad (6)$$

or since R and n, in practice, small, compared with B, we may say that the best possible value of the ratio as nearly as approximately

$$\frac{n}{r} = \frac{B}{c}\sqrt{\left(\frac{A}{r}+\frac{1}{N}\right)} \qquad \ldots\ldots (7)$$

We perceive, therefore, that the best value of n depends upon c. If the current flowing through each cell is very weak, a large number may be advantageously used; but if the current is a great one, then the probable value of r, depends entirely upon c, and n is small, for it is the "tension" or work per unit of current, that is wanted, of current—that is the current per unit surface of the electrodes—which has to be overcome. In a very small current an accident, not only because it is small, but because it is small, more important still, slowly and steadily acting, and so we may give up secondary action; but to overcome a large current of many ampères through the cells there must be, due to secondary actions, and an electromotive force of five ampères would still be very inefficient.

I will therefore suppose that the actual value of r is determined by practical considerations, and is measured by a galvanometer deflection, (p) fixes the best value of n in terms of $n = \text{unity}$, and the value of n'. The equation (6) shows that the best value of c is the maximum permissible value for the current through each cell.

$$\text{Let } c = (1-\alpha)\,A. \qquad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

But if it is a suitable value, only will the charging be very slow, but, unless the engine is absolutely steady, the value of the rate of the cells becomes helpful to drive it. It need not be so very far short of this upper limit before the current instead of through the same strength only will not be usually great enough to reduce n to n', the minimum value h, new B much below B, and so we may put pretty nearly

$$n' = \frac{E}{r} = A\,n\,r.$$

Or, putting in the last value of c from (8) we get

$$n = \frac{A\,B^2\,(A+R)}{r\,c\,(A+B)+B^2+r\,(A+B)^2}. \qquad (9)$$

The current through the field magnet which enters into this expression is not an arbitrary constant, even at a given speed, since it depends upon how much current is lagged off through the external circuit—that is, upon n'. Nevertheless, the above equation has a properly high resistance, it will be found that c is very nearly independent of n', unless that latter is enormous. And as we have supposed and that n' is nearly very great, we may regard the value of c as the given speed as nearly constant, and may measure it with a galvanometer.

Practically, the value of n would be determined by adding to the series of cells until the current it brought down to the desired small value, taking care that the limit E is not nearly approached, for fear that a disconnection in the speed of the engine might cause it to fall below $n\,r$.

Observe that the greater n is the greater n may be, so as to maintain the most economical ratio (6).

FOURNIER'S ELECTRIC BATTERY.

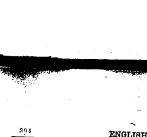
AN alcohol battery possessing some novel features has been recently patented in this country by M. Gen. Fournier, of Paris. The principal novelty is the use of a paste, of consistency of thick cream and glycerine, which is moulded into any suitable form for use as a battery-plate, either in primary or secondary batteries. The patentee claims that he can use either metallic oxides capable of forming, with glycerine a solid compound insoluble in water, or forming the plates, the lead oxide and glycerine are mixed in such proportions as to form a thick paste, sufficiently fluid to be run into moulds. In about twenty-four hours after being thus "cast," the mixture sets into a solid mass which is insoluble in water. This compound is exceedingly conductive, so much so that when immersed in dilute sulphuric acid together with a circuit with metallic zinc, it becomes positive to the metallic state as fast as the zinc is dissolved. It is, therefore, says the patentee, eminently suited for use in galvanic batteries, as it will prevent the electric polarisation, and it will thus either entirely replace carbon or be applied in layers upon carbon, and, as a depolarising agent, it enables one to obtain a simple and rapid battery.

As above mentioned, the compound becomes completely reduced, and, therefore, in the present example we have metallic lead as the product of the reduction, which, being in a complete state of division will be very readily metallised for use again as a depolarising agent, or even become peroxidised, and may then be employed with advantage in the construction of secondary batteries, which may be charged by the direct peroxidised of lead. Or the compound is a compound of lead oxide and glycerine which is not readily reducible, and which will lead to the metallic state.

The oxide of lead in the oxide best suited to form the compound with glycerine, but other matters still better, such as the various galvanic elements, such as the peroxides of lead, manganese, &c., may be employed, although not capable alone of forming solid with glycerine, are nevertheless susceptible of solidification when mixed with glycerine (as above mentioned) with lead oxide and glycerine, and form therewith a solid mass. The addition of peroxides confers greater depolarising properties, and the compound then contains, weight for weight, a higher proportion of oxygen; besides which the peroxides being better conductors of electricity than the oxides, the internal resistance of the battery is notably reduced and its power correspondingly increased. The degree of conductibility necessary to enable the portions of the mixture not already penetrated by the electricity promptly to be the passage of the electric current, and permits of the production of gas at only those points at which the mixture is in contact with the plate, is very suitable for use either in primary or secondary batteries.

Let us consider, first, the action of a primary battery, in which a plate composed of glycerine, lead oxide, and lead peroxide, supplemented as above mentioned, and plunged in a suitable solution of sulphuric acid contained in a cell, forms the negative plate or element, and a copper plate, for example, of suitable thickness forms the positive plate or element. When the circuit is closed, the sulphuric acid attacks the copper plate forming sulphate of copper, and disengaging hydrogen which passes to the plate composed of glycerine, lead oxide, and peroxide; that plate should soon be covered and penetrated more and more by the liquid set in contact with it, and it is capable of very readily oxidising it. The hydrogen which is disengaged at the surface of the plate will act with sufficient energy in reducing as the acid acts on the copper plate, and there results in the compound plate an oxygen to oxidise the hydrogen thereby disengaged.

A battery thus composed is, as to spark, or indefinite duration, as it may be readily reconstituted or reconverted into its primitive elements by the passage of an electric current. Suppose that the whole of the sulphuric acid has combined with the copper and formed sulphate of copper, and the hydrogen thereby disengaged has combined with the oxide of the oxygen of the compound plate of lead oxide, lead peroxide, and glycerine, there will remain



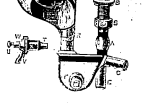


Fig. 327 illustrates the basin properly fitted

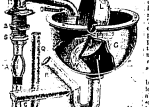
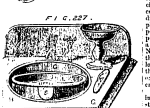


Fig. 328 illustrates the basin properly fitted



In the battery only the plate of copper partially attacked, sulphate of copper, and the plate of reduced lead. If new an electric current be passed through the battery in the proper way, the sulphate of copper will be decomposed, copper will be deposited on the copper plate, the oxygen of the decomposed sulphate of copper will combine with the reduced lead plate and recalcitrate it, the sulphuric acid will be set free again, and the battery will then be reconstituted and ready for further action.

In the case of secondary batteries the compound plate of oxide, peroxide, and glycerine is immersed in a dilute sulphuric acid solution, in presence either of a sheet of lead, or, better still, a plate composed of lead oxide, metallic lead, peroxide, and glycerine. A current passed through this battery under proper conditions will decompose the water, the oxygen combining with the plate oxide, peroxide, and glycerine, completely peroxidising it, the hydrogen passing to the other plate. Thus we have the elements of a Plantè accumulator, with the difference that the substances employed are in a condition more favourable for oxidation and reduction than steel lead.

ON THE ACTION OF THE MICROPHONE.*

By Prof. JAMES BLYTH, M.A., F.R.S.E.

IN the microphone transmitter, as usually employed in circuit with a battery and a bell telephone, we have essentially two pieces of carbon resting lightly against each other through which the current passes. That the instrument may work with sufficient delicacy it is necessary that the pieces of carbon should be in contact of small sufficient to ensure for the current to pass between them, and, further, that the pieces may not press together so tightly as to prevent any motion of the one sufficiently by the other. The action of light is specifically well described by the term "loose-contact." Now, in order to study the action of this, I endeavoured the action of the microphone, that is the conditions of steadily due to the conditions and arrangements of the parts, I endeavoured to make the action that depends on it loose-contact, and, secondly, the effect produced by tremors set up in the instrument, or wooden supports and connections together, by its sound waves which strike against it and are thereby propagated.

For distinction we may call the first of these the "loose-contact" and the second the "tremor" effect. In experiments I have endeavoured to arrange the instrument so as to isolate these effects, and, so far as possible, examine each of them separately. To isolate the air effect it is obviously necessary either to fix the carbon rigidly in their supports so as to avoid any motion of the one relatively to the other, or to immerse the instrument when these last case in the water that carries it to loose-contact, and, secondly, the effect produced by tremors set up in the instrument, or wooden supports and connections together, by its sound waves which strike against it and are thereby propagated.

For distinction we may call the first of these the "loose-contact" and the second the "tremor" effect. In experiments I have endeavoured to arrange the instrument so as to isolate these effects, and, so far as possible, examine each of them separately. To isolate the air effect it is obviously necessary either to fix the carbon rigidly in their supports so as to avoid any motion of the one relatively to the other, or to immerse the instrument when these last case in the water that carries it to loose-contact, and,

The following experiment illustrates how this may be done.

A, B, and C are three blocked brass finely fixed to a heavy wooden subplate. To the top of A is

soldered a piece of brass tube, B, about 2in. long and 3in. broad. To the top of B is soldered a piece of brass C, about 1in. long and 1in. broad, which is furnished, as marked by the dotted lines, M. A piece of carbonised, C, is fixed firmly into B and has a hole $\frac{1}{16}$in. in diameter drilled through its centre. A long piece of carbon, T, pointed at one end, passes tightly through the tube K and can be moved backwards and forwards by the screw A. A piece of carbon, C, is fixed firmly into B and has a hole $\frac{1}{16}$in. in diameter drilled through its centre. A long piece of carbon, T, pointed at one end, passes tightly through the tube K and can be moved backwards and forwards by the screw A. A piece of carbon, C, is fixed firmly into B and has a hole $\frac{1}{16}$in. in diameter drilled through its centre. A long piece of carbon, T, pointed at one end, passes tightly through the tube K and can be moved backwards and forwards by the screw A.

* A paper read before the Royal Society of Edinburgh.

ELECTRICAL ACCUMULATORS OR SECONDARY BATTERIES.*

By Prof. OLIVER J. LODGE, D.Sc.

(Continued from page 317.)

SO far we have investigated the amount of chemical action in a Faure cell, when a given current is passed through it; but though that is important it is by no means all that we want to know, for there is no reason that exactly will go on in every cell through which the same current is driven, and the chemical work done by a given current on one cell, therefore, mechanically measured, that, of course, the more cells we have in series, the greater the opposing power—or electromotive force—we shall need the current through them; and the electrical energy delivered, then by a given current generator is determined, therefore, by its available electromotive force and by the current's quantity. In this respect chemical work is very similar to the condition of every other form of work, for it is the product of two factors.

Chemical work, as a source of current, a dynamo-machine driven, is subject to Ohm's law (page 7). Of this by being ready to accumulate and drive the current energy magnets and armature, while the other is the resistance, which will cost both of it, and distribute it by power available at a current we have supposed to the air; neither portion is spent in doing the useful work, which is that of maintaining the current through the external circuit. The distinction is real if perhaps upon the power of the generator, and indeed the ratio of the two is called its efficiency. We may, perhaps, premise that a probable value for this ratio is as much as 7, but it is not likely to be more than 9 or 10.

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Consider, as we assume for the present, a constant electromotive force in volts between the terminals of the cell, and a constant resistance in ohms. Suppose, then, that the current is C amperes, which is the chemical equivalent of z grammes per second, multiplied by the number of volts, e, at the same time producing in the whole water-equivalent of w grammes per second, and distributing heat. We will, therefore, take p as a known quantity.

Now N Faure cells and storage them, or to produce such a current, so that they are equivalent to N cells each of a single one. Of these n will be in the condition of cells in work with no connecting wire, and $N - n$ will be in the condition of cells short-circuited if all the leading cables used happen to be taken into account if they are thick enough to be considered as sharing the resistance of the combination of cells in question.

* From the *Engineer*.

To drive a current C of z Amperes through the resistance would require an electromotive force of w volts, which we may call $w e z$, if we put e for the current passing through each of the n series of cells. But this electromotive force is not enough to maintain the current, for more than an infinite; for directly its cells begin to charge, they each exert an opposition force of e volts to the current. This opposition e may or may not vary during charging; but it probably does not vary much, except at the first hour, or so, and it may be measured by readings of the potentiometer between the terminals of a charged cell separately disconnected from the charging circuit. We shall, however, in taking this opposition, or its value will be $n e$, and if the cell is short-circuited it falls off rapidly almost entirely because of the evanescence of the hydrogen plate with the lead. It is in consequence of this that in repeating this charging current, and this it is which we agree to call it volts. The whole set of cells will offer an opposition force $n e$ volts.

If the cells are not uniform we must determine the average e for the n cells, and e, but there is very possible reason for forcing out the cells from the unsatisfactory or uniform ones, and storing them in sets, and afterwards keeping them uniform by subjecting them to precisely similar treatment. It is in practice of maintaining the power of a working battery by occasionally adding an instalment of fresh cells to replace worn-out ones. In this case, unless it is carried on with regularity, a mixture of cells will be produced of very unequal and very different ages, and consequently of very different efficiencies.

Now, as we have only considered in the simplest possible manner the chemical action going on in a Plante or Faure cell, let us consider for a few details of the behaviour it is necessary to know to weigh the actions very closely. In this study we will be greatly assisted by an excellent memoir of Messrs. Gladstone and Tribe, which is to be found in the *Chemical Society Journal* for 1878, in the *Electrician*, 21 and 28 and 30, and doubtless also in other places. A letter of Messrs. A. R. Sims read to the *Society*, February 16th, is also of great interest.

As a preliminary, the reader is recommended to try a few experiments with two simple lead plates, immersed in a tumbler of a finger. Arrange them both behind, and determine them in ordinary dilute sulphuric acid in water. Then, without disturbing anything, pour them for some currently, arranged and which half them slowly and carefully, and a small addition of them to the solution, and note carefully without disarranging the others.

Now connect them with a single Grove cell, and you will see a few minutes bubbles of hydrogen rise from the cathode plate, and oxygen from the anode. Connect with the platinum is already coated with a white crust of $PbSO_4$. In addition to the current will be very much weaker, and no bubbles will be noticed, and presently all action must cease. The discharge current which can be obtained is very nearly weak, as well as for having powerful, or even helpful, to the current. Now the addition of a single Faure cell and connections and notice the direction of the needle, and the direction of the current through it may be kept as low as 5 or 6 milliamperes if it is not to be more than an hour or so. It is quite possible to make r almost wholly negligible compared with e. We shall then get out of the plates somewhat more than the amount of chemical action per second that we passed through, viz.—

$$N = n \frac{76 \rho}{e}$$

$$= 300 \rho \text{ say.}$$

The equations of last week, expressing the chemical total decomposition on both sides of a Faure cell when a given current is passed through it, may be used to express the decomposition produced in a whole set of cells when the proper connections and subject to the utilised home-power p for N hours, by using $\frac{p}{N}$ for the equation $p = 76 \text{ amp} \cdot \text{cm} \cdot \text{cm}$ and $\frac{p}{N}$ for p as before supposed, the number of cells does not signify, for the more cells are used, less will be seen how important this is, and how just the charge with a very low amount of current; hence the more cells charged at once the more economical the process will be. This is why it is usually found to be the most economical when as it usually exist to the highest number of cells simultaneously charged in series, as the current is not to exceed two-fifths of the maximum electromotive force available, expressed in volts. But it may be nearly as great as this with advantage. There seems to be no limit to the number of cells that may be joined up in multiple arc, and apparently the more the better, as the "load" on the armature of the dynamo must be of very low resistance, or they will get heated if as it very often is, they are worked out through such cells in small. Edison's and other armatures seem just the right resistance for some of these machines which are used for electroplating purposes. The wire on the field magnet is short and very large, so as to magnetise them strongly without expending of too strong a current, even though it is thrown with the highest available electromotive force.

The highest available electromotive force is the difference of potential between the terminals of the shunt dynamo when they are disconnected from the external circuit, so that the whole of the current is passing through the armature and round the field magnets. There must be some connection between the two, and this wire on the field magnets, and on the armature, and the number of coils which will give the most economical result, though it is not a question that is decisive to economy-case; but it can no doubt be worked out by a little trial, and I will try next week. Meanwhile let us put in a convenient practical form part of the result of the above activity, viz., that if the best arrangement is adopted in every way, so many being allowed, and the dynamo is driven by electrical motion produced, the total amount of any substance of "atomic weight" w and valency v that can be decomposed or liberated, as the case may be, by p horse-power utilised as current is any time t, is

$$\frac{746 p}{1000 \frac{w}{v}} \cdot t \text{ pounds per hour.}$$

which becomes for Faure cells, where v is 2 volts,

$$\frac{w}{3} \cdot t \text{ pounds per hour.}$$

For instance, 2·8 pounds of litharge can be reconstituted, or also reduced, per hour, by the horse-power supplied to this purpose and to nothing else. The theoretical results are 2·1 p reduced, and 0·7 p peroxidised; that is, 0·3 pounds of solution may be acted on after allowing for the most favourable circumstances. Then, if 5 horse power are utilised as current, 21 lbs. may be acted on per hour, or, say, a ton in 24 hours. To form 120 cells, each containing 2½ lbs. of moistened peroxide of lead, and 2½ lbs. in plates, means 1,440 lbs., which for $p = 5$ gives $T = 288$. But the cells so acted on, of course, will not be fully charged, they will take longer—say, at the very least 360 p hours.

ELECTRICAL ACCUMULATORS, OR SECONDARY BATTERIES.*

By Prof. OLIVER J. LODGE, D.Sc.

(Continued from page 318.)

THE subject of accumulators is very large, we shall find a strong current; we suppose that hydrogenated lead and as much oxygen is one another at first, though the hydrogen is in small, while the size does not. Double the current and you keep half gone already stored with to make the hydrogen of hydrogen adhere better, and even amalgamated it with mercury, but both of it by hydrogen lead, as long as the hydrogen lasts, it is scarcely inferior to a platinum or lead. A current thing, however, it is that even copper opposed to peroxide of lead will be found to convey almost much stronger than when hydrogen is not as strong as hydrogenated lead does. This, of course, is the foundation of Sutton's cell.

All these experiments show the high value of peroxide of lead as the electro-negative element of a cell. Peroxide of manganese is very good, but not quite so good as lead peroxide, which I am impressed by the fact that any of those oxides are not in this way, and it is necessary for them to be in good metallic contact with the electrode, so as to form its real surface.

We can further learn from the first three experiments that if peroxide is not formed on the + plate there is not a considerable evolution of oxygen gas; and then learn convinced that its formation is due to the action of the current.

The action is probably this: first SO_4 liberated against the + plate, some combines with the lead to form $PbSO_4$, but the whole is not thus consumed, for if it is liberated sufficiently fast, and the rest decomposes water, liberating oxygen, and forming free sulphuric acid. Of the oxygen atoms so liberated some combine with the lead to form peroxide, other molecules of oxygen; and perhaps all this oxygen acts. But another part of the SO_4 forms with $PbSO_4$ acts as $PbSO_4 + O + H_2O = PbO_2 + H_2SO_4$, making some more sulphuric acid and also peroxide of lead. Another portion of oxygen may very likely attack the sulphate of lead, and so peroxidise it.

All this is probably quite particular case on. Hydrogen is liberated on the − plate, and it reduces this peroxide. In such cases conducting contact with the lead plate, without first disappearing as $PbSO_4$, but still it is formed by direct solution; that the sulphate of lead itself gets ultimately, though slowly, peroxidised; and sulphate of lead in a non-conductor it can only be acted on by secondary action.

Another experiment of Gladstone and Tribe's is also very instructive. It shows the plates in plain water—or salt it, but as only oxygen gas is given off this is not upon them with twenty Grove's cells, and then surface has stood in the acid a short time before if you like—and then with but two Faures, but only charging, it will heat itself very slightly with $PbSO_4$; but this subsequently does not appear to be easily reduced by the hydrogen, and it is soon full of as a fatal white thing descending current.

Let us now see what is the action of a Faure cell. Suppose it to be fully charged and to have its terminals connected by a wire, so that a current may flow round the circuit. Then, of course, the + plate will be peroxide of lead, and the − plate will be spongy lead. Now, as we have already explained, the current will be very much weaker, and no bubbles will be noticed, and presently all action must cease. The discharge current which can be obtained is very nearly weak, as well as for having powerful, or even helpful, to the current. Now the addition of a single Faure cell and connections and notice the direction of the needle, and the direction of the current through it may be kept as low as 5 or 6 milliamperes if it is not to be more than an hour or so. It is quite possible to make r almost wholly negligible compared with e. We shall then get out of the plates somewhat more than the amount of chemical action per second that we passed through, viz.—

$$N = n \frac{76 \rho}{e}$$

$$= 300 \rho \text{ say.}$$

The equations of last week, expressing the chemical total decomposition on both sides of a Faure cell when a given current is passed through it, may be used to express the decomposition produced in a whole set of cells when the proper connections and subject to the utilised home-power p for N hours, by using $\frac{p}{N}$ for the equation $p = 76 \text{ amp} \cdot \text{cm} \cdot \text{cm}$ and $\frac{p}{N}$ for p as before supposed, the number of cells does not signify, for the more cells are used, less will be seen how important this is, and how just the charge with a very low amount of current; hence the more cells charged at once the more economical the process will be. This is why it is usually found to be the most economical when as it usually exist to the highest number of cells simultaneously charged in series, as the current is not to exceed two-fifths of the maximum electromotive force available, expressed in volts. But it may be nearly as great as this with advantage. There seems to be no limit to the number of cells that may be joined up in multiple arc, and apparently the more the better, as the "load" on the armature of the dynamo must be of very low resistance, or they will get heated if as it very often is, they are worked out through such cells in small. Edison's and other armatures seem just the right resistance for some of these machines which are used for electroplating purposes. The wire on the field magnet is short and very large, so as to magnetise them strongly without expending of too strong a current, even though it is thrown with the highest available electromotive force.

The highest available electromotive force is the difference of potential between the terminals of the shunt dynamo when they are disconnected from the external circuit, so that the whole of the current is passing through the armature and round the field magnets. There must be some connection between the two, and this wire on the field magnets, and on the armature, and the number of coils which will give the most economical result, though it is not a question that is decisive to economy-case; but it can no doubt be worked out by a little trial, and I will try next week. Meanwhile let us put in a convenient practical form part of the result of the above activity, viz., that if the best arrangement is adopted in every way, so many being allowed, and the dynamo is driven by electrical motion produced, the total amount of any substance of "atomic weight" w and valency v that can be decomposed or liberated, as the case may be, by p horse-power utilised as current is any time t, is

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For instance, 2·8 pounds of litharge can be reconstituted, or also reduced, per hour, by the horse-power supplied to this purpose and to nothing else. The theoretical results are 2·1 p reduced, and 0·7 p peroxidised; that is, 0·3 pounds of solution may be acted on after allowing for the most favourable circumstances. Then, if 5 horse power are utilised as current, 21 lbs. may be acted on per hour, or, say, a ton in 24 hours. To form 120 cells, each containing 2½ lbs. of moistened peroxide of lead, and 2½ lbs. in plates, means 1,440 lbs., which for $p = 5$ gives $T = 288$. But the cells so acted on, of course, will not be fully charged, they will take longer—say, at the very least 360 p hours.

IMPROVEMENTS IN SECONDARY BATTERIES.

THE accumulator, or storage-battery, is now recognised as forming an essential portion of many installations of the electric light, especially under conditions where there is a difficulty in keeping the prime mover constantly at work. It is obvious, therefore, that amongst the numerous applications for patents in connection with electric lighting, "improvements" of secondary batteries already form a large percentage. In one for which Mr. R. Kennedy, of Glasgow, obtained provisional protection a plate of clean lead is coated with a layer of lead fluoride or peroxide, and laid in a bath filled with dilute acid. A sheet of lead being suspended over it, current is sent through, and a deposit of close-grained, spongy lead is formed on the lower plate, which can then be cut up to suitable size, and covered with a coat of lead fluoride, obtained by mixing chloride of lime, lead monoxide, and subsequently mixing the product with glycerine. The plates of zinc and lead are then placed in a trough, and the preliminary bath are coated with a solution of lead fluoride in glycerine, lead chloride, and lead sulphate. Messrs. Elwell and Donaldhouse have obtained a patent which covers a number of separate points, viz., cells packed with lead shot, cells filled with hollow balls of lead, which latter are made by coating with lead soluble substance in the form of spheres, and subsequently dissolving out the core; cells filled with cinders, charcoal, coke, asbestos, &c., coated with metallic lead, lead deposited from a salt, such as lead acetate, by means of zinc, lead plates attached to compressed cakes of red lead. Other cakes may be made of lead, obtained by mixing red oxide of lead with litharge or Paris or cement, china clay, powdered glass, and zinc. Fine divided porous lead, obtained by filling a cell having two compartments divided by a porous wall with solution of lead acetate, and reducing the chloride as electrolytes two plates of lead are available, and as soon as the zinc is dissolved it is not replaced by metallic lead, dressing off the exhausted and replacing by undiluted water. In cases where the cells are started with metallic lead plates, oxygen or hydrogen are added to the liquid to assist in the formation of peroxide of lead. In this specification it is stated that porous lead may be obtained direct from lead ore by dissolving it in acid and precipitating the metal by zinc. Another plan has been patented on the Continent by Herr Bröthofer, of Leipzig. In this case a solution of pure red-lead plate of zinc is decomposed by the current, and a thin deposition of lead takes place on the steel star. As an anode this lead foil is employed, after having been previously prepared by folding it lengthways from top to bottom in order to increase its surface. The foil is dipped into an aqueous paste of pure litharge prepared with dilute sulphuric acid, and is coated with a thin layer of caoutchouc. The oxygen coming in contact with the lead foil forces on its surface an exceedingly thin layer of peroxide. By closing the circuit the previously-deposited lead is re-dissolved, and its original sulphate of zinc produced, while the peroxide reduces half a finely-divided lead out of the peroxide, but also a part of the lead plate. By a new regenerative current zinc is again deposited on the zinc plate, while the deposited peroxide is oxidised to peroxide. The peroxidised lead is in said, render the cell ready for use. Yet another invention, which, at least, has some points of novelty, is described in the specification of S. Cohen, of London. In this case the patentee applies to a sheet of lead a layer of mercuric sulphide (HgS) in the form of cinnabar or vermilion. The coated lead sheet is rent into the form of a box or of a spiral, and is used as the positive electrode of the battery. A second sheet is prepared in the same way for the negative electrode. Both sheets are perforated and placed in a cell of dilute sulphuric acid. As soon as the current enters hydrogen is liberated, which reduces the mercuric sulphide, causing a deposition of lead, and leaving a spongy surface of the lead. Immediately the effects of local action are manifested, lead nitrate disappears, thus the oxygen formed, without being destructive to the plate, consequence the water, and in this way local action is always concerned, and invokes backwards and forwards as the cells are charged and discharged, and peroxide of lead is thus formed, the precipitated sulphur uniting as a sublimate. Sulphide of mercury (HgS_2SO_4) may be used in place of mercuric sulphide. These are a few of many patents for secondary batteries, the value of which may be safely said to be an unknown quantity.

THE NEW ELECTRIC LAUNCH.

ALTHOUGH no sufficient particulars are yet available for estimating the actual working cost of the new electrical launch built by Messrs. Yarrow for the Electrical Power and Storage Company, there is much reason to believe that before long electrical launches will become very common on the Thames, if the company can carry their way in erecting the requisite plant for charging the accumulators at several spots on the upper reaches of the river. A steam launch has obvious drawbacks, which we need not specify, and if these who put boats at it in that can only expend upon getting a supply of coils when they require them, even a considerable extra expense in fitting for power will not prevent the rapid introduction of electrical launches. The new launch, which is now on its way to the Vienna Exhibition, is 101 ft. in length, and is driven by a Siemens motor, the spindle of the armature being coupled direct to the propeller shaft. The motor being of the Siemens pattern occupies little space, and is placed under the floor in the stern sheets, the accumulators being arranged across each side, under the seats, and extending from the engine to under the fore. The accumulators are fitted with four trunnions, two for going ahead, and two for astern; a couple of lines leading from each bracket by the side of the steersman enabling him to change the direction of the movement in a moment, while a cylindrical switch enables him to put on the speed energy of 10, 20, or 30 cells, as may be desired, or to stop altogether. The total weight of batteries, dynamo, &c., is about two tons, or very nearly the same as that of a steam launch, boiler, and coals; but the great advantage of using an electrical launch is seen in the fact that the work expended absorbs only a small portion of the power, whereas, in a steam launch of similar power, several attendants at least will be required. The propeller has three blades, 36 in. in diameter, and 42 in. pitch, which revolves at the high velocity of 1,000 revolutions per minute, without causing vibration, and without any noise, except that caused by the water acting on the water, and the peculiar hiss of the commutator and the brushes. On the occasion of her recent public trial the launch, with 21 persons on board, ran from Temple Pier to Hammersmith, with the tide, in 37 minutes, including a slight delay caused by a basket fouling the screw. The distance is not quite six miles, and a watercan can save a good many yards by steering on

RECENT IMPROVEMENTS IN VOLTAIC AND STORAGE BATTERIES.

THE recent development of electric lighting has apparently given an impulse to the production of improvements in, or modifications of, voltaic batteries, some of which are undoubtedly of value; but, for obvious reasons, the attention of inventors seems mainly directed to the construction of storage cells. If we may judge from the claims put forward by the patentees, Messrs. Hyde, of Cumbernauld, a battery recently described by him is better suited to working the electric light than the Bunsen or Grove, the complete but this space, is very economical, and at the same time of great power and permanency. In a carbon-zinc battery, composed of broken coke, graphitised charcoal or other varieties of carbon, either platinised or not, in the carbon cell, and small lumps of amalgamated zinc in the zinc cell, by which means the patentee is able to expose a larger amount of the surface of the chemicals to the chemical action of the fluids in which they are immersed, and give a larger amount of conducting power to the negative element. The zinc is prepared in a commercial form by pouring it, when in a molten condition, into water, and afterwards amalgamating it. As regards the liquids in which the zinc and carbon elements are immersed, the pat-nee has found that it is advisable to modify the ordinary practice, and has found that numerous experiments that some of the best known galvanic batteries, such as the Bunsen, Grove, Daniell and others, would answer the purpose, but convenient for the purpose of domestic lighting, because they were cheap, in case consumption of zinc, and also because there are objections to the use of the carbon cell of nitric acid, as it gives off offensive vapours. With the view of obviating these objections he has obtained very advantageous results by putting in the carbon cell hydrochloric acid, either pure or diluted, with about one-fifth of its volume of water; but its action must be strengthened by the addition of a small quantity, usually not more than from 2 to 10 per cent., of some powerful oxidising agent such as nitrous or nitric acid, sure, regulated by percentages of potash or other containing two or more atoms of oxygen.

In the zinc cell he uses sulphuric or hydrochloric acid diluted in the ordinary way, according to the strength of the zinc cell chemicals of the sulphates of iron, soda, potash, or magnesia, being preferred for the sake of economy, and also because they are not liable to evaporate.

Amongst recent improvements in storage or secondary batteries we make no contribution a novel feature the invention of Mr. D. D. Fitz-Gerald, of Brixton (No. 3481, 1881) in which carbon is employed in conjunction with lead or compounds of lead. The carbon is in the form of fragments, which should be in direct contact with each other at one or more points, whilst the interstices between the fragments are filled with lead in a state of division, or with an oxide of lead, such as red-lead or plumbic peroxide, or with an insoluble salt of lead, such as the sulphate. The carbon fragments may with advantage be in the first place impregnated or coated with lead by immersing them in a solution of a salt of lead that metal such as the acetate, and subsequently reducing the metal either by heating in a current of hydrogen gas, or by means of air or by electrolysis, and the impregnated fragments being in the latter case placed in a solution of a suitable electrolyte—preferably a solution of the acetate or nitrate of lead with which a plate of lead is used as anode. In the construction of a cell or couple with the carbon fragments the latter are divided into two portions, each of which is in contact with a plate of carbon, to which a suitable terminal is attached by the use of a binding-screw or by casting on to the carbon plate a lug or piece of lead in which a connecting or terminal wire is imbedded. The two portions of carbon fragments are prevented from coming into contact by the use of a diaphragm of felt, of unglazed earthenware, of Paris plaster, or other suitable material.

Mr. Fitz-Gerald prefers to employ boxes or vessels of wood rendered waterproof by immersion in melted paraffin, the interior portions being further coated with a waterproofing substance such as marine glue. These boxes, or containing vessels, have two of their dimensions very large in comparison with the other dimensions, so that when an oxide of the box is removed the remaining portion has the form of a square tray. A plate or strip of gas carbon of smaller dimensions than the bottom of the tray is laid flat upon the latter, and is made to project through the side of the tray sufficient to make a link a contact. A layer of carbon fragments of about thickness as nearly to half fill the tray is then laid upon the bottom, and lead in a state of division, such as as cells or leadskin, is laid on the metal is rubbed on to the carbon and shaken down into the interstices between the carbon fragments, and subjected to a pressure sufficient to bring the carbon fragments into good conductive contact with each other and with the carbon contact piece. A plate of porous earthenware, a sheet of felt or other suitable material to constitute a diaphragm, is then laid upon the compressed layer, the edges of the diaphragm being impervious to the tray. Or a layer of Paris plaster may be cast on the layer of carbon fragments, the plaster being used in combination with the felt, or otherwise. Upon the diaphragm is then placed a second layer of carbon fragments with the lead-oxide mixture filled with lead or a compound of that metal, exactly as in the previous case. The fluid of the box constituting a lid or cover to the tray is then fitted with sufficient space to be lying between the carbon fragments and conductive contact. To secure uniformity of action the carbon fragments may be employed, and for this purpose are introduced during the electrolysis a glass tube may be carried into the upper portion of the box or containing vessel. The electrolyte may be dilute sulphuric acid in the proportion of one of acid to ten or twelve of water.

Mr. J. W. Swan, of Newcastle, has also patented further improvements in secondary batteries, in which, after corrugating the plates, as described on p. 61, Vol. XXXIV., he exposes the plates to the combined action of a weak acid, and binds acid, and atmospheric air, which results in an oxidation of the surface of the plates. The plates thus treated are paired with other plates in the combined action of a weak acid, and peroxide of lead

ENGLISH MECHANIC AND WORLD OF SCIENCE:

TESTING BATTERIES OF LOW RESISTANCE.*

THE practical difficulties which are found to exist in carrying out the ordinary battery resistance tests, when these tests are applied to the measurement of batteries or accumulators of low resistance, and the inaccuracies attending the usual method, therefore, of overcoming these difficulties may prove useful. One fruitful source of error is no doubt imperfect connections from the terminals of the various cells not being properly cleaned or screwed up, whilst the resistance of the connecting wires themselves may introduce an error which cannot be neglected when the cells to be tested are in extraordinary small; for instance, the resistance of a single cell of an accumulator may be as low as ·001 ohm, that is about the resistance, of 12 inches of copper wire of No. 13 B.W.G. or 1·10th in. diameter. Supposing, however, that the proper precautions have been taken so as to avoid such errors as the foregoing, a considerable difficulty still remains to be overcome. It is pretty generally known by those who have had to make practical measurements that in order to take battery tests with anything like accuracy, it is necessary that one measurement be made with the battery connected to a resistance coil of exactly equivalent to the resistance of the battery itself; this is known as the "method of equivalent deflection," method we first connect the battery to a galvanometer of very low (and consequently negligible) resistance, and then having noted the deflection, we introduce into the circuit a resistance sufficient to reduce the deflection to that point which is obtained in the current if owing in the circuit has been halved; the value of the resistance or other resistance added in the circuit is the resistance of the battery. Instead of reducing the current to one-half absolutely, it is sufficient to introduce sufficient resistance in the circuit to produce a decided diminution in the deflection, and then from the two deflections so observed, and the resistance added in the circuit, the resistance of the battery can be determined by a simple formula.

Another well-known method is to charge a condenser from the battery, and then to note the discharge; a second discharge is then taken with the battery in circuit, and then the resistance of the battery is determined by a simple formula. Now, in once the two methods just mentioned are correct, it is very necessary that the values of the resistances be decided one. Fortunately, if the first definition of a Thomson's galvanometer, say, be 100 divisions, then the reduced deflection should not be less than 100 divisions, and preferably it should be as near to 100 divisions as possible. Assuming, however, that 150 divisions are obtained, this would mean that the battery is shunted by a resistance of two-thirds times the resistance of the battery. Now, supposing we tried to test a single cell of an accumulator having a resistance of ·001 ohm by this method, then, since the shunted cell should have a current flowing through the latter equal to

$$\frac{2 \text{ volts}}{\cdot 001 + \cdot 0015} = 800 \text{ amperes},$$

a current sufficient to fuse or at least seriously heat (and therefore change the resistance of) a resistance coil, even if the latter were massively constructed, and be only measured in the battery for a very short period of time.

In order to reduce the strength of the current flowing in the circuit, either the resistance in the latter must be increased or the electromotive force must be diminished. By the following simple ex-

* Dr. Hoorn, in the *Electrical Review*.

pedient we can effect the required result:—Take 11 cells, say, of the battery or accumulators to be tested, and divide them in two sets of 6 cells each, and 5 cells each, and then connect the two sets in series, but in such a way that the negative pole of one set is connected to the positive pole of the other set, then by connecting the ends of the two sets oppose one another, the electromotive forces of which correspondingly will be that of 11 cells less that of 5—or 11 cells. Then we have a battery with an electromotive of 11 cells, but with an electromotive force of 1 only. We make a test with such a battery or accumulator, which would have just forfeited, then the shunt which would have just forfeited, then the shunt would have a resistance of $\frac{11 \times \cdot 001}{11 - 5} = \cdot 0018$ ohms, and the current flowing through it would be

$$\frac{2 \text{ volts}}{\cdot 001 + \cdot 0018} = 454 \text{ amperes.}$$

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, FEBRUARY 16, 1883.

THE DANIELL CELL.

By JOHN T. SPRAGUE.

THIS is the only galvanic battery which gives us an approximately constant current, and has, therefore, many important uses. It is used, however, on account of its generally supposed; but is subject to variation from several causes. These causes call for and repay a careful study, because they illustrate many of the principles of electricity, as well as for their own practical importance.

A battery which would at all times, and under all variations of external work, generate a uniform electromotive force would be invaluable; most of the books indicate that the Daniell does this, and define its electromotive force as being volt. 1·079. Unfortunately, this force is by no means so definite. Let us first clearly understand what we require and mean.

Constant current. When the battery once set up a battery under certain circumstances, giving a certain current, then that current shall be steadily maintained till the materials of the battery are exhausted. This involves several considerations: current depends upon, 1st, the electromotive force; (1) the electromotive force; (2) the resistance of the circuit. Of course, the conditions assume that the external resistance remains unchanged; therefore the constancy, or fluctuation of current, may arise from variations in either the force generated, or in the internal resistance of the battery. As to this latter, there is an inevitable change, due to the formation of the products of decomposition of the cell—namely, that the conductivity is naturally diminished as the fluid in the cell accumulates; the same occurs when the cell is exhausted by absorption of some ingredient of the fluid, but the difference is less because the original fluid is weaker.

Duration is quite distinct from constancy; it depends entirely on the cell containing materials enough to continue working the required length of time; this is, therefore, a question mainly of size of cell, as related to the required work. This is now pretty easily comprehended by aid of my "chemic" unit of current hour, which, by the way, because it requires 1 chemical equivalent in grains of every agent taking part in the work for every 10 hours, and as 3·68 chemics = an ampère current, the calculation is simple for any required conditions. The essential re-action of the Daniell is the substitution of zinc for copper in the sulphate; therefore in any one hour there must be provided a supply of copper sulphate of 120 grains per chemic per 10 hours; or multiplying this by 3·68, we have 72 grains per hour per ampère of good crystallised sulphate, containing 25 per cent. of copper. On this point it should be understood that sulphate of copper is often very impure, iron and zinc replacing the copper, and therefore the salt should be examined.

Of course there will be a loss in heat action corresponding to the consumption of zinc and proportion to the cell does less electric work. Of course, also, it is useless to supply the salt in excess of the quantity of zinc available, and for prolonged working it is necessary to provide for removal of the water arising from the dissolved salt.

The electromotive force of the Daniell is subject to many causes of variation which have been usually slightly neglected. According to the chemical theory, it should correspond to the heat of combination or replacement of copper by zinc, which, according to the determination of Julius Thomsen, is 26,150 calories per gramme atom, agreeing also with the actual heat generated electrically, which he found to be 26,282 calories; three numbers being for the two equivalents, bring out the electromotive force as 1·1863 volt as the theoretical value, using the values formerly received. Dr. Wright, who has examined the subject, using other values, makes this equal to volt 1·185, and his experimental determinations of the force with solutions of acid of different strengths give values.

Sp. gravity of liquids	1·038	= volt 1·123
"	1·060	" 1·133
"	1·070	" 1·142
"	1·176	" 1·163

Sulphate of zinc at the zinc plate has advantages over acid because it does not set up appreciable heat action. I have endeavoured to measure its comparative force; but the various disturbing causes presently to be considered prevented my arriving at any certainty. I believe the force to be the same with sulphate of zinc half saturated and with acid of 1·038, which is one part acid to ten of water by measure.

The difficulty of getting exact measures is at the zinc plate. I find that cutting several strips of zinc from the same sheet, amalgamating them alike and at the same time, they will give forces varying as much as volt ·03. Besides this difficulty, the mere suction of the zinc plate in the liquid will produce a similar amount of fluctuation, though no appreciable effect results from moving the copper plate. This is probably due to the disturbance of the small bubbles of gas which form at all defective points of the plate, and protect it from further action; these being shifted, a fresh action takes place on the zinc, which lowers its available force for the time. Dr. Wright states "in 24 hours I found that but little difference was produced by using pure commercial, or by amalgamated, zinc, or zinc coated with a film of copper." This is entirely different from the received opinions, and very different from my own experiences. I find that amalgamated zinc has the higher force by about ·01, as compared with new sheet-zinc, and more as against corroded zinc, and that the E.M.F. of any zinc plate is always increased by cleaning off the resiliency impurities, and renewing the amalgamation.

The effect of copper deposit on the zinc is very marked, and may be easily tested; if the zinc plate be touched with a copper wire the force falls ·05. This is not, as sometimes said, an effect of *contact* lowering the potential; it is a direct chemical action; there was already a copper contact in the zinc conductor soldered to the zinc; in fact, merely touching with copper out of the liquid produces no effect; the copper must be under the liquid, so that it sets up a local action. I found that by adding a little copper sulphate to the zinc solution, so as to have always copper on the zinc plate, the force fell ·03, when the touching with a copper wire produced no effect. It is evident, therefore, that where a constant E.M.F. is desired, the zinc plate used should not be free from copper. But all loose deposits of copper should be removed at intervals.

Variation of temperature affects the E.M.F. Heat raises the force; it does so by affecting the solubilities of the two salts, and applying externally the energy absorbed in solution. I find that between 32° Fahr. and 52° there is a difference of volt ·01, and between 50° and 60° also ·01, and between 56° and 100° about ·023.

These experiments were carried out by means of cells consisting of U-tubes; the bends of which contained sand mixed with oxide of zinc, to prevent passage of the copper salt. I found these remained in perfect action for a week without a trace of copper passing; the tubes were mounted in stands with mercury cups, and the plates of metal had wires attached, so that they dropped into the cups as the plates were inserted in the tubes, and could be readily exchanged.

The galvanometer used was a reflector of 9,000 ohms resistance. The plan adopted was to oppose two cells and observe the deflection due to any difference in the forces. These deflections were valued by a simple, though only approximate process, which may prove useful to experimenters, as it places at their disposal any desired electromotive force. I connected a large Daniell cell with my resistance instrument of 1,000 ohms arranged in decimal sets. Now, by the law of distribution of potential, this gives a complete range of E.M.F., because any interval at any part of the circuit of, say, 1 ohm furnishes a force of volt ·001, provided we use it against a large resistance. Therefore, by including in the circuit of the experimental cells and galvanometer, different intervals of the resistance instrument, I could add just so much E.M.F. as was necessary to balance the condition which increased that of one of the cells, or value the actual deflections: in this experiment volt ·001 produced a deflection of 100 on the scale. Unfortunately, I had not the means of making the most difficult measurement of the actual force of the Daniell in any given condition, for which different experimenters give values ranging from ·9304 to 1·2, though the figure generally accepted is 1·079.

It is generally conceived that the Daniell is not subject to "polarisation"; that is to say that its E.M.F. is constant whatever the external resistance may be; this is not exactly the case; it is affected by the "density of current" derived from it. According to Dr. Wright, a surface of 12½ sq. centimeters (19·5 sq. inch) will maintain its E.M.F. up to a current of ampère ·001, and will lose 1 per cent. if called on to produce ·005, and 2 per cent. if called on to produce ·01. These figures are, however, entirely special, according to a particular construction. The cause at work is very clear; it is, that the current is exactly in proportion confined to the supply of copper salt presented to the cell, and that the solution is not strong enough to meet the demand, we have copper, not in copper salt, but in sulphuric acid, because the copper has been removed from the molecules adjoining the plate; thiscan only be corrected by the process of diffusion. His battery appears to have been arranged for the experiment in the very worst manner possible, with the copper plate at the top in a weak upper solution, shutting above a denser zinc solution. My object in these experiments was to discover the best arrangement to provide a constant and reliable electro-motive force, such as is needed for experimental purposes, and one which could be set aside ready for use at any time.

M. Gaiffe some time since devised a form for this purpose; it consists of a compound inner cell, the upper part of which is porous; this contains the copper and copper salt. The outer cell contains the zinc in form of a ring at the top of the cell, and a plate or wire of copper at the bottom connected to the ordinary copper pole: the idea is that as the copper salt passes through the porous cell it will sink by its greater gravity, and form a stratum at the bottom when circuit is closed, the resistance between the zinc and the external copper being less than that to the interior of the cell. This outer stratum of copper salt will be first reduced.

I have modified this by making the inner cell consist of a copper cylinder fitted with an upper part of porous earthenware cemented to it, and have also placed the zinc in the inner cylinder. This cell is useful for many purposes, but cannot be relied upon as a steady electromotive force,

MR. EDISON ON STORAGE BATTERIES.

SIMULTANEOUSLY with the publication of the specification of Mr. C. F. Brush, of Cleveland, Ohio, relating to his invention of "Secondary Batteries or Magazines of Electricity," American papers have arrived containing reports of an "interview" with Mr. Edison, in which that gentleman expressed his opinion about storage batteries. Mr. Brush's specification is a formidable affair, as may be judged from the fact that the Patent Office prints it at 2s. 6d. It is illustrated by twenty-one figures, and there are altogether fifty-six "claims," so that those ought to be a good many novel points about the latest invention which the correspondents of the daily papers have taken under their patronage. For the benefit of those who may wish to procure a copy of what must, in one sense, be a remarkable document, we may mention that the No. is 3163, July 1, 1882. To return for the moment, however, to Mr. Edison's opinion, if we may accept the report in a London paper, he did not mince matters, but declared the storage battery to be, in his opinion, a "catchpenny, a scientific humbug, a mechanism for swindling by stock companies." Such expressions do not emanate well from their alleged author, however true they may be, especially when we have further on that in 1879 Mr. Edison himself patented a storage battery and a method of using it in a system, after having rung all the changes on it. His plates were prepared like Plante's, which thought were "dodges to save," are better than some of recent invention. After his first disdainful of scornful criticism we gather from the report that Mr. Edison went into the matter in the usual scientific spirit, and whether he is correct in all his assertions or not, his views ought to be commended to the attention of those who are studying the question from the standpoint of investigators. "Scientifically, storage is all right, but, commercially, as a business, storage is a failure." The ordinary form is (Plante's battery) and he can store electricity, but, as he adds it, but it is gradually lost, and will all go in time." These words express exactly the opinion which have been put forward in this country and in the columns of this paper, but Mr. Edison goes on to explain why the storage battery is a failure commercially. The efficiency which is commonly stated at a very small below that of the current employed to charge the battery, begins to diminish after a certain number of charges, and by-and-by, the capacity also declines. Owing to corrosion of the sustaining plates, the effects of local action, and other causes, the yearly depreciation is, according to Mr. Edison, not less than 50 per cent. of the first cost if used daily, so that in four years, at the outside, a complete outfit of new accumulators will be needed wherever the system of electric energy is adopted for the purpose of lighting a building. In this way, we think, he safely assumes that the storage battery do deteriorate in power with age (whether used or not), but if the latter they are utilised or not); but if the rate of deterioration is anything like that stated by Mr. Edison, the cost of accumulators will be practically prohibitive in any commercial scheme of electric-lighting. A very simple plan is that with a plant of engines and storage batteries, the former could be used during the day to charge the latter, and then during the night both could be used to supply current to the lamps, which is quite feasible; but, then, remembering what has been said above, and the additional fact that the storage batteries will cost about twice as much as the plant which is to store them, it is not difficult to find where the economy can come in. As Mr. Edison puts it, an interpose between the source of the current and the lamps where it is to be used, a "thing in which there is a loss both in charging and discharging, and a loss in standing"—losses which exhibit an increasing ratio as the battery gets older. On pp. 495, 516, it will have been observed that others are aware of the commercial disadvantages of the accumulator; but it may be that in the future some one will discover a means of storing electric energy without waste, or with that minimum amount of waste which would not entirely discount the glorious advantage of the storage battery in the matter of convenience. The storage battery has its legitimate uses, but we suspect that where it is a question of the economical utilisation of energy it will have no place in the system. During the last four or five years, inventions of storage batteries have been almost pouring into the Patent Office, and we have given descriptions of many of the most promising in these columns; but a few months ago rumours began to circulate that Mr. Brush, the inventor of the well-known dynamo, had invented a secondary battery which was superior to anything else of the kind. We did not pay much attention to these rumours, only to procession of "corkscrew" deposits, but also to the arrangements of the elements, and to devices for automatically controlling the current employed in charging the batteries, and for measuring and recording the energy spent in the work. The process of forming the battery adopted by Mr. Brush is based on that of Plantè—that is, he employs lead plates; but he clearly explains wherein the defects of the earlier arrangements lie. The ordinary form of secondary battery lead plates are increased in dimensions subjected and, and when a current is passed through, a coating of peroxide of lead is formed on one of the plates, while the other coalesces the latter coating of the water. The exciting current being withdrawn, the two lead-plates are joined by the chemical work done, a cell, a current flowing between them, but in the opposite direction to the exciting current. The action of the exciting current becomes slower as the coating of the peroxide grows thicker; and if it is withdrawn when a certain coating is completed between the plates, it is found that local action takes place between the coating of peroxide and the metallic lead supporting it, and the former is gradually reduced to a lower oxidation until it becomes unable to yield a secondary current, unless recharged or reoxidised. That explains the loss of charge, and also the high resistance of the plates after long standing, for peroxide of lead loses conducting power with loss of oxygen. The charging must be reversed in order to revive both plates, and this the hydrogen plate may have a greater capacity equal to that of the oxygen plate. Use the combination of the hydrogen and oxygen, when the battery is discharging, forms pure water in the spongy coats of the plates, and that also increases the resistance. Further, the production of a coating of peroxide, and its reduction on discharge, causes the lead plates to unravel electrically a coarse and corrosive surface to the opposite plate, and the result is that in time the coating peels off in parts, while every time that the battery is worked soft plate of lead is formed, which exercises a deleterious influence. According to Mr. Brush, these disadvantages are avoided by the use of three plates, or two plates and a metallic cell. Two plates are so arranged that they receive a coating of peroxide, while the hydrogen plate is placed between them; or the two plates may be put into a lead vessel, and both receive a coating of peroxide, or coating with a layer of oxide of lead, mixed with caustic alkali, instead of the other salts of lead, which are stated to yield non-coherent deposits. Compressed, rolled, and perforated plates are well adapted to retain the coating, but they should be prepared by having the hollow part filled with peroxide of lead, and then compressing them, and then uncovering them horizontally in a bath of caustic soda or potash. When the depressions of one side are properly coated, the plate is reversed, and the other side treated in the same manner. Mr. Brush says that plates of other metals than lead may be used—such as gold or platinum, in which cases the peroxide cannot lose its oxygen by local action. Another method of coating the plates with porous metal is to reduce the lead from the oxide and other salts by a reducing gas at a temperature insufficient to cause fusion. Mr. Brush accomplishes that by placing the plates in a chamber in a horizontal position, charging them with lead oxide or nitrate, and passing through the chamber carbonic oxide mixed with nitrogen. The coating thus produced is said to possess properties differing from those of spongy lead, and from those of the electrical deposit of lead, having many of the advantages of the latter while being free from the disadvantages of the spongy lead. Plates may also be made of metallic lead and the oxide, pressed together into a compact and firmly coherent body, the value of oxide ramifying and extending through it, and forming channels for the passage of the electrical action. Other modifications of forming plates are described by Mr. Brush; but so far as we can see, the disadvantages of the storage battery still remain sufficiently numerous and serious to warrant much of the criticism to which it has been recently subjected by Mr. Edison.

SECONDARY BATTERIES AND THE ELECTRICAL STORAGE OF ENERGY.

THE first of a course of two Cantor lectures on the "Secondary Batteries and Accumulators of Electricity," by Prof. Oliver J. Lodge, M.A., F.R.S., was delivered on Monday evening last. The lecturer said that the subject of storing energy was very numerous, and might be divided into two classes—namely, those in which the energy was stored up by the raising of weights, as by the pumping of water into a reservoir; and that on a very different principle of storing energy for future use, as a force.

Another instance mentioned was by the rolling of springs, or producing strain in them, as in the winding-up of a watch. Any elastically strained body in winding-up watch. A third form of accumulating energy was by charging a Leyden jar. The action of the jar form of a Leyden jar was that it was a chemical action, but that was not the case. Chemical action than is a mere straining of the molecules of the glass vessel. If the glass be strained by pressing it, or by pulling it under the internal tension, producing a disruptive discharge and perforation of the glass vessel. There were the various chemical methods of storing energy. One chemical method was by the process of electrolysis, and other explosives which depended on heat because of that this use of the term chemical energy was somewhat unreasonable in the case of explosives, for in it were combined substances not in a state of equilibrium, which, by a disturbance, rearranged themselves when a light was applied to them. The results of the action of the explosive energy of chemical energy. By the application of heat was produced a material which could be used to do work. Then there was the case of gunpowder, the lead, and a peroxide, but these were not satisfactory for use as plates than either lead peroxide. Its peroxide was less soluble in dilute sulphuric acid than lead peroxide, and hence, when used in plates, gave the largest quantity of electro energy. The action of the cell was that when it was charged by the oxygen which was set free at one of the plates passed into the other plate, and by the act of expression the molecules between that it did; but Dr. Frankland, who was present, said that he had made careful experiments of a somewhat similar character, and considered that it did not. Whatever the explanation might be, the fact remained that the secondary battery was undoubtedly a valuable one. Dr. Frankland thought that it would be signalled by the positive and negative plates, and that the current would be signalled by the negative plate, and that the current would be signalled by the liquid, the lecturer was not able to say whether it was so or not. The cell was then charged with a current, and from which the current was taken, and it was found that the negative plate was signalled by the liquid with the current left. In other words, the cell was signalled by the liquid with the current left. In other words, the cell was signalled by the liquid with the current left. In other words, the cell

themselves. This was devised by Bessa and Sellon almost simultaneously, Sessa being actually the first in point of time. In its perfected battery known as the Faure-Sellon-Volckmar, the lead becomes a grid filled with an extremely composition, which is the peculiarity of the invention, and to obtain the whole process of manufacture, and to exhibit the specimens they now before them of the work in various stages. First of all, cast-iron moulds were procured, stored all over like a grid-iron with a network of straight channels. Two of these mixtures were put together, and the mixture of red lead and acid was put in the moulds, and when about of lead were cast as the result. These framed grids were then filled with compositions—litharge for the positive and sublead for the negative plate, the composition being made into a paste with diluted sulphuric acid, and run in. Though the plates were somewhat dusty, as might be seen, the composition adhered to the lead, and could only be removed by heating the plates hack. The next stage was to form cells. A large number of plates were put together in a trough, all the positives and negatives being kept by themselves, and each plate was separated from the next one by a frame of vulcanite. The dilute sulphuric acid was then poured in, and the cells were nearly all assembled. They gradually became blackened upon the lines of the laminæ, the centres of the holes being the last portions to change colour, and the whole surface was in a spongy condition accessible to the liquid. As they would see from the specimens, a peculiarity about the Faure-Sellon-Volckmar cell was its dark colour. The plates were then stored in Faure cells ready for use, being carefully isolated by the India-rubber inside. Another plan was now being tried by Mr. Thornton of packing out the composition from certain holes and filling them up with the peculiar indestructible plugs; but if the plugs were not put in properly they would be forced out of the holes. The mode of estimation in the liquid was ascertained by an ingenious copper balance and hydrometer. The plates were made in two sizes, the one double the size of the other, and were packed together, also positives and also negatives, in a box. The small sizes of cell were known as the "Volckmar" cells, and the large ones as the "Faure" cells, the term signifying, of course, such a power "per hour," and combinations of cells were manufactured up to five H.P., the only difference being in the number of plates per cell. About 24 negative plates could be set in a small size of plates, and such a pair would discharge a current for six hours at 10 ampères, or for three hours at 20 ampères. The author stated that he had 20 cells at his factory in Liverpool, and he found them almost perfection. He was indeed surprised at the amount of energy contained in them. Having explained the process of charging and discharging the cells, Mr. Lodge mentioned that the reduction of the lead oxide to metallic lead was not carried out in the cells, therefore, that no more sulphate should accumulate than was absolutely necessary. If accumulate more rapidly likewise than in the action. Indeed, if kept in action, these cells were very efficient; but if suffered to be idle, they rapidly deteriorated. Most of the difference found in the cells was due to the unequal density of the mass. The sulphate on the positive plate was less important than that on the negative, because the cells attacked the former far more readily. The chief second of the most economical use of a secondary battery lay in charging them slowly, never filling the cell beyond its capacity, and it never completely if possible, discharging it. Secondary batteries, as well as slowly as possible, although this cannot always be practicable. The electro-motive force in a small cell or half h.p. cell was about 2 to 2½ volts per hour, or about 10 ampères for six or eight hours. By a series of diagrams on the walls, it would be seen that the amount of energy was nearly uniform for to the end of discharge. This was a fact which made a battery realities. It was to be hoped that the small engineers would be able to "very remarkable."

Of the nature, the battery found the somewhat doubted by Professors Ayrton and Perry the best for the purpose, and it was a striking example of the improvements introduced into pure science by the electrical industries. The author gave a formula to determine the internal resistance of a cell—

$$R = \frac{E - e}{C},$$

in which formula R represented the internal resistance, e the current, E the electro-motive force when producing no current, and e the same potential when producing a current. This resistance was extremely small, never exceeding ·002 of an ohm.

TRIBE'S IMPROVEMENTS IN SECONDARY BATTERIES.

On page 913, Vol. XXXVI., we gave description of a negative plate for secondary battteries, the construction of which had been patented by Mr. Alfred Tribe, of Denbigh-road, Bow. That gentleman, it may be remembered, has been engaged with Dr. Globtzow in carrying on an elaborate series of experiments with Crystal accumulators, and their exhibit at the Crystal Palace was amongst the most interesting of the purely scientific branch. Recently Mr. Tribe has obtained a patent for a positive plate, which is constructed as follows: A rectangular frame, preferably grooved, may be employed, having three sides of prepared wood, slate, porcelain, or any non-conducting substance, the fourth side being open to dilute sulphuric acid. The foundation is completed by the use of a sheet of suitable conductor, preferably of lead, the same being cut to project beyond the liquid. The frame may be made entirely of any suitable conductor, such as lead, or it may be made entirely of wood, porcelain, or slate, a suitable conductor (preferably of lead) being placed within the groove and passing round the frame, or nearly so, on three or both sides, either partially or wholly. Into or upon one or other of these frames the positive plates of lead or mixture, or the same in mixture with compounds of lead, such, for example, as the oxides of lead, or the sulphate of lead, or mixtures. The peroxide of lead, or the mixture, may be brought to the desired consistency by the employment, either of water, or, by preference, of dilute sulphuric acid, and, if necessary, the peroxide remains in the retaining frame until the same has consolidated. Or a core consisting of a compressed mixture of lead and mixtures, or the same mixture in a state of paste, may be coated with sulphate of lead. The peroxide may be fitted into the retaining frames, to which is supplied a mixture of a suitable consistency, consisting of peroxide of lead or mixture, or peroxide of lead or mixture in combination with other compounds of lead—such as sulphate of lead, or the oxides of lead, or mixtures of the same in conjunction with water or with dilute sulphuric acid. The element prepared by any one of these methods, and of any convenient shape (which may be other than that mentioned), may be encased by any suitable porous supporting wrapper, such as felt, flannel, calico, asbestos-cloth, or the like, and the plate thus encased is then reduced to the metallic condition, electrolytically as is well understood. When the reduction is practically completed, the current so obtained is then capable of being employed in secondary batteries as positive elements in conjunction with a negative element, such, for example, as that described in the previous specification. The plates may be also established into the circuit of a battery, as the claim in the recent patent is for a positive plate, consisting of lead in combination with a frame of lead, or in combination with a frame of non-conducting material, but with a conductor of lead connected substantially as described. The fact that Mr. Tribe has taken out patents for a form of secondary battery, in which peroxide of lead plays the important part, may be taken as a fairly conclusive evidence that at present nothing better is known, though announcements continue to be made of discoveries or inventions of secondary accumulators, the performances of which are said to be "very remarkable."

loss of liquid need occur; and, as soon as it has been used, it can be removed from the water, wiped, and heated on the plate until the water is completely dissolved. The beaker once more filled with a little water, and removed; the liquid is allowed to evaporate till syrupy, the "syrup" is diluted with its own bulk of hydrochloric acid, and the whole evaporated carefully to complete dryness. After finishing a dozen tests, the dry residue is treated with 5—10cc. of HCl and reduced. Phosphorus and the acid heated until the iron is dissolved. By this process the silicon has been converted into insoluble silica, which, together with any graphite present, is now floating in the liquid. The acid solution is next evaporated somewhat, diluted with rather more than an equal bulk of boiling-hot water, and passed through a small filter-paper into a tall cylindrical precipitating-glass of about 70cc. capacity. This must be done by the filtration will be very slow. The beaker is rinsed with a little hot water, sufficient to wash out all the ferric solution, the ashes which adhere to the beaker being allowed to remain, and the filter is washed with a few fresh lots of hot water till the washings come through colourless. The beaker is then rinsed free from ashes, which may be thrown away, the filtrate and washings containing the oxide of iron, warmed, and a little water added; after the precipitate has thoroughly settled, the clear liquid may be drawn off within five pipette-loads, and the crucible and contents again boiled and weighed. This is not, however, quite right, as the ashes will not be necessary if the ash is taken in washing the pipette.

The dry yellow ammonium phosphomolybdate thus obtained contains 1·63 per cent. of phosphorus; as that its weight × ·0163 represents the weight of phosphorus in the 2 grammes of iron or steel operated upon.

Another Table on the Percentage.—Since the factor of the phosphomolybdate ppt. is regulated by the presence of hydrochloric acid and chloride, these must be removed before the molybdate solution is added. The reason why HCl is added at all is, that if the original nitric acid solution of the iron were evaporated to dryness to separate silica, a residue would be obtained which would contain nitrate of iron, $Fe(NO_3)_3$, and only with great difficulty again is hence HCl is added solely to enable the silica to be separated, and this having been done, it is removed again by repeated evaporation with HNO_3.

In precipitating the phosphomolybdate, it is essential that a *large excess* of molybdate solution be present. In presence of an excess of molybdate solution, no precipitation occurs if the temperature be raised much above 50° C., there is danger of some molybdic acid being precipitated, which would increase the weight of the ppt. The 50cc. is white, and 10cc. of it will fully saturate the pressure is probably the cause. To insure the absence of a ppt. of molybdic acid in the solution, the details of the process should be followed as closely as possible. The presence of a large quantity of ammonium nitrate very much accelerates the production of this ppt.

It is necessary to add plenty of acid, in addition to that which is already present in the molybdate solution. But care must be taken to prove that the ammonium nitrate added does not contain free nitric acid, or a low result will be the consequence.

My own experience leads me to believe that the addition of ammonium nitrate tends to cause the formation of an impure precipitate, and that where the ppt. is weighed direct, it is better to add none. The ppt. is slightly soluble in the 5 per cent. NaCl solution, so that when more than is necessary must be employed. Ammonium chloride, in combination, dries away 2 parts by weight of the ppt. means less than 2 per cent. of the whole ppt. which cannot be washed from the filter paper may safely be neglected.

L. A.

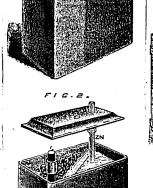
(To be continued.)

SECONDARY BATTERIES AND THE ELECTRICAL SYNDICATES' EXHIBITION.—II.

THIS second and last Conte lecture on this subject was given on Monday evening by Prof. Oliver J. Lodge, M.A., D.Sc., of Liverpool. The first was taken by Mr. W. H. Preece, F.R.S. The lecturer commenced by referring to his own experiments with a little battery on the platform of the theatre, which consisted of only one cell, and which, though very small, was capable of working on the action of secondary batteries. The experiments were then performed, and the possible of lead, it acting better than any other known electrolyte. In the experimental cell he had been using two plates of lead. If he substituted a clean lead plate for one of the lead plates, and put the cell in action, a deposition immediately took place in the peroxide of lead, though whether it was really attached by the dilute sulphuric acid he could not tell. But by substituting for the platinum plate a copper, they would see that the latter metal was more strongly plus, and that its action was more rapid. Copper was therefore a better metal than lead for the plus plate. The copper was oxidised, and formed a sulphate of copper, and as that dissolved the liquid in the glass cell was gradually assuming a blue colour. This would proceed either until the plate could was saturated, and could take up no more copper, or, if the current were reversed, until the whole of the copper was deposited. This was the principle of a Sutton cell, but with the action reversed. As to the quantity of energy which could be stored as lead on the table showed for some time on a piece of falling-off. It was not very clear why the heating cell was not in more general use, although it was probably due to the expense of the metal used or which fills. For small cells, however, a piece of lead answered very well, and he imagined, it would be still better than copper, but they would observe that the action was very slow in a very brief time, and could not be renewed either by real or by washing. Therefore, it was necessary to use a strongly plus metal, and he had found that a lead plate was a good one for the purpose. Dr. Gladstone and Mr. Tribe had said that a thin coat of vermilion was formed on the plate. He would next remove the vermilioned, or positive plate from the cell, and substitute for it a hydrogenised plate, when a very powerful secondary combination, action, would be produced. This hydrogenised plate of lead was therefore, resistance, and the result was that the current was one to sixteen-sixteenths of an ampère, which was of very great value in preventing local action on the plus plate. He would next take a piece of sprung lead which had been heat him just before the lecture. This he had prepared, the same as for the vermilion, and he found that it lasted longer in force, and the electric ball would keep the current up for a short period. Lead could be rendered spongy in various ways—electrically, chemically, or mechanically, and by any of these means the surface exhibitions of the surface exposed to the action of the liquid was greatly increased. Then postponing the period at which the maximum force on its surface required effecting, and enabling it to be used in positive or plus plate. He would, in passing, refer to the great advantages derived from the impurity of lead in its use as a support for the peroxide. They would see that when he took a piece of clean lead and hydrogenised it, then it refused to pass a current after the first minute, and if this were not the case, they would be unable, for a short time, to send a current through the battery, for the lead and its peroxide coat would act as a miniature cell. This they saw if a piece of copper foil was added to the cell, the cause for this peculiarity was that the copper was more plus than lead, and would act on the latter. The reason for this protection was the thin but insoluble coating formed of lead sulphate protected the plate, and would be the life of the cell, for, if it were soluble, a violent local action would set in, and the cell be spoilt. It was known that manganese was not so good as lead. It had been recommended by several of the cells described by various writers, but the cost was considerable and troublesome. Mr. Lodge then described and explained the Sellon-Volckmar cell, which was known. The minus plates could be improved by being hydrogenised, and by rolling the paste. The plan adopted by Wulf, of Liverpool, was to form a thin coating of lead by means of electricity, and then to add the electricity deflected again a bend, from which it was removed by a knife. The Sellon-Volckmar cell was perfected, and in the process of Kodish was used was beat or rolled. A plate eight, again, be coated with salt of lead, which was removed by the blow of a hammer. The plate was then hydrogenised his plate increased with a thick sulphated coat, and was ready for use. He would now call the attention to the glass plates he had tried, he had not found anything better than lead, but Planté cell was second other considerations had to be borne in mind in selecting a battery for practical purposes, such as constancy, repair, and economy of the cells. The lecturer dealt next with the question of electrical energy, and pointed out that the energy of a battery depended upon, as at times they needed to ascertain the current, electro-motive force, and resistance. Ohm, and energy, and of these the first two were known as electrical quantities, and the third as mechanical. For measurement of current, the unit of measurement being ampères; for that of electro-motive force, volts; and for that of resistance, ohms or galvanometers. The quantity equalled the current multiplied by the power equalled the current multiplied by the power equalled the current multiplied by the electro-motive force; and the energy equalled the quantity multiplied by electro-motive force, or the power multiplied by the time. Electro-motive force might be regarded as corresponding to pressure, resistance to friction, and the result of a given amount of work was done. The quantity (a current x time) was measured by a Joule's meter, and the power by a Watt meter, or by means of the galvanometer. It seems best to use the Siemens' dynamometer for the purpose, as at times they needed to ascertain the current, electro-motive force, and resistance of the cell, and energy, and of these the first two were known as electrical quantities, and the third as mechanical. For measurement of current, the unit of measurement being ampères; for that of electro-motive force, volts; and for that of resistance, ohms or galvanometers. The quantity equalled the current multiplied by the power equalled the current multiplied by the electro-motive force; and the energy equalled the quantity multiplied by electro-motive force, or the power multiplied by the time. Electro-motive force might be regarded as corresponding to pressure, resistance to friction, and the result of a given amount of work was done. The quantity (a current x time) was measured by a Joule's meter, and the power by a Watt meter, or by means of the galvanometer. It seems best to use the Siemens' dynamometer for the purpose, as at times they needed to ascertain the current, electro-motive force, and resistance of a cell and the amount of energy it could store and give out. The latter could be found by using or failing of that beam of the balance which was connected with the armature, and the quantity of work done by this means was found by multiplying the current by the distance and the change and discharge of a cell, and hence the percentage of return and loss. Cue gramme decomposed or dissolved equalled 1·9 ampère hours, and power was measured

THE INSULITE SEALED CELL.

THE British Insulite Company, Limited, with three holes, into two of which the electrodes have recently brought out a useful form fit water and air-tight, by the aid of collars of battery cell constructed of their special formed of pieces of rubber tubing; while the compound, and have also fitted it with a well fitted a closed by a stopper and capsule, forming and connections in a manner which will com- a release-valve to provide for the slight ment itself to the attention of all who can variations in the pressure of the contained appreciate the advantage of having an elec- air. When the capsule is screwed home, tric cell which can be arranged to communicate the cell may be shaken about or inverted between, say, the sitting-room and the kitchen, in a without injury or escape of the liquid; few minutes. The illustrations show the Insulite and one turn of the capsule is sufficient to leave the cell in a permanently working condition. The Insulite lid, having been fitted to the electrodes, is pressed down on the diaphragm, and outrageously soldered in position, the zinc being inserted about two turns with the average amount of sealing-wax cement, and being readily replaced when worn out. The diaphragm is made by nickel-plated cups, split and held by pinching screws to the carbon and zinc rods, and as the latter are tightly surrounded by rubber, there is little risk of defective connections from corrosion or other effects. As will be seen in



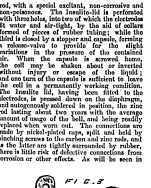


Fig. 3, the magnets and hammer are all covered by the bell, and the whole arrangement is as neat and portable as can be desired. It commends itself at a glance to all who want an electric bell which can be fitted up practically at a moment's notice. The cells are of such a shape that a battery of them occupies the minimum of space (see Fig. 1), and they will doubtless be found in many places where cells of other kinds would not be tolerated nuisances. The E M F of a single cell is said to be about 1·6 volt, with an internal resistance of 1·5 ohm. For portable electric bells they appear to be just what was wanted, while in the battery form they will be found very useful for testing purposes where the lineman has to carry his battery out of the way anywhere where a rail can be driven, as, when in such position that their capacity is afforded the cell for performing its duty. Insulite is a material which apparently is excellently adapted for the formation of cells, as it is exceptionally free from impervious to oxidation, and is self-contained, so to speak technically, it can be outgenerously used. In Fig. 2 the cell is shown ready charged, with the lid fitted. It is an oblong vessel, on plan, with a diaphragm of porous material securely secured in opposite corners, thus dividing the cell into two equal compartments. In one there is a carbon rod surrounded by fragments of carbon about the size, and in the other the familiar zinc-

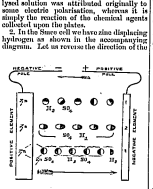
The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, JUNE 1, 1883.

SECONDARY BATTERIES.

By JOHN T. SPRAGUE.

THERE requirement of science was based upon the natural fact that most operations are reversible: a falling weight will drive clock-work, and the clock-work will raise the weight. So in chemical action oxygen and hydrogen combine and give up energy while forming water, and an equal quantity of energy applied as an electric current decomposes the water (unburns it, in fact) and separates the gases. In this action the energy connected to one equivalent H 1 grain, O 8 = water 9, is measurable as 0,806lb.-ft., and the electric conditions represent an E M F of 1·5 volt. In like manner every chemical action which, giving up energy, constitutes a battery or electric generator, can be reversed by means of a superior E M F, when it receives and stores up energy. Such batteries are therefore called *accumulators*; they are also called *polarisation batteries* because the E M F found to exist upon pairs of plates in an electrolysed solution was attributed originally to some electric polarisation, whereas it is simply the reaction of the chemical agents collected upon the plates.

2. In the Smee cell we have zinc displacing hydrogen as shown in the accompanying diagram. Let us reverse the direction of this



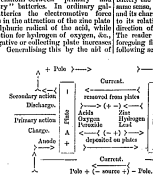
force, as shown by the arrows, adding also a molecule of water H_2O which is to be decomposed; then we have $ZnSO_4 + H_2O$, which becomes changed into $ZnO + SO_4H_2$. O: the zinc is separated, sulphuric acid formed, and oxygen set free, provided there is nothing for it to unite with.

3. In the Daniell cell we have zinc displacing copper from its sulphate, $CuSO_4 + Zn$ becoming $ZnSO_4 + Cu$, with generation of an E M F of 1·07 volt. Applying the same superior force we can reverse this process, and by electrolysis of the sulphate from a copper anode convert it into copper sulphate and deposit zinc. Here a Daniell cell, when exhausted, can have a reverse current from a dynamo-machine passed through it, and be fresh charged. This is one of the forms of "accumulators" which has been proposed, but it is not practicable for reasons which will be explained hereafter.

4. Reverting to the conditions of § 2, we have oxygen freed, and this is wasted energy; it may be saved by collecting the oxygen and using a plate in such a manner as to form a gas battery which will gradually absorb the oxygen; or we may use a plate of such material as will absorb the oxygen chemically; such an electrode exists in the ordinary manganese cell, or Leclanché battery, for the exhausted sesqui-oxide of manganese will take up the oxygen again and reform the peroxide. Iron, or oxide of iron, will also act in this manner, and Lead is, however, found most suitable, because in the presence of sulphuric acid, lead does not pass into solution from the anode, but forms peroxide, and this being a good conductor constitutes a very powerful negative element or battery plate.

5. Zinc, in the presence of acids or alkalies or of most metallic salts, sets up spontaneous action; therefore, the next step towards an ideal accumulator is to substitute some metal not so acted upon; palladium has the property of absorbing 900 times its volume of hydrogen, forming with it a true alloy, in which hydrogen apparently becomes a perfect solid metal, and conducts electricity; but for the cost of palladium this would be a valuable electrode. Experiment has shown that lead is the best available metal, and we then come to two plates of lead, with a solution of sulphuric acid between them, in which the decomposition of water is produced by electrolysis, the oxygen forming peroxide of lead, while the hydrogen is partly occluded in the porous lead surface, and partly employed in reducing pure lead from previously formed compounds.

6. A slight sketch may now be useful in fixing in the mind the principles involved and the relations between "primary" and "secondary" batteries. In ordinary galvanic batteries the electromotive force originates in the chemical action of the zinc plate for the sulphuric radical of the acid, while the attraction for hydrogen of oxygen, &c., at the negative or collecting plate increases the force. Generalising this by the aid of

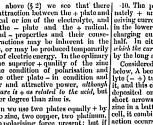


the figure above (§ 2) we see that there exists an attraction between the + plate and the – radical or ion of the electrolyte, and between the – plate and the + radical. These + and – properties and their consequent attractions may be inherent in the substances, or may be produced temporarily by means of electric energy. In the ordinary battery the superior + quality of the zinc sets up the condition of polarisation and attracts the other plate – in condition and polar order and attractive power, *although its ion undergoes a + relation to the acid*, but + in a lower degree than zinc is.

7. If then we use two plates equally + by means of two zincs, two copper, two platinum, we have no polarising force present: but if by any means we can set up differential attractions at the plates, the force comes into existence. If we insert an electric source in the external circuit, we polarise the two plates in opposite directions, and give them this differential attraction for the ions of the electrolyte, to an extent depending on the E M F available; that is to the difference of potential we can set up between the plates. Again, if we modify the plates themselves by coating them with different substances the same effect is produced. If one of the platinum plates is lifted and exposed to the air, its attraction for hydrogen is increased by the film of oxygen absorbed.

8. If we pass an electric current through the two platinum plates in acid, we coat the plates, one with a film of hydrogen, and the other with a film of oxygen; these two films now become the active agents, and their attraction for each other, resulting across the chain of intermediate molecules of the electrolyte, sets up the electric polarisation. Precisely the same result follows from the pressure at the two plates of any other substances having affinity for each other, a condition necessarily set up by any action of electrolytic decomposition. Thus with lead plates, the hydrogen reduces any oxide and is partially occluded in the lead, producing a + plate of lead or hydrogen representing the zinc of the ordinary battery; the oxygen produces peroxide of lead, representing the silver and acid of the Grove, or other powerful oxidant.

9. It is important, at this stage to avoid some probable confusion about *poles* and *plates*, the more especially because Dr. O. Lodge, in his valuable series of articles on accumulators in *The Engineer*, which have appeared in these pages, has contributed to this confusion by using the term + *plate* for that connected to the + pole of the source while charging, and which becomes the + pole of the battery when discharging. But to obtain a clear idea of the relations of the secondary and primary battery the name terms must be used in the same sense, and the word *plate* in the battery and its characters as + or – refers exclusively to its relations to the electrolyte, and to direction of the current *within the battery*. The reader should therefore refer to the foregoing figure, and compare it with the following scheme of arrangement.



10. The plates A B are shown as alternately + and –, according as they are receiving electricity from the source, as shown in the lower half of the diagram, or discharging currents, as shown in the upper half. In either case that *plate is + from which the current passes to the liquid* as shown by the long arrows at the ends of the plate.

Considered as charging from the source, below, A becomes +, therefore the electrolyte (– +) turns its negative ions towards it, and this class of radicals or ions is either liberated on the plate, as shown by the short arrows, or if the plate is soluble, as zinc is a battery or copper in a depositing cell, it combines with these ions. The precipitation occurs at the + plate B where the + radicals subjoining it are deposited.

Considering as discharging, B becomes the + plate by virtue of the presence there of the + ions which attract the – ions of the electrolyte, the conditions being now those of the ordinary battery.

11. "It should be observed that if such a cell is connected to the source, and an external circuit is also connected just as shown, the plate A becomes a constant + *pole* to this external circuit; but a very complicated set of conditions would arise. In fact, the cell and the outer circuit would be derived circuits to the source, and it would depend upon relative forces and resistances what

n.s. Cor. gold fabrics, 1883.

THE BRUSH STORAGE BATTERIES.

The New System to be Introduced within the Next Three Weeks.

The citizens of the Brush Incandescent Illuminating Company announce that Mr. Brush is now ready to manufacture storage batteries at the rate of seventy a day, the works in Cleveland, Ohio, being finished. For the last six months work has been going on upon the new buildings, which are intended solely for the manufacture of batteries and are supplied with engines of 2,000 horse power. Mr. Brush says that he has greatly improved his batteries since the exhibition of their power which was given last autumn, and now has no hesitation in competing with gas or any system of electric lighting. He became convinced years ago that the arc light, while well suited to street illumination, would not do for dwelling houses or even for many public buildings. The light is too trying to the eyes and casts too black shadows to be pleasant indoors. The incandescent light is as soft as that of gas and does not affect the atmosphere. For reasons of economy it was decided that any system which would permit of incandescent and arc lighting from the same machines and wires was to be aimed at, and the storage battery was settled upon as the best device for building the electricity for each house. The great advantage of the storage battery is that no matter how irregular the charging of the battery may be, its emission of electricity is perfectly steady; no matter how a cistern may have been filled, the flow of water from its faucet will be perfectly regular. The great trouble in feeding incandescent lamps directly from a dynamo machine is that the light shows every variation in the running of the engine; every time the belt seem passes over the fly-wheel a tremor in the light shows it; when the engine runs faster or slower, it is perceptible at once. The current used for the arc lights would never do for incandescent lighting, owing to its irregularity, but it is just as good for charging a battery as any other current. The plan of the Brush company is therefore to put batteries into every cellar and connect them with the street wires which feed the street lamps.

The company is making four standard sizes of battery—five lights, ten lights, twenty lights, and forty lights. The smallest size will occupy the space of a small trunk, and the size of the batteries increase in proportion to their power. They can be put in any part of the house, from cellar to garret, or in the vaults under the sidewalks. The current in the batteries will supply the number of lamps they are intended for for five hours. Thus, a twenty-light battery will supply twenty lamps for five hours, or ten lamps for ten hours. A meter registers the flow of electricity through the battery, and also acts as an automatic cut-off when the battery is fully charged. Mr. Brush contends that the batteries will improve with age; but whether they do or not will be the company's affair, for none will be sold. They will be put in houses and the lamps supplied without charge. The cost of the light, according to Mr. Brush, will not be more than that of gas, at which price it is expected to put in batteries as fast as they can be made. The light needed by an ordinary four-story house, twenty-five feet wide, does not average in winter fifteen lights for five hours.

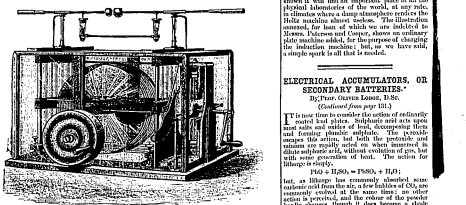
Contracts for lighting by this system have been made with a number of persons, and the batteries are promised within the next three weeks. Among other places, the Central National Bank, some of the stores along Broadway, and the Madison Square Theatre have been wired by the company for the new light, and are now awaiting their batteries. At the Madison Square Theatre it was said yesterday that not only would the light be better, especially in summer, as it gave out no heat, and did not consume the oxygen of the air, but it promised to be twenty-five per cent. cheaper than gas. The Boston factory of the company is now turning out Swan lamps at the rate of 10,000 a week. As there is no work to be done in the streets to introduce this system of lighting, there is no reason why the work should not proceed rapidly after the batteries are received. From the same batteries power can also be taken for running small motors for sewing-machines, lathes, etc. The whole system of batteries, lamps, and motors can be seen by any one interested in the matter at the company's offices, No. 863 Broadway, where they have been in operation all winter.

It is well known that upon the appearance of the first Brush storage batteries suitable of the company's offers, suits will be instituted for infringement of the Sellon lamp patent, and of the Faure battery patent, and that the most eminent expert and patent lawyer of precedence in this country is ranged upon one side or the other in the coming contest, which promises to be the most important ever fought over patent rights.

and have a surplus to propel the machine at the speed aimed at. A velocipede with a 48l. wheel must make 150 revolutions per minute to cover a mile, and if that is to be accomplished in three minutes, when it is to be propelled on its tires in a straight line, it is impossible to carry an engine of heavy weight, a motor running at high speed must be used, and the power be transmitted from the crank-shaft of the engine to the driving-axle by means of gearing.

WIMSHURST'S INDUCTION ELECTRICAL MACHINE.

ALTHOUGH the development of the electrophorus has proceeded steadily with the advance of scientific knowledge, it has scarcely kept pace with the development of machines for producing current, at all events in recent years. We have, however, had an opportunity of examining an electrostatic induction machine which is certainly much in advance of anything of the kind previously known. The method of developing electricity by the inductive action of a body previously electrified was known and utilised previous to the commencement of the present century; but although several designs had been brought forward it was not until Holtz introduced his well-known machine in 1865 that such machines were known to the subject. The Holtz machine and its variations (see p. 327, Vol. XXIII.; p. 344, Vol. XXV.; p. 129, Vol. XXXIII.) are all difficult to make and troublesome when made, for in a moist state of the atmosphere it is only by a great deal of labour they can be made to work at all. The Bottsch machine, which consists of an ebonite disc mounted in front of an electrified plate of the same material, is in that respect an improvement on the Holtz, but it is far less powerful. Carré's dilatateur machine is a combination of the older and newer forms, an ebonite disc revolving to the extent of about one-third of its surface in front of a plate provided with felt friction rubbers and turning in the opposite direction to the ebonite disc. Both plates are thus electrified, and the electricity is collected by means of metal combs. This machine is very powerful, but is somewhat troublesome to start, and requires a considerable amount of power to drive it. Wimshurst's machine, which consists of an ebonite disc mounted in front of an electrified plate of the same material, is in that respect an improvement on the Holtz, but it is far less powerful. Carré's dilatateur machine is a combination of the older and newer forms, an ebonite disc revolving to the extent of about one-third of its surface in front of a plate provided with felt friction rubbers and turning in the opposite direction to the ebonite disc. Both plates are thus electrified, and the electricity is collected by means of metal combs. This machine is very powerful, but is somewhat troublesome to start, and requires a considerable amount of power to drive it. Wimshurst's machine, which consists of an ebonite disc mounted in front of an electrified plate of the same material, is in that respect an improvement on the Holtz, but it is far less powerful. Carré's dilatateur machine is a combination of the older and newer forms, an ebonite disc revolving to the extent of about one-third of its surface in front of a plate provided with felt friction rubbers and turning in the opposite direction to the ebonite disc. Both plates are thus electrified, and the electricity is collected by means of metal combs. This machine is very powerful, but is somewhat troublesome to start, and requires a considerable amount of power to drive it. Wimshurst's machine, which consists of an ebonite disc mounted in front of an electrified plate of the same material, is in that respect an improvement on the Holtz, but it is far less powerful. Carré's dilatateur machine is a combination of the older and newer forms, an ebonite disc revolving to the extent of about one-third of its surface in front of a plate provided with felt friction rubbers and turning in the opposite direction to the ebonite disc. Both plates are thus electrified, and the electricity is collected by means of metal combs. This machine is very powerful, but is somewhat troublesome to start, and requires a considerable amount of power to drive it.



(p. 116, Vol. XXX.). To obtain successful results with these machines, a comparatively high speed is necessary, and, with the exception of Carré's, a damp atmosphere is productive of a great degree of vexation to the experimenter. The Voss machine, the latest invention of the kind that is well-known, which was illustrated and described on p. 345, Vol. XXXIII., has the reputation of being indifferent to the state of the atmosphere, but its power is limited by the difficulty of multiplying the number of plates. Mr. James Wimshurst, a member of the constructive staff of the Board of Trade, has recently introduced a machine which possesses all the power of the Holtz, if not more, with the great advantage that it is practically indifferent to the state of the atmosphere; and further, can be made at a comparatively low cost. Many of the most useful scientific apparatus now have come to us in advance science, and the time is not far distant when the name of Wimshurst will be as widely known as that of Holtz. A few machine on his plan have been already made by Messrs. Paterson and Cooper, of Little Britain; but that constructed by himself is probably the most powerful electrostatic induction machine in existence. It consists of 12 circular plates of common window-glass, 20in. in diameter, which run between 24 strips of similar glass, supported in such a manner that the discs rotate freely between them. Twelve of the glass strips rest on bearers at the bottom line of the discs, and the other twelve are supported a little above the centres, leaving room for the passage of the spindle on which the discs are mounted. There is thus little friction of a mechanical nature, except that of the spindle in the bearings, and this is reduced to a minimum by including in these apertures pads of the great merit of Mr. Wimshurst's invention is found. In the first place they are made up of many plates of graphitic oxide in the armatures on the same side, and there is consequently great loss of effect from neutralisation; but Mr. Wimshurst prevents that by connecting all the armatures on one side by a copper wire, which leads to a conductor, and thus forms a handy means of imparting the initial charge to the machine—a small spark sufficing for the purpose, when the machine is properly insulated. At a comparatively slow speed the large machine we saw gave long handles of spark discharge in the open air between knobs separated by 2in. and more, and when small condensers were hung on the terminals a shock nearly equal to that obtainable from a Leyden jar of 3,000 cubic inches. Turning the hand wheel of the winch at a slow rate, the machine gave from four to five sparks of three inches in length for each revolution, the line of fire being solid and apparently continuous. Such an experiment is sufficient evidence of the power of the machine, which is a decided advance, and one upon which Mr. Wimshurst, the inventor, is to be congratulated. It is not the least merit of the machine that any ordinary person can construct one for himself at very moderate outlay; and as economy becomes known it will win an important place in all the physical laboratories of the world, at any rate, in climates where a damp atmosphere renders the Holtz machine almost useless. The idea of the machine is not new, as Mr. Wimshurst admits, Nicholson, Bennet, and Cooper, shew an ordinary plate machine added, for the purpose of charging Leyden jars, the machine; but, as we have said, a simple spark is all that is needed.

ELECTRICAL ACCUMULATORS, OR SECONDARY BATTERIES.*

By Prof. Oliver Lodge, D.Sc.

(Continued from page 131.)

IT is now time to consider the action of ordinarily coated lead plates. Sulphuric acid acts upon lead salts and oxides of lead, decomposing them and forming plumbic sulphate. The peroxide escapes readily from the acid, but the protoxide and sesquioxide are rapidly acted on when immersed in dilute sulphuric acid, without evolution of gas, but with some generation of heat. The action for litharge is simply,

$$PbO + H_2SO_4 = PbSO_4 + H_2O;$$

but, as litharge has commonly absorbed some carbonic acid from the air, a few bubbles of CO_2 are commonly evolved at the same time; no other action is perceived, and the colour of the powder hardly changes, though it does become a whole lighter. The reaction for minium is not quite so simple—it is this,

$$Pb_3O_4 + 2H_2SO_4 = 2PbSO_4 + 2H_2O + PbO_2.$$

No adulteration of carbonate is commonly met with in minium, and accordingly no gas is evolved, but the formation of black peroxide makes itself manifest by a rapid darkening of the

* From the *Engineer*.

ELECTRICAL ACCUMULATORS OR SECONDARY BATTERIES.*

By Prof. Gaston Planté.

(*Continued from p. 154.*)

THE coatings of both plates being now fully formed, the one all peroxide, the other all metallic lead, the gas which is liberated against their surfaces is no longer absorbed, but begins to rise in numerous bubbles from both the same as from the oxidising plate. A new battery the first few times it is charged, and discharged, does not work well. The fulness of the cell can therefore be told in these two ways—a greater escape of gas and a higher opposition electro-motive force than usual.

The proper or "classic" resistance of the cell is now a minimum, however, for these reasons—because the oxidising surface, the fixed surface of the positive plate, and the free lead, which are as near as they can possibly be, have their acid in the solution in concentrated not in dilute state, that which has been absorbed by the lead having been restored; and because the cell will have been warmed by the charging current. The cell is therefore in all respects at its very best, and if left to itself will remain powerful current for a few seconds if called upon.

But suppose it is not called upon for a current, but simply allowed to stand idle for a time, what will happen to it? First, of course, it will cool, and thereby slightly increase its resistance; but more important than this, the gas which is clinging in minute bubbles to the surface of the plates will act in bubbles and gradually rise, thus lowering the electro-motive force of the cell somewhat. The gas which now escapes is chiefly, as the reader knows, a large quantity of hydrogen with enough half charged with the latter, more especially perhaps if it is amalgamated, and accordingly the hydrogen escapes through it in its abnormal state, retains a perfectly satisfactory rate.

No further change of importance can be expected to be noticed after the lapse of several months or even an hour; but if the cell is set aside for a day or two a more serious change sets in. The first surface of the lead loses some of its hydrogen which has been absorbed slowly by acid, a slight case of insulating sulphate being produced; and these changes, though perceptible, are not of a serious character, but if the plates were insulated, yet no circuitously wandering (Whereby

* From the *Explosa*.

do occur, because they lower the electro-motive force and increase the internal resistance at the same time. The cell, with and supported by a plate of unoxidised lead, and the peroxide sufficiently for a considerable time, and I can say that I have stood there in my quantity for a week or so, provided there is no leakage between its terminals. I advertised, however, that a temporary short-circuiting of the full cell before setting aside, which, though not necessary as far as the other purposes, would have a decided effect in slowly diminishing the store of hydrogen; and that the insulated would not bear standing like quite as well as a perfectly full one.

The main part of the change which occurs during standing seems to take place at the + plate. Here the plate, oxidised to peroxide, with and supported by a plate of unoxidised lead, and the peroxide sufficiently to allow sense of the latter to be perceptible, owing to the position of the two substances, when there is here a complete battery, and accordingly a certain amount of local action sets in, some of the lead becoming oxidised and sulphated, while some of the peroxide is partially reduced. If this action goes on to any great extent it is most disastrous, for the effect is to establish a layer of insulating film or layer, of sulphate and lower oxide, between the lead plate and the rest of the peroxide mass, and it may sometimes happen that the coating is thus completely detached from the plate so as to leave it quite bare, but suppose it only gets detached in patches, the internal resistance will thus be increased, and the current which will be obtained shared by the total amount so reduced; but the electro-motive force would not be likely to be much affected, the effect of the local action had extended itself through the whole thickness of the peroxide. After this it is probably would so reduced by more standing than any current having been demanded from the cell.

Messrs. Gladstone and Tribe have called attention to this local action, and pointed out one reason why it goes on more slowly than might at first sight be expected, viz., that the film or crust of sulphate formed on the lead protects it from the insulating power, and only permits deeper parts to be attacked in by reason of its porosity. Another reason why the action is not at all rapid is that the surrounding mass really permits a very inconsiderable amount of circulation in the liquid, in that it soon becomes saturated with the acid, and is only slowly diminished by diffusion. Still, the local action does go on more or less rapidly, and it is clear that, however, the main cause of the loss of power of the cell while standing. Moreover, the differences noticed among different cells seem to depend very greatly on the facilities which some seem to offer to this action, and to the consequent greater or less confinement of the peroxide coating. Why the coating should be more or some cases more readily than in others is by no means clear; but it may happen that a too rapid evolution of gas caused by a too powerful charging current, might mechanically effect a separation between the plate and its coatings. It must be remembered, however, that the coatings may easily become electrically dead, not by actually detaching film—especially in patches—but by other mechanical influences may remain almost unimpaired.

The naturally occurring cure for these evils would be either to support the peroxide on carbon, or other such unattackable substance, or else to use no support at all, but to make the plate wholly of peroxide, but though the use of carbon would do away with the action, scarcely any form of carbon can resist the action of nascent oxygen, and accordingly in various counties described in passing, and the powder makes a worse battery than the oxidised plate, and therefore connection between the plate and its coatings; in fact, the coatings are liable in time simply to drop off. The use of peroxide alone lacks support, but when the cell is discharged and the peroxide reduced to lead, it will no longer be a conductor, and it does not appear probable that such a cell could ever be discharged to any extent, however, the difficulties of making developed permanent contact with such non-metallic substances are considerable, and their use would therefore be very inconvenient.

SECONDARY BATTERIES.

CHLORINATED batteries, or rather patents for them, are becoming somewhat numerous of late. Still, however, and the number of known combinations is very large, the practical commercial value of these is practical would would not occupy much space. Probably descriptions of secondary batteries already in type would not occupy many volumes, but certainly a new list of them recently taken out for modifications of the Planté cell would occupy a column or two. There is must be confessed a family likeness to one very nearly all of them, and it may be safely surmised that the Patent Office will stop the chief benefit from a pecuniary point of view. One of the most recently patented, and one of promising devices is that known as the B.T.R. cell, from the names of the patentees, J. S. Bremner, W. Taylor, and T. King, of Cannon-street, E.C. This invention relates to the formation of plates for electrodes, made of insulating lapse the materials in combination with suitable metal ribbons; also of insulating tapes covered with metal, or in combination with metal ribbons, gauze, wire, or strips, or to used as to form a carrier for which the material of lead, or lead in a finely divided condition, such insulating carrier being sandwiched, as a rule, between the metallized ribbons, or their substitutes. The insulating carrier and metal ribbons may be made in any convenient manner, and may be corrugated longitudinally and transversely. The insulating strips are coated with the powdered lead, lead material on one side, and with salts of lead on the other. Part of the insulating also relates to plates formed as above, and used in combination with an improved cell made of wood sealed, consisting of with pitch, lined with a cell of paper, treated with paraffin, and having a layer of paraffin interposed between the wood and paper cell. Sometimes an extra particle and of sheet iron is used outside of the wooden one, with an inch-paced layer of paraffin wax. Part of the invention further relates, in combination with glass tumblers, or vessels of them, to a mode of connecting the different sets of plates together, so that any one plate may be easily removed, and the combination of a lock attachment for connecting the cells together, together with an improved tube for ventilating the cells; also in combination with the above improved plates, part of the invention relates to an improved mode of applying sticks, rods, tubes, or strips of active matter or in combination with glass, porcelain, vulcanite, or of metal or wood covered with non-conducting materials. The invention refers, in combination with the above improved cell, to the use of an insulated tray or stand supporting the cell, and for holding all to prevent return current by earth. The claims in this case are for the construction substantially as described. Another device, which, however, proceeded no further than provisional protection, is that of Dr. Aron, of Berlin, in which the accumulation consists in impregnating capillary substances with a lead combination, and winding them into the polar plates. The capillary substances may be fibres stitched on lead plates, and subsequently impregnated with the active compounds, and the polar plates may be of disfigured substances perforated with numerous holes, being of wood, silver, or other metal. Another patent is one by C. T. Kingzett, London, and relates to the form of the electrodes, as well as to the compounds used. The patentee prefers electrodes of a brush-like form, in which the "bristles" are hollow, and with the "stock" are in one piece, which is inserted into the lead compounds. From practical investigations the patentee concludes that while red-lead may be usefully employed at the electrode at which oxygen is set free during the charging process, it may be preplaced with advantages at the other pole, by the sulphate, chloride, or oxychloride of lead; or, better still, a freshly-prepared mixture of litharge and dilute sulphuric acid. Hydrochloric acid may be used as an electrolyte, and it is preferred to charge the cells in one direction only. The patentee refers to chloric hypochloride, as an agent for prolonging or revivifying the action of secondary batteries, and for exciting free access of the electrolyte fluid to the various parts, more particularly to those of tubular-pipes, wicks of porous material, and a "Leclanché" cell, E. T. Wade, 46, Lombard-street, strikes out a new line, for in this case the electrodes are made of carbon and zinc, and half chromium and iron, or "other suitable metals;" the zinc are covered with a layer of an oxide of manganese, occasionally mixed with a little chloride acid, and retained in position by a covering of asbestos fabric, woven open glass, or a portion of the porous earthenware. Chromic acid other than these zincs were to immersed in the fluid and probable of chromium are produced by the action of nearly zinc, and the current gradually charging current. The patentee says that peroxide, until, at the end of five and three-quarter manganic acid as a permanganate and solution of hours, it has reached its maximum, and is an excmanganese, or an oxide of copper may be used polisent caused. The result shows that each with suitable electrodes, instead of the oxides of battery practically involved 5.8-p. deer, the chromium. M. Sonrier, of Brussels, has also consumption of zinc being 1,563 grammes, obtained a patent, one part of which relates to a 2,000 grammes, and sulphuric method of applying moisture to lead plates by acid 7,200 grammes. The 5-p.-hour is means of a thin sheet of wood, or other suitable recoiling it with some equidistributive substance. Another part describes a porte made of minium, ally obtained with the consumption nickel, as a substitute for the usual sheets of lead. The in- estimate of 4 grammes of zinc per ampère-hour, ventor of the 5-and-10 battery, and the B. Hospitalier stated that the battery of electric porcelain absorbing the acid, the latter being ex- motive power, would suffice to support for five hours in tray. M. Sonrier also uses a light and porous the lamp having carbons a full third of an inch cake, the interstices of which are filled with lead, in diameter, with a current of seven amperes, by first soaking in a solution of the nitrate, and a difference of potential of 40 volts at the reviving the metal by heat, and then pressing terminals of the arc. No attempt was made to minium, or other suitable metallic preparation, reduce the weight of the two batteries employed, into the pores. That object is effected in other which was 1480lb.; but, according to M. Hospitaways—e.g., by mixing the paste with aluminium lier, it would be easy to construct two batteries powder, which is said to be oxidised by the sul- of equal power to weigh not more than 1040lb., phuric acid, and by adding the aluminium in such a manner as to considerably less than an accumulator capable of that while the metal is obtained in the desired containing an equal amount of energy. state, the block is kept as porous as possible. Such are a few of the recent ideas in connection with the formation of secondary batteries; but it may be doubted whether any of them are better than the simple Planté form, when that has been brought into its best working condition.

GROUVE'S NEW BICHROMATE BATTERY.

A TEST of M. Trouvé's new bichromate battery has been made by M. Hospitalier with two sets of six cells each. The cells are of closable, and are arranged in a box or trough in such a manner that they can be easily removed —one side of the trough being hinged so that the cells can be slid out when the plates are drawn out of the solution. The elements are connected in series, the zinc of one cell being coupled to the two carbons of the next, and a winch and ratchet enables the plates to be wound up out of the solution, or to be immersed more or less deeply. The electric cells are much larger than is absolutely necessary, and the quantity of solution required for the charge is therefore large. Hospitalier's solution was made up as follows:—Bichromate of potash 1½ kilog., and sulphuric acid 2·8 kilogs., that is 12 oz., 2 lbs., and very nearly 6lb. respectively. This gives 130 grammes of bichromate per litre of water, or 8·5oz. to 1·7o pint, say, 8·5oz. to 1½ pint, a solution half as strong again as that used by Paggenhoff. But M. Trouvé uses a much stronger solution on certain occasions, from 200 to 250 grammes of bichromate of potash being dissolved in each litre of water. The standard solution is 1 kilogramme bichromate, 1 do. sulphuric acid, and 1 pint of water. The bichromate of potash is powdered and added to the water, and stirred; then the sulphuric acid is poured in very slowly through a fine strainer, the mixture heating slowly and gradually. The bichromate, once dissolved, remains in solution, and the preparation occupies altogether about ten minutes. The zincs are fixed to a rod of wooden strips, and would be enfeebled in the injury of the solution. The total weight of a battery of six cells is said to be 39·3 kilogs., say 74lb. In the experiments made by M.

example in the form of powder, may be placed into or upon the existing frame, and subjected to pressure. The peroxide of lead may be employed in a plastic or a moistened condition, either with water or with dilute sulphuric acid. Or one or other of the non-conducting lead compounds—such, for example, as the monoxide of lead, or the sulphate of lead—may be mixed with peroxide of lead, and be subjected to pressure in the existing frames, and there be converted into a peroxide of lead by electrolytic action; or a core of compressed peroxide of lead may be put into the centre of the existing frame, and covered with some suitable lead compound, which may be then converted into peroxide of lead by electrolytic action. The negative element, when prepared, may be sheathed or inclosed in artificial or vegetable parchment, felt, porous earthenware, or other equivalent materials.

When the negative plates, composed of peroxide of lead, are employed in secondary batteries, the positive plates employed therewith may be of any suitable element, and the exciting liquids or electrolytes may be similar to those now employed in secondary batteries.

Mr. W. R. Bevis, of Cinderford, patents a method of constructing secondary batteries of a thin strip of lead, folded up with a band of paper, cardboard, or other such slips with red-lead. The porous material may be asbestos, felt, spongy indiarubber, or wood. The cells are poured into chambers, bags, or closed vessels, in which hold fits sulphuric and diluted sugar-water, and holes are punched through from each side roughly, the barrel edge and the bulging on the punched edge serving to keep the red-lead within the envelope, and its metallic contact with the lead walls, which are thus rendered more rigid.

A greater departure has been made by M. de Lalande, who, in conjunction with M. G. Chaperon, of the Mines d'Aiwaz, Spain, has patented a new battery, in which oxide of copper is the depolarising agent. The negative element is formed of a rod of zinc cut often in a porous cell packed with pieces of carbons, the interstices filled with a mixture of copper. The positive element is of zinc, in a solution of caustic soda or potash. This combination is extended for use as a primary battery, but it may be employed as a secondary. Mr. Brush, of Cleveland, Ohio, has obtained an American patent for a secondary battery, in which the plates are formed with projections for the oxide of lead, which is compressed after filling.

From these notices it will be understood that recent improvements follow rather the endeavour to hit upon the best shape to work up the lead and its peroxide into convenient forms, than to discover other combinations more efficient and less troublesome, if more costly, than the recent designs. Meantime, it is worthy of note that in a recent case the simple Plantè is preferred, probably because there are no royalties to pay.

ANIMAL PARTNERSHIPS.

AN intimate connexion subsisting between different animals is that known as Commensalism; commensalism may exist between any two animals, which may be said to sit at the same table, or to live in the same room or stable. Of late years naturalists have become acquainted with numerous examples of this form of animal partnership, and in the recently issued volume of the "Transactions and Proceedings of the New Zealand Institute" Mr. Hutton discusses the question as to whether the Australian Native Bear, or Koala, is to be considered as a commensal animal. Mr. Hutton says that in a little [illegible] of the Koala [illegible] the roof has been [illegible] a few [illegible] caterpillars [illegible] the Koala [illegible] leaves of the [illegible] and like a [illegible] colouring [illegible] back of its [illegible] afforded to [illegible] On removing [illegible] Mr. Hutton [illegible] specimens [illegible] its hitherto [illegible] leave [illegible] of a living [illegible] however, [illegible] has been [illegible] the world [illegible] have a while [illegible] life to the [illegible] tion has [illegible] sight on the [illegible] whether [illegible] be ever seen [illegible] Koala without [illegible] detached [illegible] stances, it [illegible] seems to [illegible] fishermen [illegible] for fishing [illegible] bird is attached [illegible] turtle, and [illegible] numerous [illegible] crocodile, [illegible] they leave [illegible] with many [illegible] the large [illegible] other dead [illegible] fish-leaves [illegible] swimming [illegible] these point [illegible] selling to [illegible] number of [illegible] fish, and [illegible] tentacles, [illegible] fishes. It [illegible] numerous small specimens [illegible] while the [illegible] occasionally [illegible] fish-shoals [illegible] and in the [illegible] which, [illegible]

SECONDARY BATTERIES WITH LEAD PLATES.

It is well known that M. Gaston Plantè "forms" the plates of his secondary battery by oxidising one electrode and reducing the other to a divided state, which permits the chemical actions during charge and discharge to go on more completely. That electrician has recently been studying these chemical actions, and finds that part of the peroxide of lead is transformed into sulphate of lead by the sulphuric acid in the water about the plates. This result has likewise been confirmed by Messrs. Gladstone and Tribe. He has also attempted to increase the accumulating power of the battery by procuring a galvanic deposit of lead on the plates in the first place. But these galvanic deposits would not adhere sufficiently well to the plates, and he has arrived at the conclusion that the best plan is to transform the metal of one electrode into peroxide nearly through and through, and to reduced lead on the other. This has been accomplished by changing the direction of the primary current at intervals with periods of rest between. By this method of preparing the cells, M. Plantè states that it will be possible to obtain a discharge current sufficient to deposit about 74 grammes of copper (1150 grains) per kilogramme (2·2 lb.) of accumulator battery. The system of charging the battery in contrary directions, reduces the lead on one plate and oxidises the other to a corresponding depth, so that during the subsequent discharge the hydrogen from the decomposed water in the battery reduces the peroxide of lead formed by the primary current, and the oxygen oxidises an equivalent quantity of lead. The efficacy of the period of repose between the opposing currents is explained by M. Plantè on the ground that at the end of a certain time the plates of lead thus modified have become less good conductors on their surfaces, and hence the primary current, when it starts again, naturally follows the path of least resistance and enters the liquid at the metal surface under the film of oxide, and not by the surface of the oxide itself, thus outlining a new thickness of metal, and superposes the oxide already formed. A cell thus formed preserves its charge for months. The formation takes a considerable time but it may be hastened by heating the liquid bathing the plates. This is, however, a process requiring trouble, and M. Plantè has substituted the following plan. The plates are left for twenty-four or forty-eight hours in a bath of nitric acid diluted with half its volume of water. They are then washed and placed in the sulphuric acid bath ($\frac{1}{10}$ acid to $\frac{9}{10}$ water) and submitted to the action of the primary current. The action of the nitric acid is evidently to corrode the surface of the plates and give a better surface to the oxidation by the current. Secondary currents thus treated give in eight days after three or four changes of the primary current, discharges of long duration, whilst those made without the preliminary bath of nitric acid only give the same results after several months of operation. The new process thus renders M. Plantè's electrical cell of far more practical value than it has hitherto been.

ELECTRICAL ACCUMULATORS, OR SECONDARY BATTERIES.*

By Prof. Gaston Lucie, D.Sc.

(Continued from p. 61, Vol. XXXV.)

IN the last article I described a few typically important forms of cells which could be made with two clean lead plates immersed in dilute sulphuric acid, and connected at pleasure with a battery, galvanometer or bells. Before going on to the subject of coated plates, it may be well to draw attention to the consequences which a series of observations on plain plates will bring home to the experimenter.

If the surface of the plates are in the ordinary dull condition, he will find, on supplying two fresh cells to them through a galvanometer, that the charging current at first is considerably stronger than it is after a few seconds. He will notice that oxygen rises from the + plate before any hydrogen from the – plate, and that as soon as both gases are freely given off the charging current is considerably weakened. He can also, by reversing the electromotive force of the cell in this condition in very little below that due to two Grenets; it is, I believe, about 2 volts. If the plates are brightened up just before insertion in the acid, the charging current will be weak from the beginning, and oxygen will at once be given off. The strange phenomenon which is observed when the cell is left to itself once more is due to the absorption of the first-formed hydrogen by a coat of oxide on the – plate; and if for this plate we use a purposely oxidised piece of lead, the absorption of hydrogen, and the consequent small production of it during charging current, will continue for some time. The explanation of this is that the oxide of lead in contact with the + plate if it ordinarily coated itself with an absorbent of oxygen; but as this is not the case, no particular effect is noted when the surface is varied, unless, indeed, it be purposely coated with some oxidisable substance. To some extent nitrites and nitrates act both as oxidisable substances and depolarisers, but the latter are the more important and that the most under normal a current through two lead plates coated with litharge or minium than through two plates without any coating at all. The electromotive force of two thrown, which is almost compensated by two clean plates, is amply sufficient to send a strong charging current through two plates coated with red lead, until the coatings are both acted on, the gases no longer absorbed, and the cell full. As this state of things is approached the electromotive force of the cell gradually rises in a very decided manner.

With regard to the effect of amalgamating either or both of the lead plates with mercury, my experiments lead me to conclude that a mercurialised surface of a plate is worse than useless. A coat of oxide of mercury, whether it be left on the plate for a day or long as it adheres, and any rate does not much obstruct the action of the peroxide of lead; but there is a certain point in the discharge when this coat falls off in a sheet, carrying with it apparently whatever peroxide of lead is present too, for the discharge current suddenly falls to zero wherever the plate has been mercurialised. This is a curious observation, but the fact still remains that mercury is unsufficient, and therefore useless. Amalgamation of the – plate does, however, appear to help the occlusion of hydrogen, and is therefore so for advantageous.

The experiment of Professor Herschel, detailed in the last article, is repeated with a modification. Instead of using a plate of the coarse kind produced by a piece of cable that lead as the – plate, and a piece neatly coated with peroxide as the + plate; the current is very weak, and hardly able to ring a bell. But it will be found on careful inspection that this feebleness of current is only arrived at after a second or two; the current at first is much more of a quite strong. The real cause of the feeble current is the formation on the surface of sulphate or peroxide of lead, which forms on the clean lead plate the instant it is used to produce a current, and effectually screens it from the liquid. It causes, in fact, a sudden increase in the internal resistance of the cell. This can be proved in a very simple manner, by observing that the lead plate so treated does not absorb hydrogen with the same ease when opposed to hydrogen-coated lead, zinc, or anything. Wiping removes the film, and restores the full power to the cell. Allowing the plate to remain in the acid for some time also removes the film to some extent, but slowly. As long as any hydrogen is absorbed, and the lead it appears to sustain unlimited current; and the lead is unchanged, but as soon as the lead itself

* From the *Engineer*.

causes such as plod of water. After fixing, soak in three or six changes of water, and then transfer to a solution of acetate of lead. Again wash and dry into prints: then study each well.

FAURE BATTERIES AS A SPECULATION.

PUBLIC notice has once more been attracted to the Faure secondary battery for the economical storage of electricity, by the recent curious transactions between the English Company formed to work M. Faure's patents, and the notorious financier who appears to control the development of this remarkable speculation. It was recorded in last week's JOURNAL that the English Company who had addressed themselves to the work of manufacturing these accumulators had been constrained to alter their policy, at the bidding of M. Philipart, in favour of a mere Stock Exchange procedure. Instead of trying to make a business in accumulators batteries, the Company are therefore committed, by this last move, to the doubtful work of launching licenses or concessionary companies, looking for profit to the premiums to be extracted from these dastiful efforts. The true reasons for this sudden change of front are not given in the report of the meeting of shareholders at which it was consummated. The Chairman of the Company admitted, in as many words, that the alteration was against his wishes, and contrary to the opinions of the Board; but as M. Philipart had the majority of votes in his own hands, his demand was perforce complied with. Something was said at the time about a friendly action between the Company and another joint-stock undertaking, also subject to M. Philipart's influence, who were described as the owners of an accumulator which is the only possible rival of the Faure battery. It is by no means clear, however, how the interests of either scheme can be advanced by proposal to abandon manufacture and stop all sales while a process of improvement is carried on. Ordinary people, not likely to see the magic that still seems to cling to matters electrical, will be disposed to consider that this proceeding on the part of M. Philipart and his friends is intended to mask something else which was not desired to be known. Applying the common principles of trade to the circumstances, as they have been laid before the public, it does not require powers of deep perception, or a mind warped by prejudice, to conclude that the main reason for this change is that the old work of the Company did not pay, and has consequently been abandoned for a movement which is expected at least to reassure shareholders as to the safety of their capital. If the Faure Company could have made a reasonable profit, and could have looked forward with confidence to an unlimited business in the future, it is strongly suspected that M. Philipart is known to be, would not have been content to let matters go on steadily. The very reverse of indifference must have been at work to cause the abandonment of an undertaking that has only been recently launched at great cost, much of which has been expended in preliminaries that have now been rendered abortive. As it is only right to suppose that the enterprise of making accumulators was not a philanthropic venture, but a business undertaking for profit, we are justified in arguing that to relinquish it implies that its main object has not been attained.

There will show whether a great discovery of M. Faure, as it has been popularly regarded, whereby electricity was rendered able to shut up in a box, like Jack-in-the-box's genii in his turn, is now to be consigned to the limbo of failures. It is not so very long ago that the sanguine spirit of Sir William Thomson led him to indulge in those vivid descriptions of the best of energy which was sent from Paris to Glasgow, that afterwards turned out to be the beginning of the second great modern electrical *furore*. The production of this electric lighting by the dynamo machine actuated by steam power the consumer make his own gas. The result of this backward-lead at this time became an old story, and the occasional failures on the part of the Faure Company is to confirm the impression of the lighting were known to be inevitable so long as the work that was done in a hand-to-mouth manner from engine to lamp. If of the earliest experimental stage, and consequently not fit to be was felt that something analogous to the pasboilers of the older system of lighting, or the accumulator of the hydraulic press, was also necessary for electric distribution. At this juncture Sir William Thomson wrote the famous letter in which M. Faure's arrangement was introduced to the public; and when those supply, force, sometimes uncontrollably; the anode plates disintegrate only drawback of electric lighting had been removed. A name and so on. The accumulator is indeed no more a box of the hydraulic accumulator were paralleled at last.

The recent proceedings of the Faure Company, taken in connexion with the unaccountable delay in the business development of the system of electric storage by the Faure or Sellon-Volckmar system, will help to convince the general public—what many to be an electrical apparatus. "Indeed," remarks our contempo- people have known for some time—that secondary batteries are rary, "it will be readily understood that, inasmuch as lead oxide among the delusions of the age. When these appliances were first brought out, it was shown in the JOURNAL that their utility would be extremely limited, even if they did everything that could be suspected of such structures. When incandescent lighting divert the dynamo could not be shown to be on commercial way of working, it must be granted that interposing an extra pair of exchanges of energy in the process would only result in an increase of expenses, to say nothing of the additional labour and capital expenditure also thrown in with the disturbing battery. It was not known at this time that the structure of the so-called accumulator rendered it so uncertain in working that, for all practical purposes, no such arrangement could be said to exist. By statements appearing in a recent issue of the *Engineer*, however, we must cease to consider the Faure battery in any other light than that of a toy. How far this toy has proved to those who believed in it need not now be said.

It is no disgrace to any one to be unacquainted with the theory of the Plante battery, which is the foundation of all secondary batteries yet made; but a general knowledge of the structure and principle of these appliances is desirable for the clearing up of ideas and the explanation of the causes of difficulty and failure in working. According to the *Engineer*, it is not easy to learn how the Faure batteries are now made; but it appears that the cell is composed of two sheets of very thin lead, one 16 inches and the other 20 inches long, and both 6 inches wide. These plates are first thickly coated with red lead mixed into a thin paste with water, and a sheet of parchment paper is laid on this red lead. The sheets are afterwards covered with felt, and rolled up together; small slips of india-rubber being used to keep the surfaces apart. The roll is then put into a leaden vessel, and separate wires connected to the vessel and its contents. The cell thus constructed is filled with a weak solution of sulphuric acid, and the whole is ready for charging. "Such, then, is the Faure battery; nothing can apparently be more simple or easy to make." After this it is somewhat surprising to read that "the Faure battery has, in the strictest sense of the word, no commercial existence." Why does this conclusion follow upon such a seemingly favourable introduction? The answer is not far to seek.

One contemporary goes on to say that the battery just described —so simple that it can be made by any one used to laboratory work—can be charged either by a dynamo or by an ordinary gas main battery. So far, this is what has been said by all interested electricians. The accumulator would store up a weak or intermittent current during the day, and give it off as desired during the night in a form suitable for incandescent lighting—nothing simpler. Now comes the declaration that, after all is done by way of storing and charging the battery of one or more cells of the most approved fashion, "all these experiments have taught the same lesson—steady, that the battery is not trustworthy, save in the most experienced hands, and that even when used with great care it is liable to go to pieces and to prove worthless just when most wanted." The *Engineer* makes the serious suggestion that fire-engines are not half-a-dozen Faure batteries in existence which could be sent out to do a couple of nights' lighting with certainty. Strong language indeed is this to come from "the progress of electric storage" by the well-known circumstances of the previous failure of the Faure Company to supply charged batteries for the use of consumers. It is true that the managers have endeavoured to explain away this backward-ness on the part of the Faure Company is to confirm the impression which, in reasoning or reversing, gives up an uncertain premises. If by the existence of the battery, one or more cells are removed for the purpose of charging and discharging, the secondary battery cannot be said delivering during eight hours a current of 50. Each cell, in fact, represents over a hour-power of energy for one hour. Public demonstration will be made very shortly, and it is stated that probably within a few weeks, at the Crystal Palace Electrical Exhibition, 500 incandescent lamps will be shown running upon one set of 25 large cells of this new

as well while the battery is being charged as while it is being used; down, little can be more difficult to ensure than the permanence of the structure." We are sometimes oppressed with the sense of singularity when stating our deliberate conviction that, in matters of electric lighting, notwithstanding the dust and confusion raised by the multitudinous crowd of modern inventions, very little real progress is being made even from a purely philosophic point of view; while in the matter of business there is no progress at all. It is with considerable relief, therefore, that we record the opinion of the *Engineer*, that the red lead and suitable lead storage battery is at last here. It costs £40, and as cheap as it was in 1883.

It may be objected, against this very sweeping conclusion in favour of electrical accumulators in their present form, that the experiments at the Crystal Palace last spring, when the Admiralty Courts were lighted by Faure-Faure lamps served by Sellon-Volckmar batteries, and the occasional lighting of a railway train by the same means are proofs that there is some good in these inventions. A party of electricians have also enjoyed a few runs on the Thames in an electrically propelled boat; and Professor Ayrton has dazzled pedestrians, in the neighbourhood of Capel Court and elsewhere, with his tricycle driven and lighted by storage batteries. It may be answered that none of these trials can be considered to rest upon an ordinary commercial basis. As for the Palace experiment, it is known that tens of batteries were employed in this service; but, at what cost will never transpire. Some results of this class have been noteworthy as improvements to persevere in the same road; but it is absurd to pretend that commercially successful results have been even approximately realized. Those the dreams of many an enthusiastic journalist that the way is prepared for the universal distribution of power of electricity, in the same manner as milk is hawked from a cart—the same being warranted to wear and work well for lighting, cooking, heating, or driving domestic machinery—is yet far from realization. Again and again has this result been promised by the newspapers; but it is more certain than ever that many things must first happen. Forbearance among these necessary preliminaries we should be disposed to cite the emancipation of electrical science, whether concerned with problems of storage or otherwise, from the baneful influence of financiers or the Philippart stamp. With reference to the events which form the occasion for this article, *The Times* remarks that "sometimes the more new in terms of preparation; and the *Engineer*, with more knowledge, joins in the warning, and gives simple reasons for so doing: "There is not at this moment any secondary battery in existence, the success of which can be assured that the inventor would be justified in asking the public at large to invest in it." These are weighty words; but there is ample justification for their utterance at this time. What chance is there that the crude and uncertain Faure battery will continue to hold its own against everything that may be brought forward avowedly to supersede it during the next ten years? The world be a bold man who would affirm that science has said its last word on this subject; and yet, under any other conditions, the proposal of M. Philipart is worse than rash—it is foolish. It is in a measure fortunate, however, that the opportunity has been given to study the principles of the present condition of systems of electrical storage. The *Engineer* is to be thanked for the work it has done, and for the plain statements by which one more electrical illusion has been cleared away.

Iowa, March 1882

NEW ELECTRIC ACCUMULATORS.—It may interest those who have been looking forward to a practical application of electric lighting to private houses and to a possibly general use of the electric current from central offices, and of electricity, may be placed under ready command to know that great improvements have recently been made in electrical storage or accumulating batteries. It is stated that these improved batteries are of small size, have the facility and possess 24 times the storage capacity of those known as the Faure accumulators, and that they are of such a practical construction that they can be readily connected when necessary to the electric mains, and that the cost is less than that of the Faure. Each cell, of about 12 inches cubic foot in size, and consisting of sheet of lead, with metallic materials, is capable of containing 400 ampères, and of delivering during eight hours a current of 50. Each cell, in fact, represents over a hour-power of energy for one hour. Public demonstration will be made very shortly, and it is stated that probably within a few weeks, at the Crystal Palace Electrical Exhibition, 500 incandescent lamps will be shown running upon one set of 25 large cells of this new

THE COST OF ELECTRIC LIGHTING BY BATTERY.

IT has been announced of late that M. Trouvé has succeeded in producing a bichromate of potash battery capable of satisfactorily supplying incandescent electric lighting for domestic use. M. Hospitalier has experimented with these cells with a view to finding the cost of this method of lighting, and has communicated his results to the French Physical Society. With two batteries of six elements, connected in tension, six Swan lamps were maintained, when it regularly took from 8 to 5 ampères for 4½ hours, 5 minutes. The electro-motive force developed by the two batteries was 0·95 Siemens power per hour. The consumption of material was as follows:—Moulded zinc, 1·665 grammes; bichromate of potash, 2·300 grammes; sulphuric acid, 7·200 grammes. The cost of the material for these cells is easily found. The amalgamated and moulded zinc costs at least 1 franc per kilogramme; the bichromate of potash costs 2 francs per kilogramme; and the sulphuric acid 20 centimes per kilogramme. Thus in the present case the cost for a prime cost for material consumed of 7·70 fr., or (say) 6s. 2d., for maintaining during one hour six lamps of 16-candle power. If cost is increased to 9 fr., or 7s. 6d. for 16 candle-lamps. The cost of the same amount of light from common coal gas at 3s. per 1000 cubic feet would be 1·2d. This method of comparison is recommended the *Revue Industrielle* as a means of checking the fantastic calculations of amateurs of electricity. It is at least evident that incandescent lighting by battery power is not at this rate likely to be generally patronized.

Engineering, July 1887.

Engineering, June 1888.

The Faure Battery.

The first public exhibition of the Faure secondary battery in this country was that to which we have referred in another Note, where a number of Sturm coal oil lamps were maintained in incandescence at the conversazione at King's College on Saturday last. That we believe this quite a number of installations for lighting purposes have already been made in private houses, so that the full practical value of the apparatus will not long remain an unknown quantity. Meanwhile arrangements on a large scale are being made in London for the practical and commercial development of the invention. We have already taken pains to criticise the unwise and exaggerated claims made for the Faure battery in Paris with which the financial combination that had acquired the patents thought fit to take the public by storm, and pointed out that an interesting and valuable invention was likely to suffer from such a treatment. We are therefore the more gratified to learn that, in this country at all events, the value of the Faure battery is not likely to be damaged in the same manner, the sanguine of those gentlemen (especially that of Sir William Thomson) interested in the matter being a sufficient guarantee that no more will be claimed for the battery than it can fulfil. So far as light producing is concerned, Sir William Thomson probably suggested the real field for its usefulness, and as incandescent field it should be, when it be said that the battery would do for the electric light what a water-cistern does for an incessant house supply. It will also afford the means of obviating those interruptions in an electric light arising from irregularities in the motor, or from its temporary disablement, since if the dynamo-electric machine be employed to charge the batteries, and the latter are used to supply the light, the resulting current will be absolutely uniform. For working tramways not for some other purposes the batteries have been experimented upon with reasonable success, and doubtless much will be done with them in this direction. All this, however, is widely different from the original and sensational proposition to deliver batteries duly from house to house for giving light and power at prices competing with gas and steam; widely different, and infinitely more satisfactory, and within its legitimate limits, we may expect to see the Faure battery take a prominent place amongst the practically useful inventions of the day. Before dismissing the subject for the moment, we wish to correct two errors which have unfortunately appeared in a recent Note. The first referred to the date of the Faure patent, and stated that inasmuch as the date of this patent was the 26th of May, and that detailed descriptions of the arrangements had appeared in the public journals before that date, the validity of the patent may be called in question. So far from this being the case, the date of the patent specifying the Faure battery is dated January 11, 1881, long before any descriptions were made public, and subsequently patents have been granted in most other countries, including Germany and the United States, where objections of the most exacting kind successfully contested. The patent dated May 26, to which reference was made, is, we believe, for further modifications not yet ready public. The second error referred to the mode of charging the Faure battery. It was stated that it could only be charged by a voltaic battery. Were this the case the arrangements would of course be utterly without commercial value. As a matter of fact it can be charged by any direct current generator.

Accumulators and Metallogens.

Dr. H. Aron, of Berlin, who is well known for his investigations of secondary batteries, has entered scientific phraseology with the somewhat pacific term of metallogène, by which he denotes a mixture of any metallic oxide with collodion, the solution of gun-cotton in a mixture of alcohol and ether which is so largely used in photography. Dr. Aron's experiments commenced in the year 1883, when it appears that he, before the proposals of M. Faure became known, used plates consisting of spongy lead, which, however, he found in subsequent experiments suitable only as negative electrodes, the formation of anhydride of lead at the positive electrode probably disturbing the conductivity of the battery. Dr. Aron proceeds, it is stated, the use of minium, and once even asked his assistant to prepare a minium plate; he did not carry out the idea, as he considered it impossible to fasten the minium properly to its plate. Later on, however, he prepared a lead plate with a coat of minium and collodion made into a paste, and proceeding on those lines he obtained some interesting results. Metallogen seems to admit of further useful application. If the carbon of a Leclanché cell is brushed over with a paste of peroxide and collodion, the carbon rod needs no further adjustment, and may directly be placed with the zinc in the vessel containing the solution of chloride of ammonium without requiring a special porous cell. Dr. Aron further observed that to impart to the lead plate the necessary crystalline structure, it need not be placed in nitric acid previous to its further preparations, it will be sufficient to use a mixture of sulphuric acid with a little nitric acid in the battery, or, better still, to employ at first pure sulphuric acid, and then, after the lead has become covered with a thin coating of peroxide, to add the nitric acid, when this peroxide, being practically impenetrable to nitric acid, will prevent any too energetic action. Plates may thus be prepared to the depth of one half millimetre much more quickly than under ordinary circumstances, and they readily acquire a good charge, but they do not appear to be able to hold this charge so long as a Faure or Sellon-Volckmar battery.

would yield the illuminating power of 11·9 candles; but as an equivalent consumption of Paris gas only gives 9·6 candles, the ratio between them will be 81 per cent. The quality of the Paris gas will therefore be lower by nearly 20 per cent. than that of the London gas; in other words, the standard for gas in London being 16 candles, that for the Paris gas would be (16×20·8) 12·96 candles. Such would be the result if the matter could be treated by simple calculation. But this evidence of inferiority would not be correct: inasmuch as with the London standard burner the gas is consumed under much better conditions than with the Paris burner. The character of the burner has an unquestionable influence on the illuminating power of the gas; and not to take this fact into account is, of course, to make a very serious mistake—such a mistake as would be made by comparing two gases of different qualities on the one burner, for example, in a flooped burner, and the other in an ordinary straight-slit burner; although it is perfectly well known that, in order to obtain the light of 1 Carcel it is necessary to consume 2·7 cubic feet of Paris gas in the former, and 4·5 cubic feet in the latter. In this matter, therefore, the only conclusive experiments are those which are direct. The experiments made in the Municipal Laboratory of Paris by M. P. Leblanc, the Official Gas Examiner, and contained in a report of M. Huet, the Sub-Director of Works, gave 14·7 candles for a consumption of 5 cubic feet of Paris gas when it was burned in a London standard burner. The inference, therefore, would be only about 8 per cent.; and not 19 per cent. Even when operating with a Bunsen photometer, such as is used in London for official gas testing, it has, we are told, occasionally been found that Paris gas has shown an illuminating power of almost 16 candles. Proceedings then to endorse the discrepancies in the estimation of the value of the Carcel which have recently been brought out by M. Schlæsser's experiments (to which reference has already been made in the JOURNAL), M. Cornudet remarks that it is difficult, in the presence of such divergencies, to rely with certainty upon the average of a small number of tests; and therefore he says it will be necessary to avoid the results of repeated experiments, specially made in London with the Paris apparatus, and particularly with the same kind of photometer, in order to be absolutely correct. He considers, however, that in the meantime we shall not be very far from the truth in reckoning 14 English candles as the illuminating power of Paris gas, as compared with London gas of 16 candles. He then recites briefly the regulations in force in the Metropolis in regard to the pressure and purity of the gas, and the duties of the Chief Gas Examiner; and with these observations the first portion of the paper closes.

We next come to the statistics of the four Companies who were supplying London with gas at the time the paper was written. In preparing this section of his work, M. Cornudet has, of course, drawn extensively on Mr. Field's "Analysis," as well as on the half-yearly reports of the Companies, for the sake of brevity and clearness; and this he acknowledges. He has, however, converted the figures into their French equivalents; and this has necessarily involved labour for which the readers should thank him. These figures, though interesting and instructive to a foreigner, as showing the importance of the London Metropolis, are scarcely need reproduction in these columns. The tables give the quantity of coal and coke carbonized, the growth of the consumption in the years 1879-82; also the quantity of gas made and sold, the loss by leakage, and the annual percentages of increase in consumption. The stations of each Company are specified; and they are likewise indicated in a general map annexed to the paper, showing the districts of supply. M. Cornudet then proceeds to deal with some of the statistics in a manner which will be equally interesting on both sides of the Channel. He compares them with those of the gigantic Company in Paris (la Compagnie); and concludes the paper with some remarks on the conditions under which the gas companies carry on their business in country and suburban districts. These remarks are important enough to justify their consideration in another article.

Gas and Water Companies in the Money Market.

During last week the amount of business done in the Gas Market, with an absence of the violent fluctuations produced by sharp speculating on the dear coal question, left the Gaslight and Coke and South Metropolitan Amalgamation Schemes going their own sweet way. There is nothing but to wait and see how it will fare at the hands of the Board of Trade. In the meantime, the prices of the stocks are not high enough for recent buyers for a rise to realize upon; while they are too high for those who have to look to consumers upon now. The they remain pretty stationary. But they can scarcely be called firm: for even the buyers of the separate Companies's securities to admit that it is far from being free from serious difficulties, some of which have been already mentioned in our columns. In ultimate fate depends upon whether the Board of Trade may consider them to be susceptible of modification; or, on the contrary, may find them of such a nature as to place it beyond the statutory powers of the Board in regard to amalgamation to sanction. Them will probably be no lack of opposition, or demonstration of opposition, of a kind, on the part of the Vestries and District Councils; but if they can see their way to gaining anything by a compromise, they are not likely to take up the contention that the Scheme is absolutely objectionable, and *ultra vires* of the Board. Imperial Continental has been in good demand, and shows no advance of 6. Oriental, too, continues to improve.

* See Vol. XLI., pp. 938, 1007.

Three weeks ago we drew special attention to Water Stocks as giving good promise of improving prices. Since then all the Companies have made substantial advances; and their progress upward is still very well maintained. Chelsea and West Middlesex have gained 8 each; Southwark, 9; Kent, 6; and New River (which we noted last week as being underpriced) is now marked 5 higher.

The markets closed at the end of the week as follows:—

Issue	Paid	When Dividends Due	Price Nov. 9	Price Nov. 16	Rise or Fall	Name.	Paid up Capital	Quarter Pence.	Last Dividend Paid.	Yield per cent.
£	£				p. c.	GAS COMPANIES.				£ s. d.
980,000	10	15 Oct.	18	18	—	Alliance & Dublin Con. Stock	10	10—12	—	5 11 6
200,000	5	31 May	15	15	—	Bombay, Limited	5	15—15	—	5 0 0
1,000,000	10	15 Oct.	23	23	—	Brighton Consolidated	10	20—20	—	4 6 0
100,000	10	31 May	12½	12½	—	Cambridge	10	12½—12½	—	4 0 0
12,692,800	Stock	31 Oct.	125	125	—	Commercial, Old Stock	100	250—250	—	3 12 1
1,000,000	10		2	2	—	Do. New Stock	100	5—5	—	5 0 0
750,000	10	28 June	14	14	—	Do. Do. Scrip, &c.	100	28—28	—	5 0 0
857,200	20	25 June	9			Continental Union, Limited	20	21—22	—	5 12 0
2,000,000	10		7			Do. New Scrip	10	17½—17½	—	4 0 0
750,000	10		7			Do. 7 p. Cent. Pref.	10	17½—17½	—	4 0 0
291,600	17	27 July	11			European, Limited, New	25	42½—42½	—	3 16 0
60,000	10		11			Do. Scrip	10	17½—17½	—	3 16 0
172,000	10		11			Do. Do. 7 p. Cent.	10	17½—17½	—	3 16 0
1,000,000	Stock	15 Aug.	11			Gaslight & Coke, A. Ordinary	100	125—125	—	4 0 0
1,000,000	10		11			Do. Consolidated	10	21—21	—	4 0 0
833,000	10		10			Do. C.D.&E. Scrip, 4½	100	225—225	—	4 0 0
833,000	10		10			Do. C.D.&E. Scrip, 5	100	225—225	—	4 0 0
833,000	10		10			Do. C.D.&E. Scrip, 6	100	225—225	—	4 0 0
1,500,000			11			Do. 7 p. c. Pref.	10	34½—34½	—	4 0 0
1,000,000			11			Do. 8 p. c. Pref.	10	34½—34½	—	4 0 0
1,000,000	10	28 June	11			Do. 10 p. c. Pref. Stock	100	250—250	—	4 0 0
1,000,000	10		11			Do. 10 p. c. do.	100	125—125	—	4 0 0
1,000,000	10		11			Do. Scrip	10	17½—17½	—	4 0 0
2,000,000	10	31 May	12			Imperial Continental	100	125—125	—	4 0 0
1,000,000	10	31 May	10			Independent Gas	10	25—25	+ ½	4 0 0
1,000,000	10	31 May	10			South Metropolitan, 5 Stock	100	250—250	—	4 0 0
1,500,000			11			Do. 6 do.	100	250—250	+ 5	4 0 0
1,500,000	10	28 June	11			Do. 6 p. c. Pref.	10	34½—34½	—	4 0 0
						WATER COMPANIES.				
600,000	Stock	28 June	71			Chelsea, Ordinary	100	100—125	+ 8	3 11 5
1,000,000	10		7			East London, Ordinary	100	100—100	—	4 0 0
1,000,000	10		7			Grand Junction	100	100—100	—	4 0 0
1,000,000	10		7			Kent, Limited, Ordinary	100	100—100	+ 6	4 0 0
852,427	10	31 Dec.	15			Lambeth, 10 p. c. cons.	100	125—125	—	3 11 1
1,000,000	10	31 Dec.	15			Do. 10 p. c. Preference	100	125—125	—	3 11 1
125,000	Stock	31 Sept.	15			Do. 6 p. c. Deb. Stock	100	150—150	—	3 19 1
1,000,000	10	31 Dec.	15			New River, Ordinary	100	125—125	+ 5	3 12 0
1,000,000	10	31 Dec.	15			Do. 10 p. c. Preference	100	125—125	—	3 12 0
714,200	Stock	15 June	8			Rivers & Vitruvian, Ord. c. cons.	100	137—150	+ 3	3 13 1
1,250,000	10		4			West Middlesex, Ordinary	100	100—100	+ 8	4 0 0

Incandescent Electric Lighting by Means of Accumulators.

MM. D. Mosnier and A. Gorrissen have reported to the French Metropolitan Electrical Syndicate upon the vessel operation of the application of the Sellon-Volckmar secondary accumulators to electrical lighting and mechanical traction. This is a part of the general inquiry undertaken by these investigators, at the instigation of a syndicate specially formed for the special purpose, and anxious to ascertain the truth of the matter, divested of interested colouring. The minutes of the report leave no doubt on the subject of accumulators is to collect, in the form of chemical action, electrical energy supplied to them from an exterior source, and to restore this energy in the form of electrical currents by virtue of inverse chemical reactions. This double transformation cannot be realized without a loss of work, which it is very important to value as exactly as possible. The duty of an accumulator is the ratio between the quantity of electricity supplied to it and that which is given up by it in its discharge. This coefficient was determined experimentally with a battery of 10 cells, of the 17·5-kilogramme *type*, which was received full charged. The battery was discharged, recharged, and then discharged alternatively four times. The final discharge was stopped at the moment when the battery was in the same electrical state as at the commencement of the first charge. It was thus ascertained that (1) the total quantity of electricity restored by discharging was equal to 81·95 per cent. of that supplied in the charge (this was the *duty in quantity* of the battery); (2) the sum total of energy restored by the discharge was equal to 62·14 per cent. of that supplied in the charge (this was the *duty in work*—which is really the most important result in practical use).

The capacity of an accumulator is measured by the total work which it is able of performing after having been entirely charged; but, in practice, accumulators are never completely discharged, because the last hours of a thorough discharge would only furnish a feeble flow of energy which it would be difficult to utilize. The energy remaining in the accumulator at this instant is not entirely lost, but constitutes a permanent reserve necessary for the regular working of the apparatus. (Would it be right to liken this quantity to the residual charge of gas in the dome of a gasholder?) The practical capacity of an accumulator, then, is less than its total capacity, and is measured by the useful work capable of being extracted from the cell before it has to be recharged. Thus it was found that the battery of 10 elements in question, containing 175 kilogrammes of useful material, was capable of supplying continuously a total work of 470,352 kilogrammètres, or 2·4841 horsepower-hours; which corresponds to 14·2 hour-horsepowers per tonne of useful material, or 70 kilogrammes of useful material per hour-horsepower. The mean yield of the battery was 14·76 ampères, or 0·84 ampères per kilogramme of useful material contained in one cell of the series. The capacity ascertained from the preceding determinations is not absolute; and it is probable that in consequence of improved methods of construction, the weight of

EXPERIMENTS ON THE ESTIMATION OF LEAD AS LEAD DIOXIDE BY MEANS OF THE ELECTRIC CURRENT.*

By Frank Dyson.

These experiments were undertaken to investigate anew the practicability of the determination of lead as lead dioxide in acid solution. The first experiments in this direction were made by Luckow† and by Moor.‡ They used a solution containing copper and 2½ per cent of free nitric acid (calculated as anhydrous HNO_3), and obtained in this solution satisfactory results, weighing the lead as lead monoxide, into which the dioxide was converted by ignition. Luckow§ says: "The complete precipitation of the lead occurs only in the presence of at least 10 per cent of free nitric acid, if only lead be present. If the solution contain copper also, less free acid is required. With less than 8 per cent free nitric acid, lead is liable to be thrown down on the negative pole with the copper as metal."

Hilpert‖ proceeds in the same way as Luckow, but warms the solution to 60 degrees in Bohgreen. The work of Pierail¶ and Meeczatzi in solutions containing tartrates, and of Classen and Von Reis** in oxalate solutions, relates to the precipitation of metallic lead, and has therefore little connection with the present subject.

The substance used for analysis in the present experiments was lead nitrate whose purity was proved by estimating the lead. This was done by igniting the lead nitrate and weighing the residual oxide, PbO.

Two determinations gave:

	I.	II.	Theory
Weight PbO, obtained	0·6600	0·6723	required.
Weight PbO, theory	0·6365	0·6543	
Per cent of Pb	67·5600	67·5647	67·54

A solution was made of this lead nitrate containing 1·6600 grams to the liter, and 25 cc. of this solution were taken each time for analysis. Of this solution, 25 cc. should yield 0·6366 gram dioxide.

In a neutral solution, the lead was deposited partly as metallic lead on the negative, and partly as lead dioxide on the positive electrode. Three portions of the solution were then taken, and to No. I. 14 per cent of free nitric acid (calculated as anhydrous HNO_3), to No. II. 5 per cent, and to No. III. 10 per cent, were added. After sixteen hours' action of the current, the lead dioxide thrown down was found to be:

	I.	II.	III.	Calculated.
	0·6358	0·6355	0·6360	0·6366

The coating on No. I. was not strongly adherent.

In the next trial, No. I. received 10 per cent, No. II. 18½ per cent, No. III. 10½ per cent of free nitric acid. The results were:

	I.	II.	III.	Calculated.
	0·6360	0·6724	0·6360	0·6366

In the next trial, 50 cc. solution of lead nitrate were taken and ten per cent of free acid added. The results were:

	I.	II.	III.	Calculated.
	0·6218	0·6181	0·6452	0·6533

In No. III., owing to irregularity of the current, the dioxide came down unequally and scaled off readily.

A solution of copper containing 0·2360 gram copper in 25 cc. was made up, and three portions, each containing 25 cc. of this solution and 25 cc. of the lead solution, were subjected to the action of the current after adding to No. I. 5 per cent, to No. II. 8 per cent, and to No. III. 10 per cent of free nitric acid. The results were:

	I.	II.	III.	Calculated.
	PbO_2.	Cu.	PbO_2.	Cu.	PbO_2.	Cu.	PbO_2.	Cu.
	0·6358	0·2360	0·6324	0·2364	0·6375	0·2360	0·6366	0·2360

The copper was in all cases slightly black.

In presence of iron with 14 per cent, 7 per cent, and 10 per cent of free acid, the results were:

	I.	II.	III.	Calculated.
PbO_2	0·6031	0·6255	0·6236	0·6366

The lead ore scaled off badly, thus accounting for the low result. The electrodes used had areas of 19·18, 19·19, and 40·40 square centimeters respectively.

To sum up, one may say this method is reliable where the amount of lead is not too large and where there is a sufficient amount of free nitric acid present. Where the lead does not exceed 0·05 gram, it may be thrown down as lead dioxide and weighed on ordinary electrodes. Where larger amounts are present, aliquot parts of the solution must be taken, or a platinum dish may be made the positive pole. The lead dioxide washed by decantation.

Since these experiments were made, this method has been largely used in this laboratory for the estimation of lead in galena and in slags and mattes. From 10 per cent to 20 per cent of free nitric acid should be present; if there is too much, the lead dioxide, as fast as it is thrown down, redissolves in the nitrous acid resulting from the decomposition of the strong nitric acid. In slags and mattes, therefore, the decomposition and possibilities of a Faure battery which had been sent to him from the laboratory of the inventor in France. His words aroused much attention, and the staff of the leading journal being on the alert, a cleverly constructed leading article in the next issue of the paper was devoted to the subject. The main point made by the professor was in the announcement that a million foot-pounds of energy, available for the production of power, light, or heat, was stored up in the 75 lbs. weight of metal composing the battery in question. Large numbers have a wonderful influence on the popular mind, and therefore it is not surprising that such a nominally great power, boxed up in a few sheets of lead, should have thereby the newspaper writer, and probably many others besides. It was not long, however, before another scientific man arose to state that Sir W. Thomson's figures meant so little that the wonderful box of M. Faure was equalled in value, as a source of work, by a piece of common coal weighing 14 ozs., which could be sent anywhere in a letter. Much of the dispute between the two professors and their respective followers, which caused upon this striking disclosure, is more fencing with the main issue. The facts appear to be that Sir W. Thomson had allowed himself to indulge in a little imaginative computation, strictly true, of course, from a theoretical point of view; and that Mr. Osborne Reynolds, in answering him in such a peculiar manner, also dealt in an imaginative manner with facts which, although real enough in their way, are scarcely capable of practical interpretation. In other ways, however, Mr. Reynolds shows a capability of sticking in hard every-day truths which it might have been hoped Sir W. Thomson would have also shown, instead of making a parade of strictly theoretical considerations without qualifying them as such. Mr. Reynolds maintains that even where the source of power to be converted into electricity and back again costs nothing for maintenance—such, for example, as the water power of Niagara, to which Dr. Siemens looks, as becoming a supply of energy for almost the whole of the United States—the bare cost of the conductor, and means of converting the current into work, must be more, even as a matter of carriage, than the transport of so much coal or wood will be needed to develop the same power at a given distance. He also considers that the effect of the use of electricity for conveying power, &c., will only tend to enhance the value of coal, rather than to supplant it. These fundamental considerations are, of course, unaffected by the discovery of the secondary or storage battery, for if electricity in current will not compare favorably in cost with coal as a carrier of power, so much less will the bottled article affect the value of anything in which coal is used. The discussion is interesting as a specimen of scientific fencing; but we are disposed to question its utility, whichever side may be considered to have the weight of evidence in its favour.

THE STORAGE OF ELECTRICITY.

Our contemporary *Engineering* devoted a considerable amount of space in its issue of the 21st inst. to observations on M. Faure's secondary battery, intended to store electricity for transit, or for keeping over any required period. It points out the true place of the Faure battery in an electrical distributing system to be very different from that of a reservoir or gasholder in the case of water or gas supply, to which it may unthinkingly be likened. In reality, the electric energy in this battery is stored up precisely as power is stored in a coiled spring or a reservoir of compressed air. The fact is, of course, very remarkable, and may be useful in its way; but it is not storage as implied in the sense of the reservoir of water or gasholder respectively—*i.e.*, an arrangement of a superfluous portion of the thing employed, so as to be instantly available to compensate for irregularities of consumption. It is, as pointed out by our contemporary, more analogous to the storage of water in a cistern for carriage from one place to another as a substitute for delivering it through pipes. M. Deprez, in a communication to *L'Electricien*, also demonstrates that the useful effect of the Faure battery cannot be so much as is claimed for it. This able critic maintains that not more than 82·5 per cent. of the power spent in charging it can ever be obtained again in actual work. Meanwhile, it is unfortunate that the merits of M. Faure's invention are likely to be obscured in a haze of speculation which has already set around it. Financiers have obtained a hold of it, and are promoting the wildest calculations respecting the amount of busine and profits to be derived from the use of stored electricity for lighting and supplying power to the residents of Paris. Our leading contemporary does good service by exposing the fallacy of these estimates, and points out that even if M. Reynier's laboratory experiments can be always and everywhere repeated, small power could be obtained by the use of a gas-engine, at less-than one cent of 8 Faure battery and of the electric motor necessary to transform it into power, is regard to lighting the disadvantage is still more apparent. To obtain, say, 1000-candle power for ten hours, not less than 1650 lbs. weight of batteries would be required, even if the whole energy of the battery could be utilised; but as the energy of the current falls very rapidly after about two-thirds of the cit has been exhausted, a large additional weight of batteries would h to be provided. Assuming that, from these considerations, one t of batteries would be required to give out the light of 1000 candl for ten hours, this weight of apparatus would have to be charg delivered, and the engine collected every day, and if the pr paid by the consumer for all this service exceeded 3d. per hour would be hopeless out of competition with the current system electric lighting. It will thus be seen how little chance of succ for the Compagnie Anonyme de la Force et la Lumière, which is form to work the Faure battery system, possesses.

Stored Electric Motor Power.—

A few days ago a practical illustration of the above was given in Paris. An ordinary three-horse tramcar made a tour of the principal streets of the city by means of Faure accumulators, placed under the seats, and connected with a Siemen's machine placed beneath the floor. The apparatus is, however, somewhat heavy, for it is described as weighing fifty hundredweight. The machine, which makes twelve hundred revolutions a minute, sets in motion, by means of a pulley, an axle, to which are connected the chains which give impulse to the wheels. These wheels revolve sixty times to twelve thousand revolutions of the machine. The speed of the electric tramcar is stated to be nine and a third miles an hour on level ground, and five and a half miles on an ascent, though how a distance of thirty English miles was traversed in three hours at the above speeds, stoppages included, is not clear. The experiment was considered to be a great success from all points. It was the longest distance ever traversed by means of electricity. The apparatus was under perfect control, and the estimated cost is one half that of horse power.

SIR W. THOMSON ON THE FAURE BATTERY.

The secondary battery of M. Faure has afforded Sir William Thomson and other scientific notables a good exercise in correspondence in the columns of *The Times* during the past week. The Glasgow professor commenced the episode by describing, in his accustomed striking manner, the powers and possibilities of a Faure battery which had been sent to him from the laboratory of the inventor in France. His words aroused much attention, and the staff of the leading journal being on the alert, a cleverly constructed leading article in the next issue of the paper was devoted to the subject. The main point made by the professor was in the announcement that a million foot-pounds of energy, available for the production of power, light, or heat, was stored up in the 75 lbs. weight of metal composing the battery in question. Large numbers have a wonderful influence on the popular mind, and therefore it is not surprising that such a nominally great power, boxed up in a few sheets of lead, should have thereby the newspaper writer, and probably many others besides. It was not long, however, before another scientific man arose to state that Sir W. Thomson's figures meant so little that the wonderful box of M. Faure was equalled in value, as a source of work, by a piece of common coal weighing 14 ozs., which could be sent anywhere in a letter. Much of the dispute between the two professors and their respective followers, which caused upon this striking disclosure, is more fencing with the main issue. The facts appear to be that Sir W. Thomson had allowed himself to indulge in a little imaginative computation, strictly true, of course, from a theoretical point of view; and that Mr. Osborne Reynolds, in answering him in such a peculiar manner, also dealt in an imaginative manner with facts which, although real enough in their way, are scarcely capable of practical interpretation. In other ways, however, Mr. Reynolds shows a capability of sticking in hard every-day truths which it might have been hoped Sir W. Thomson would have also shown, instead of making a parade of strictly theoretical considerations without qualifying them as such. Mr. Reynolds maintains that even where the source of power to be converted into electricity and back again costs nothing for maintenance—such, for example, as the water power of Niagara, to which Dr. Siemens looks, as becoming a supply of energy for almost the whole of the United States—the bare cost of the conductor, and means of converting the current into work, must be more, even as a matter of carriage, than the transport of so much coal or wood will be needed to develop the same power at a given distance. He also considers that the effect of the use of electricity for conveying power, &c., will only tend to enhance the value of coal, rather than to supplant it. These fundamental considerations are, of course, unaffected by the discovery of the secondary or storage battery, for if electricity in current will not compare favorably in cost with coal as a carrier of power, so much less will the bottled article affect the value of anything in which coal is used. The discussion is interesting as a specimen of scientific fencing; but we are disposed to question its utility, whichever side may be considered to have the weight of evidence in its favour.

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* From the *American Chemical Journal*.
† Zeitschrift für Analytische Chemie, II. (1863), 0-12; 19 (1880), 1.
‡ American Journal of Science, [2], 35.
§ Zeitschrift für Analytische Chemie, III. 13.
‖ Annales de Chimie et de Physique [6], 12, 560.
¶ Comptes Rendus, 1882, 94, 1, 600, 1882.
** Berichte der Deutschen Chemischen Gesellschaft, 14, 1622.

Storage Batteries.—Prof. Henry Morton recently read a paper on the storage of electricity in the meeting of the New York Electrical Society, at the Stevens Institute of Technology, in Hoboken. Edison incandescent lamps lighted the room, a two horse-power Weston electric motor stood on the future-table, and the lamps and motor were furnished with electricity from the Sellon-Volckmar accumulators. Professor Morton briefly described the principles involved in the present methods of electrical storage. He then explained the structure of the Sellon-Volckmar battery, which consists of plates, each made of a fine lattice-work of metallic lead, filled in with a peculiar mass, which was in one case a lead oxide and in the other lead sponge. The experiments made by the lecturer showed that each cell of two amperes for nine hours, with an electromotive force of about two and one-tenths volts, a quantity of current sufficient to supply forty-four of the Edison incandescent lamps of 16 candle-power, with only 80 pounds when ready for work, so that for each light of 16 candles, burning one hour, 10 pounds of battery should be provided. It is customary to add solely as a reservoir to contain the current required. Experiments with the lights in the room were made to show that the battery in many cases would only be required to act as a regulator, simply taking up the temporary excess of the entire amount of electricity used, and providing for a temporary deficiency. By connecting the lights directly with a dynamo, its current was made to fluctuate so that the lights flashed up or failed according as the current was strong or weak. By connecting the dynamo with the battery, so that any excess of current could flow into it, or any deficiency be supplied by it, the lights burned perfectly steadily. Touching on the question of using the storage batteries as a means of driving street cars, Professor Morton said that his measurements showed that each battery of 80 pounds weight contained energy equal to about 1,000,000 foot-pounds, and would thus take a one-horse car full of passengers across town, or from one end of the city to the other.

Charging Accumulators.

Owing to the high resistance of electric incandescent lamps as compared with arc lamps, the ordinary dynamo cannot be used to feed them unless they are grouped in series, or unless a shunt of a minute, sets in motion, by means of a pulley, an axle, to which are connected the chains which give impulse to the wheels. These wheels revolve sixty times to twelve thousand revolutions of the machine. The speed of the electric tramcar is stated to be nine and a third miles an hour on level ground, and five and a half miles on an ascent, though how a distance of thirty English miles was traversed in three hours at the above speeds, stoppages included, is not clear. The experiment was considered to be a great success from all points. It was the longest distance ever traversed by means of electricity. The apparatus was under perfect control, and the estimated cost is one half that of horse power.

Charging Accumulators.

Owing to the high resistance of electric incandescent lamps as compared with arc lamps, the ordinary dynamo cannot be used to feed them unless they are grouped in series, or unless a shunt of a little sulphides are dissolved in nitric acid, and the solution evaporated. A perfect and complete separation of the lead and copper is obtained. The small amount of sulphuric acid formed by the oxidation of the sulphides in nitric acid does not affect the accuracy of the determination.

Massachusetts Institute of Technology,
Boston, Mass.

Journal of Franklin Inst. May 13, 1880

Engineering & Mining Journal May 13, 1880

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ANOTHER ELECTRICAL SPECULATION.

A partial revival of excitement in the world of investors who believe in the eventual use of electric force for every kind of work under the sun is announced by a contemporary, which hastens to warn off those who might otherwise be victims of the astute financiers who have addressed themselves to the task of raising money, ostensibly for the purpose of working M. Faure's patents for the storage of electricity. M. Philipart, of European celebrity in connection with banking operations—which, however, came to grief some time since—is said to be receiving much support in France for a Company formed for the purpose of supplying portable electricity for lighting, motive power, &c. A peculiarity of this enterprise lies in the proposal to devote some of the enormous profits anticipated to be made in the electric business to the relief of the ruined shareholders of the ecclesiastic promoter's defunct bank. It is, perhaps, hardly to be feared that M. Philipart, or any of his followers, will achieve such success in this country if the experiment should be tried; but it is well to remark, as we are likely to hear loud things said of M. Faure's battery for storing electricity, that there is no commercial advantage to be expected from its use over what may be derived from the continuous current. We know what the electrical and magnetic power companies are doing, and should those even succeed in widely extending their business, the profit to be gained by the use of storage batteries would, still have to be proved. It is known that gas can be supplied through pipes with perfect success, as electric energy can be transmitted through continuous conductors; but the Portable Gaslight Company found that they could not send out gas in carts and make a good return, and the same fate would certainly overwhelm an undertaking to distribute bottled magnetism while the regular article, in bulk, is not yet established in the market.

A New Application for the Faure Battery.

—Recently a horse-car was run in England by means of the Faure accumulator and a dynamo machine connected by cog-wheels and gearing to the axles. The distances traversed were about 24 miles. The dead-weight of the car was 3½ tons; the speed reached seven miles an hour, although the car was not of the most advantageous build for the purposes of the experiment. The experiment was successful, stopping and starting the car being effected with great promptitude.

The Planté Battery for Electric Light Purposes.—The most promising of the recent inventions in electric lighting, so far as its application is concerned, is the secondary battery, with the use of which portable electric lights may be obtained. A resumption of ambient Planté Tessen, is the result of some experiments as to the efficiency of the Planté battery, as applied to electric lighting. The object of these experiments was to ascertain the power contained in charging the battery, and the hours. It took 9,500,000 kilogrammetres to charge the battery with 6,000,000 kilogrammetres, and the work returned was 3,800,000 kilogrammetres, or 40 per cent of what had been stored in the battery.

The Lighting of Carriages by Electricity.—

Particulars of the practical application of electricity to the lighting of carriages are to hand. The late Lord Mayor's carriage, when proceeding to and from the banquet held at the Guildhall, on the 9th inst., was lighted electrically, the current being generated from Gaudi's patent primary battery, placed under the coachman's seat. This is the first time a carriage has been lighted by electricity in England. The installation was carried out on a similar principle to that recently used by Baron Rechenthal in Vienna. The second instance is given by the correspondent, at Rome, of the *Morning Post*, who writes: "The Milan omnibus and brougham companies have made experiments to light their vehicles by electricity. The experiment was most successful, and it is considered likely that the system will be applied."

STORAGE OF ELECTRICITY.

A NEW secondary battery, of greatly enlarged capacity, is now attracting attention in Paris. It is the invention of M. Faure, but is confessedly a development of the well-known secondary battery of M. Planté, which is formed of sheet lead immersed in acidulated water. The latter gathers copiously on the recurved charging and discharging is repeated, through increasing thickness of the layer of peroxide of lead that is slowly formed by the process. M. Faure has conceived the idea of exciting the peroxide, with layers of minium, or the red oxide of lead, and by this means the capacity is greatly increased. The peroxide so formed is stated to have forty times the power of accumulation of the Planté. A battery weighing 75 kilogrammes will receive 1,500 kilogrammetres, or 400 ampère-hours, during one hour. As to the nature of the chemical changes that are exerted upon the surface of the minium in presence of the positive electrode, and to reduce lead on the negative, the peroxide of the reduced lead is oxidized, and the precharging lead is reduced. The battery was lately exhibited by M. Hyppite in the Society for the encouragement of National Industry. There were 21 couples weighing seven kilogrammes each connected in a Siemens excitation of minium sites, there furnished a work of 1,000 kilogrammetres, with about a third of M. Hyppite's figures, but the conditions were unfavourable. Next, a band of platinum, one millimetre long, 12 millimetres broad, and 0·05 of a millimetre thick was made to glow; then two incandescent lamps were lighted. The superiority to the Planté battery was still demonstrated. Some experiments were made lately at Hospitalfield by M. Faure's battery as a means of distributing electricity to any house or working machinery, and the results that may be supplied, and flow from the drawbacks of a system of canalisation. The method is also regarded as very promising for domestic electric lighting. A carriage, it may be added, has been lighted in Paris by M. Philipart, for obtaining from and by electricity, by assimilation of the irregular action of the heart. A Hospitalfield has pointed out the expensiveness of charging the Faure battery with electricity from chemical action.

APRIL 17, 1880.] THE ENGINEERING AND MINING JOURNAL. 271

NOTES ON BATTERY AND COPPER PLATE AMALGAMATION.*

FROM THE MINING LABORATORY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

By Robert H. Richards, B. S. Professor of Mining.

Very little has been published recently on this subject in the mining journals or the proceedings of societies.

The attention of experts has been diverted perhaps partly by the demands for pan amalgamation in refractory ores. Yet free milling ores occur in many localities, and it may be interesting to have on record the views and methods of running a small battery, especially as details of results do not seem to be accessible to students and investigators.

Rhodel, in 1881, under battery amalgamation, discusses the subject by stating that "Amalgamation on copper-plated platforms, troughs and other copper fittings," is very imperfect, and usually abandoned.

J. Arthur Phillips states, in 1867, under placer mining: "A well-amalgamated copper plate is considered as effective for saving fine gold as an equal surface of pure mercury."

In Dr. R. W. Raymond's reports, I find in two volumes mention of amalgamation by copper plates.

In 1871, in an admirable article by N. S. Keith on the preparation of amalgamated copper plates, he states: "The discovery of the utility of sand-amalgamated copper plates in the treatment of auriferous rock in the mill was simplified and cheapened the metallurgy of gold that it is now profitable to mine and reduce many gold-bearing ores and rocks that formerly would not pay."

In Dr. Raymond's report in 1872, J. A. Church discusses the use of copper plates with reference to his theory of amalgamation. I am unable to find any allusion to the use of amalgamation in either Hiltinger's or Gustzach-mann's excellent works on *Allgemeine Hüttenkunde*.

Our experience at the Massachusetts Institute of Technology has been as follows:

In the winter of 1872, the little five-stamp battery was started in good earnest. Small lots of ore, successively from North Carolina, Georgia, Colorado, and New Hampshire, were run in the mill and over the plates. After each run, the plates were cleaned up, and the amalgam retorted, gold, therefore, was not as clean as we could have hoped, but the yield of gold fairly would not pay.

In the winter of 1873-4, the battery was remodelled, for causes which will be partially accounted for later on in this paper.

After the last of these runs, the plate was scraped a second time, and, to our dismay, some more gold was obtained; a third time, and more gold. We began to wake up to the fact that we had been crediting North Carolina ore with Georgia gold, and so on. This difficulty seemed so apparent, and seemed so inextricable, that we well-nigh despaired of ever using the mill in making careful quantitative tests. I shall speak of this difficulty, in the course of this paper, as the overcoming of "dead gold."

Until 1876, we did nothing more with the mill, owing to other cares. During that year, however, we added a new expedient, or overcoming the overlapping error. It was to purchase the thinnest copper that could be found in the market, about 1/64 inch thick, and to use a new set of plates with each run, dissolving the old ones in sulphuric acid at the end of the run. This method of overcoming the dead gold. We found, to be sure, but after much trouble: and in this way we entirely overcame the overlapping error. The method was laborious and tedious, but it was the only one we knew of. Sometimes which we scraped off, about 62.75 of gold which had soaked into the plate, while the plate was in use. When the plate by only about 1/4 inch thick, it then stamped 60·6 kilos per hour. These figures are, however, only approximate, and vary somewhat as they depend upon the skill of the feeder. Either over-feeding or under-feeding lessens the yield.

Four tests have recently been made, two of them by myself, on ores from New Hampshire, one from Virginia, and one from Nova Scotia, which were sent to us through the kindness of A. Sewer Torrence, Esq., of the Ancora Iron Company.

I. The New Hampshire lot. This was composed mostly of quartz, stained yellow with iron rust, having cavities from which the iron pyrites had been dissolved. It contained a small percentage of pyrites, but no gold that was visible as we examined it by the lens. This lot contained some fine mica-schist, which was probably from the wall-rock.

This lot of ore weighed 321·6 kilos or 1427·5 pounds. A sample of it yielded to fire assay $4.14 in gold to the ton of 2000 pounds, reckoning gold at $17 per ounce troy. The total value, therefore, of the gold in this lot was $5.20.

The yield of gold in the different parts of the process was as follows:

Battery amalgam	$4.021
24 plates	.775
24 plates	.193
24 plates	.055
24 plates	.044
24 plates	.00
Stamp traps	.122
Total yield	$5.040

Stamps were assayed for gold as follows:

	Per ton.
Ore sample	$4.14
Pulp sample as sand went to plates	1.227
Pulp sample as sand went to waste	1.227
Pulps collected from overflow	1.227
Coarse tailings	1.705
Fine tailings	.705
Residue in battery after 9 hours	2.58
The total value of the ore	5.20
The total value of the amalgam	4.021

or 85·2 per cent of the gold was saved. This, reduced to value per ton, is as follows:

	Per ton.
By fire assay	$4.14
By amalgamation	3.53

85·2 per cent saved by amalgamation.

The poverty of the lean pyritous concentrations found by us corroborates the conclusions arrived at by Professor Hitchcock, who states that he has universally found the gold in these mines to be in the pyritous ore, intimately associated with the pyrites, as it is in most other localities.

II. The second lot of ore was taken from the same locality as the first, but it was taken at a different place. The lot weighed 402·5 kilos (or 885 lbs.).

* A paper read before the American Institute of Mining Engineers, at the New York Meeting, February, 1880.

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FAURE ELECTRIC ACCUMULATOR COMPANY (LIMITED).

An extraordinary general meeting of the shareholders of the above company was held at the Cannon Street Hotel on Monday last, Sir A. J. Otway in the chair, for the purpose of ratifying, or otherwise, the following agreements which had been provisionally entered into:—1st. An agreement between the Faure Electric Accumulator Company (Limited), of the one part, and the Electrical Power Storage Company (Limited), of the other part, for the sale by the Faure Company to the said Storage Company of the remaining interest of the Faure Company in the said Storage Section, and Yetchmar in England, on the terms and conditions mentioned in the said agreement. 2nd. An agreement between the Société la Force et la Lumière (Faure Zipernowsky and the French Electrical Power Storage Company (Limited), for the purchase by the Faure Company of the rights and interests of the Société la Force et la Lumière in the French Electrical Power Storage Company (Limited), on the terms contained in the said agreement. 3rd. An agreement between the Faure Electric Accumulator Company (Limited) and the French Electrical Power Storage Company (Limited), for the sale by the said Faure Company to the said French Company of the property in Paris belonging to the Faure Company, and providing for the Faure Company subscribing for shares in the said French company, as provided in the said agreement. The Chairman, in opening the proceedings, stated that the meeting was one of considerable importance. Certain contracts had been provisionally signed by the Board, but they would possess no validity until the shareholders had approved and ratified them. They had been chosen in pursuance of the policy which had already been indicated by M. Philippart and which had been unanimously approved by the shareholders on two previous occasions. After reference to the desire of the directors to be relieved from their office he stated that it was necessary, unless the matter was to fall through, that these agreements should be signed previously by the directors. He stated on the last occasion that he should not leave his place at the Board till he saw that that which he considered a set of honourable engagements taken by the directors towards the shareholders had been fulfilled, or unless the means were in sight whereby it could be fulfilled. He understood from their solicitor that those means were now supplied for the same with one fully paid-up share in exchange for the two now held with £7 paid thereon. He understood that M. Philippart would be prepared to take back the old paid, with all the certificates upon dividing among the new shares, and when they were exchanged for the shares now held, he should consider his engagements as the nominee of the present directors as administrators was terminated. M. Philippart would remain on the Board, and it would be necessary to elect another director, and those two gentlemen, forming a quorum, would be empowered to add to their number such other solicitors as they considered fit. Mr. Campbell, solicitor to the company, Mr. Campbell, the solicitor, then read a statement on behalf of M. Philippart, briefly explaining the effect of the three contracts referred to. After the execution of the contracts they expected to be able to pay a dividend of 5 per cent. on the £1 per year, and he assured them the date of issue on the £2 paid on the 40,000 ordinary shares: said M. Philippart had taken powers for allotting that during February next they would be able to declare a further dividend of at least £1 a share. As to the value of the inventions, he referred to what he stated on the 6th of November. The Storage Company could not, he said, nearly execute all the orders it received, although probably the loss of accumulators monthly, would be more than made up to the prime cost, the cost of maintenance, and the profit of the accumulator. The yield was now certified as to over 90 per cent. They had given up all idea of liquidating their company on account of legal difficulties, and must now, because they were the first in the field. Mr. Campbell having read Section 3 in effect of the first agreement, said that the Campbell having read Section 3 in effect of the first agreement, said that the second was between the Company of the patentees' interests of the Société la Force et la Lumière by the Faure Electrical Power Storage Company. Therefore, assisted by this agreement, the Faure Company would have possessed of 22 per cent. of the Faure, Sellon-Volckmar, and Volckmar process for French colonies. The third agreement was between the Faure Company and the French Electrical Power Storage Company, by the object being to sell to that company certain property in France which the Faure company now possessed, the Faure Company still the money arising from this sale, subscribing for certain shares in the French Electrical Power Storage Company.

The Chairman then called attention to the fact that the Faure accumulator originally manufactured from contract A2700, was said that the Faure a quantity of casts, which could only be taken out slowly because of the slowness of the discharge. What had been done was to make the cells hold much more for the same size, and give it out more quickly. The cells had much more coal tolerance had been made in the most direction. The accumulators which had been tested thirty were certainly twice as good as those originally sent to the experts last year. Hence the experimental tricycle could now run a measured mile in 40 minutes a rate that was impossible three days ago. The accumulator was also in 40 minutes a rate that was rejected. Two cells of giving out power was also very important to accumulators at sea. But in the matter of propulsion the giving out of energy quickly was also important.

The Chairman, in replying to a question, said he had no desire whatever to say anything unfriendly to the policy of M. Philippart in its general terms, but he was unable to agree with that gentleman in the procedure by which he proposed to carry out that policy. M. Philippart addressed the meeting in French, and intention to proceed with the matter was in his understanding. The Chairman, in a few words, explained the resolution, observed that if this meeting ratified them the ratification would be complete. The directors were not responsible for them. The resolutions were adopted unanimously. In reply to a question, he said the Faure director, who would possess satisfactory references. Mr. Campbell, on behalf of M. Philippart, stated that the shareholders would be called together in February to and Mr. Philippart terminated the proceedings.

Mr. Philippart, in acknowledging the vote of thanks, said that his best way of showing his appreciation of same would be for him to pay the foreshadowed dividends.

The English Mechanic
AND
WORLD OF SCIENCE AND ART.
FRIDAY, JUNE 24, 1881.

THE STORAGE OF ELECTRICITY.

THE storage of electricity is a subject which naturally attracts great attention at the present time, which may without much exaggeration be described as the era of electric inventions, and thanks to the letters of Sir W. Thomson, the public has been led to believe that a great and wonderful discovery has been made, which is to give us light, heat, and power from wind energy is could provided—he alluded to the question of supplying every householder who had sufficient for the same with one fully paid-up share in exchange for the two now held with £7 paid thereon. He understood that M. Philippart would be prepared to take back the old paid, with all the certificates upon dividing among the new shares, and when they were exchanged for the shares now held, he should consider his engagements as the nominee of the present directors as administrators was terminated. M. Philippart would remain on the Board, and it would be necessary to elect another director, and those two gentlemen, forming a quorum, would be empowered to add to their number such other solicitors as they considered fit. Mr. Campbell, solicitor to the company, Mr. Campbell, the solicitor, then read a statement on behalf of M. Philippart, briefly explaining the effect of the three contracts referred to. After the execution of the contracts they expected to be able to pay a dividend of 5 per cent. on the £1 per year, and he assured them the date of issue on the £2 paid on the 40,000 ordinary shares: said M. Philippart had taken powers for allotting that during February next they would be able to declare a further dividend of at least £1 a share. As to the value of the inventions, he referred to what he stated on the 6th of November. The Storage Company could not, he said, nearly execute all the orders it received, although probably the loss of accumulators monthly, would be more than made up to the prime cost, the cost of maintenance, and the profit of the accumulator. The yield was now certified as to over 90 per cent. They had given up all idea of liquidating their company on account of legal difficulties, and must now, because they were the first in the field. Mr. Campbell having read Section 3 in effect of the first agreement, said that the second was between the Company of the patentees' interests of the Société la Force et la Lumière by the Faure Electrical Power Storage Company. Therefore, assisted by this agreement, the Faure Company would have possessed of 22 per cent. of the Faure, Sellon-Volckmar, and Volckmar process for French colonies. The third agreement was between the Faure Company and the French Electrical Power Storage Company, by the object being to sell to that company certain property in France which the Faure company now possessed, the Faure Company still the money arising from this sale, subscribing for certain shares in the French Electrical Power Storage Company.

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The Chairman then called attention to the fact that the Faure accumulator originally manufactured from contract A2700, was said that the Faure a quantity of casts, which could only be taken out slowly because of the slowness of the discharge. What had been done was to make the cells hold much more for the same size, and give it out more quickly. The cells had much more coal tolerance had been made in the most direction. The accumulators which had been tested thirty were certainly twice as good as those originally sent to the experts last year. Hence the experimental tricycle could now run a measured mile in 40 minutes a rate that was impossible three days ago. The accumulator was also in 40 minutes a rate that was rejected. Two cells of giving out power was also very important to accumulators at sea. But in the matter of propulsion the giving out of energy quickly was also important.

The Chairman, in replying to a question, said he had no desire whatever to say anything unfriendly to the policy of M. Philippart in its general terms, but he was unable to agree with that gentleman in the procedure by which he proposed to carry out that policy. M. Philippart addressed the meeting in French, and intention to proceed with the matter was in his understanding. The Chairman, in a few words, explained the resolution, observed that if this meeting ratified them the ratification would be complete. The directors were not responsible for them. The resolutions were adopted unanimously. In reply to a question, he said the Faure director, who would possess satisfactory references. Mr. Campbell, on behalf of M. Philippart, stated that the shareholders would be called together in February to and Mr. Philippart terminated the proceedings.

Mr. Philippart, in acknowledging the vote of thanks, said that his best way of showing his appreciation of same would be for him to pay the foreshadowed dividends.

ELECTRICAL REVIEW.

THE CHEMISTRY OF THE PLANTÉ AND FAURE ACCUMULATORS.

[From *Nature* of the 19th inst.]

PART IV.—*The Function of Sulphate of Lead.*

IN our previous communications on the chemistry of lead and peroxide batteries, we have frequently alluded on the formation of lead sulphate and its importance in the history of a cell.

In Part I.* we showed that the local action that takes place at first energetically between the metallic lead and the peroxide is gradually diminished by the formation of sulphate of lead.

In Part II.* we stated that in the original formation of a Faure cell, sulphate of lead is oxidized on the one plate, and reduced on the other. We also described an experiment in which two platinum plates were covered with lead-sulphate immersed in dilute sulphuric acid, and placed in the circuit of a galvanic current; the result being that "the white sulphate was decomposed to a large extent on each plate, the positive being covered with deep chocolate-coloured peroxide, the negative with gray spongy lead."

In Part III.* we showed that on the discharge of a cell, lead sulphate is the ultimate product on both plates.

It might naturally be inferred from our previous statements that in the re-charging of a cell, this lead sulphate would be oxidized on the one plate and reduced on the other, as in the original formation. This matter, however, has given rise to some controversy. All subsequent experimenters admit the *oxidation* of the lead-sulphate, but Dr. Oliver Lodge could not obtain any reduction of it when pure sulphate was employed. Sir William Thomson also, when experimenting with two platinum plates and layers of sulphate, obtained only a doubtful indication of reduced metal. The question as to whether the sulphate is reduced or not on re-charging a Faure cell is one of vital importance; for if the sulphate formed at each discharge accumulates on the positive plate it would clog up the space, and, what is perhaps worse, a fresh surface of the lead would have to be oxidized (or rather converted into sulphate) at each discharge. Thus the positive plate will be continually corroded, and its life will be limited.

We have already replied to Dr. Lodge in *Nature* (Vol. XXVI, p. 312), but we thought it desirable to repeat the experiment with the platinum plates, especially with a view to determine whether the reduction was effected slowly or with any rapidity. We fastened 20 grms. of the white sulphate upon a negative plate by binding it round tightly with parchment-paper, placed it vertically in the sulphuric

* See ELECTRICAL REVIEW, pp. 21 and 211, Vol. X., and p. 61 of Vol. XI.

acid, and passed a continuous current of somewhat under an ampère. The hydrogen was at no time wholly absorbed—indeed the greater part of it certainly escaped—but after a lapse of two days, small patches of gray metallic lead became distinctly visible through the wet parchment-paper; and these gradually spread in an irregular manner. At the end of ten days it was found that the whole of the sulphate, except a few small patches on the surface, was reduced to a gray spongy mass. Although there could be no reasonable doubt that this was metallic lead, a portion of it was tested chemically, and proved to be such.

It thus appears that the *reduction* of the pure sulphate of lead is an absolute fact, although it does not take place so easily as the oxidation.

In an actual cell the sulphate of lead is of course mixed with other bodies. Thus in the formation of a Faure battery, the minium is converted by the sulphuric acid more or less completely into peroxide of lead and sulphate. We have already described an experiment in which 4,189 cc. of hydrogen were absorbed on a plate, the materials of which were capable of absorbing only 4,021 cc., if the whole sulphate as well as the peroxide was reduced. In our notebook we have the particulars of four other experiments made in each case with the same or nearly the same, amounts of material, in which 4,199, 4,075, 4,216, and 4,387, respectively were absorbed, although perhaps in not one of these cases was the experiment continued until the action was absolutely complete. As, however, it may be objected that the amount of sulphate produced upon these plates was an unknown quantity, we have in a recent experiment treated the minium in the first instance with a considerable amount of sulphuric acid. This gave us a mixture which, on analysis, was found to contain 18·5 per cent. of sulphate of lead. This mixture, when submitted to the reducing action of a current yielded a mass of spongy lead that contained only a mere trace of sulphate.

As it seemed desirable fully to establish the fact that the sulphate of lead formed on the discharge of a cell is reduced in the subsequent charging, we took the quondam lead plate of a fully discharged cell, determined the proportion of sulphate to unaltered spongy lead, and submitted it to the reducing action of a current. The amount of sulphate on the plate before passing the current was found to be 51 per cent., but, after the passage of a current of about an ampere for 60 hours, not a trace of it remained.

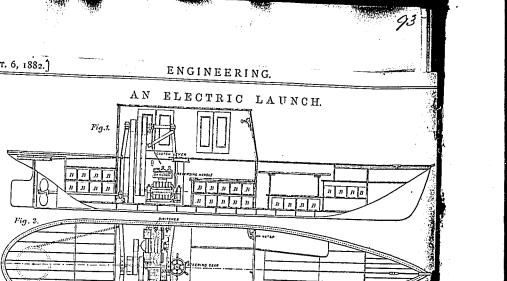
Hence it may be concluded that, during the alternate discharging and re-charging of a Planté or Faure cell, sulphate of lead is alternately formed and reduced on the lead plate, and that the plate itself is not seriously corroded. It would, however, appear desirable not to allow the whole of the spongy lead to be reduced to sulphate during the discharge, for two reasons, viz.: (1) because the supporting plate stands a chance of being itself acted on if there is not a sufficient excess of spongy metal; and (2) because the presence of this excess tends to facilitate the reduction of the sulphate.

We have already shown that sulphate of lead is produced by the local action that takes place between the peroxide and its supporting lead plate during repose. The same local action also takes during the charging of the plate, as was pointed out in our second communication, and this sulphate is, in its turn, attacked by the electrolytic oxygen. In this way the absorption of oxygen is forming the negative plate ought never to come to an end. In order to see whether this was the case, we allowed an experiment to continue for 115 hours, although the main action was over in about 40 hours. For the last two days of the experiment, the amount of oxygen absorbed was pretty constant, being about 9 cc. per hour; which is equivalent to 0·21 grms. of sulphate of lead formed and oxidized. The whole charge on the plate was 10 grms. of peroxide. This local action also takes place during the discharge, as is evidenced by the sulphate of lead formed on the negative plate always exceeding in amount that formed on the positive plate.

Through this local action taking place during the reduction of the cell, during repose, and during the discharge, the lead plate which supports the peroxide must be continually corroded more and more; and it is probably due to the insolubility of the sulphate formed that the destruction of this kind of secondary battery is so materially retarded in practice.

J. H. GLADSTONE.
ALFRED TRIBE.

AN ELECTRIC LAUNCH.

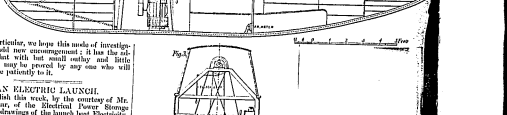


stood in particular, we hope this mode of investigation may obtain new encouragement; it has the advantages that with but small outlay and little training it may be proved by any one who will devote time patiently to it.

AN ELECTRIC LAUNCH.

We publish this week, by the courtesy of Mr. E. Volkmar, of the Electrical Power Storage Company, drawings of the launch boat Electricity, which made her trial trip upon the Thames on Thursday, September 28th.

The hull is of iron, 25 ft. long, 5 ft. beam, drawing 21 in. of water forward and 30 in. aft. She is a screw launch, the propeller being of the Colin Brown type, 20 in. in diameter, and with a 2 ft. pitch. The motor is calculated to make 350 revolutions per minute. Twelve persons can be accommodated on board, though only four were actually carried on the trial trip. The electric engines are nothing else than a pair of Siemens' dynamos, of the size known as D², and their motive power is furnished by Sellon-Volckmar accumulators, to which we shall shortly devote a detailed article. We may briefly remark that these accumulators are a modification of those of Planté and of Faure, but are made of specially compact design for the purposes of electric navigation. The cells each contain forty prepared plates, and weigh about 40 lb. They are about 10 in. square and 8 in. high, and are charged while the boat is lying at anchor by wires which come across the wharf from the factory, bringing currents generated by dynamos fixed in the works. There is room for a battery of fifty-four such cells to be stowed away, as will be seen upon the drawings, where the battery cells are marked B B. Only forty-five cells were used at the trial trip. They had a total electromotive force of 96 volts, and were capable of furnishing continuously for nine hours a current exceeding 30 ampères. When in action, the counter-electromotive force of the motors reducing the apparent strength of the current according to Jacobi's well-known theory of electro-magnetic engines. The accumulators have a total weight of somewhat less than a ton. The motors or electric engines are arranged so that either or both of them may be furnished with the current, there being a switch to each lead. There is also a commutator to switch into circuit any number of cells from forty upwards. The shafts of the motors can be thrown in or out of gear by means of an Ashpurst's friction clutch, which permits the pulley to be started and stopped with great facility without shocks. A reversing gear for the two motors is contrived by the very simple device of arranging two pairs of brushes for each collector or commutator, one pair having an angular lead forward, the other a lead backward. By a simple lever arrangement either pair of brushes can be pressed at will against the segments of the commutator. In practice this arrangement works well, the boat being very readily stopped by reversing the engines in this fashion. As will be seen from the

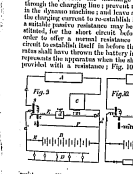


drawings, the motors are connected by belts to pulleys on a countershaft, from which a belt passes down to a pulley on the propeller axis, whose speed is thus reduced in the proportion of 850 to 350 revolutions per minute. The steering is managed by the same person who operates the switches, seated in the central cabin. A wheels being impossible in the absence of steam, this necessary feature is replaced by a large electric bell, also worked by the accumulators. The calculated average speed is nine miles per hour. This speed was actually attained on the trial trip from Millwall to London Bridge and back. The design and construction of the boat are chiefly due to Mr. A. Beckermann, C.E., mechanical engineer to the Electrical Power Storage Company.

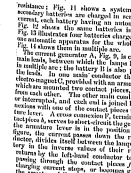
THE BRUSH SECONDARY BATTERY.

(Concluded from page 178.)

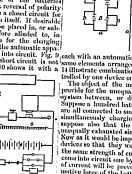
THE second part of the invention relates to devices to be used for automatically manipulating the current employed in charging secondary batteries. The objects sought to be attained by these devices are, firstly, that when no current is acting in the charging circuit the batteries in connection with that circuit will be short-circuited, so far as the charging circuit is concerned, and the latter will be short-circuited around each battery. Secondly, that when the charging circuit is established in the charging circuit, the short circuit around each battery will be opened and the battery thrown into circuit. Again, when the charging current stops each battery will be thrown out of circuit, and the line short-circuited as at first. These automatic operations prevent the discharge of the batteries through the charging line; prevent reversal of polarity in the dynamo machine; and leave a closed circuit for the charging current to re-establish itself. If desirable a suitable passive resistance may be placed in, or substituted, for the short circuit before alluded to, in order to offer a normal resistance for the charging circuit to establish itself in before the automatic apparatus shall have thrown the battery into circuit. Fig. 9 represents the apparatus when the short circuit is not provided with a resistance; Fig. 10 shows it with a resistance; Fig. 11 shows a system wherein three secondary batteries are charged in series by the same current, each battery having an automatic appliance; Fig. 12 shows the same batteries in multiple arc; Fig. 13 illustrates a battery charged in series with an automatic apparatus for the whole of them, and Fig. 14 shows them in multiple arc.



The current generator A, Fig. 9, is connected to the main leads, between which the lamps D are arranged in multiple arc; the battery B is also placed between the leads. In one main conductor there is fixed the electro-magnet C, provided with an armature-lever upon which are mounted two contact pieces, insulated from each other. The other main conductor is broken or interrupted, and is provided with a switch shown in figure, the current passes down the right-hand conductor, divides itself between the lamps and the battery in the inverse values of their resistances, and returns by the left-hand conductor to the machine, passing through the contact pieces f g. When the charging current stops, or becomes greatly reduced, the armature falls away from the magnet, and the circuit is broken between the contacts e and f, and completed through e and d. The left-hand conductor is thus interrupted, and the current then consists of the right-hand conductor, the coil connection F, the contacts d and e, and the left-hand conductor. When the charging current is again started the magnet C raises the lever E into the position shown in the figure, and the charging of the battery is resumed. Fig. 10 shows an arrangement identical with Fig. 9, except that a resistance H is inserted in place of the conductor F, and



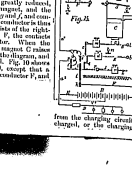
the lamps are differently connected up. In Fig. 11 there are three batteries B and three sets of lamps D,



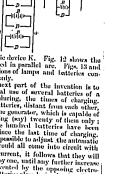
each with an automatic device K. Fig. 12 shows the same elements arranged in parallel arc. Figs. 13 and 14 illustrate combinations of lamps and batteries controlled by one device only.

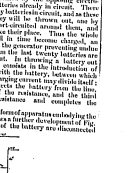
The object of this part of the invention is to provide for the unequal use of several batteries of a system between, or during, the times of charging. Suppose a lumbled battery, distributed from each other, are all connected to one generator, which is capable of simultaneously charging any) to only of them only; suppose also that the lumbled battery to have been unequally exhausted since the last times of charging. Now as it would be impossible to adjust the automatic devices so that they would all come into circuit with the same strength of current, it follows that they will come into circuit one by one, until any further increase of current will be prevented by the opposing electromotive force of the batteries already in circuit. There will now be only twenty batteries in circuit, and as these become exhausted they will be thrown, one by one, and the line short-circuited around them, and other batteries will take their places. Thus the whole hundred batteries will in time become charged, the automatic regulator at the generator preventing undue increase of current when the last twenty batteries are successively thrown out. In throwing a battery out of circuit the first step consists in the introduction of a resistance parallel with the battery, between which and the battery the charging current may divide itself; the second step disconnects the battery from the line, leaving it then thereof the resistance, and the third short-circuits the resistance and completes the operation.

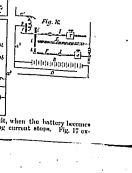
Fig. 15 illustrates one form of apparatus embodying the foregoing; Fig. 16 shows a further development of Fig. 15, wherein both ends of the battery are disconnected



from the charging circuit, when the battery becomes charged, or the charging current stops. Fig. 17 explains an addition to the devices illustrated in Fig. 16,







electromotive force of the battery B to reduced towards the close of the process of discharging. This will allow the magnet C to be energized if current is acting in the line a^1, and the lever E will be raised, and when it leaves S and L have the effect of throwing the battery into the charging circuit. If current is acting in a^1, the armature of the magnet C will be on the bottom stop, the short circuit through it will be open, the armature lever open, and the short circuit around the magnet C open, and consequently the latter is ready to act when the charging current again starts, and all this irrespective of any particular condition of the battery B. Again, the opening of the short circuit, while the charging circuit is not acting, prevents any unnecessary waste of current through the shunt.

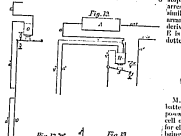
Let us now follow the operations which take place when the charging current starts, and the lever E, E, and I are at their lowest points. Matters have been so adjusted by means of the weights on the levers and the stop a, that the lever G will not respond to the attraction of the magnet C until the charging current, which excites the magnet, has reached a certain strength, approximately the normal one. Before this point is reached, however, the current may have been acting in the charging other batteries as already explained. When the proper strength is reached the lever G rises, and thereby disengages the arm attached to the lever E. By this time the lever G has approached nearer to its magnet C, whose attraction has then become sufficient to carry upward not only the lever G, but also the lever E, which is finally stopped by the contacts f g coming together. When the lever E begins to rise the contact e and of the lever I follows, owing to the counterweight at the other side of the fulcrum; thus the contact e is preserved, while the contacts i k are opened; this throws the resistance into the charging circuit. The battery B, continuing to move upwards, separates the contacts d e, and opens the resistance, thus throwing the battery charging current into the battery B. Finally, upward movement of the lever E is arrested by the catch, and the strong attraction of the magnet C for its armature is then carried in maintaining a good contact between the contacts f g, through which all the charging current now passes.

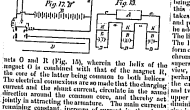
In Fig. 16 the lever lever, replacing the conductor F of Fig. 15, is provided at its extremity carries at the right hand end a contact piece d, which normally connected with the line a^1 another contact, which in conjunction with the first, connects the battery B with the line a^1. By means of this arrangement both ends of the battery are disconnected from the charging circuit when the lever E falls, because the contacts on F, as well as f and g, are then thereby separated. In Fig. 17 the circuit from the battery B to the electro-receptive devices B, is established when the contact lever is switched on to the contact pieces 5, 6, 7, 8. The contacts 6 and 8 are connected to a block 9, and are insulated from each other, but are forcibly connected with the ends of the battery B. The block is connected by wires 10 and 11 to the armature lever. When the current is active in the charging circuit, the armature is raised, as explained in regard to Fig. 15. This separates the contacts 5, 6 and 7, 8, thus disconnecting the electro-receptive devices from the battery and the charging circuit. When the charging current stops, the armature drops, and the devices are again connected to the battery. The object of the device shown in Fig. 17 is to insulate the electro-receptive devices from the charging circuit when the working current is acting therein, and is particularly applicable when a large number of batteries are charged in one line by means of a current of high electromotive force.

Fig. 18 illustrates a system of three batteries,

each with a controlling device K, charged from one source J.

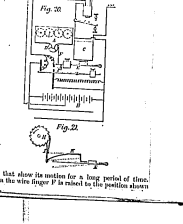
Fig. 19 shows a compound arrangement of the mag-





nets O and R (Fig. 15), wherein the helix of the magnet O is combined with that of the magnet R, the core 4c of the latter being common to both helices. The electrical connexions are so made that the charging current and the main current, circulate in the same direction around the common core, and thereby act jointly in attracting the armature. The main currents consisting constantly of the current in the almost closed circuit, due to resistance in the battery at the completion of the charge, will enable the magnet to raise its armature, and thereby all the charges already described in connexion with Fig. 18. When the charging current stops the armature will drop.

The last point sought to be attained by this invention is the record of the amount of electric energy imparted to a battery. To this end there is combined with each automatic current manipulator a time-measuring device, in such manner that while the charging current is acting to charge the battery the length of time it so acts will be recorded. When the battery becomes fully charged, or the charging current stops, the time mechanism stops also. As the electromotive force required to charge each cell is known, and the constant, it follows that the product of the number of cells by the ampère value of the charging current, and the time it is circulating, will form a reliable basis for calculating the money values of the stored energy. As, Fig. 20, is a clock movement, with



dials that show its motion for a long period of time. When the wire finger F is raised to the position shown by the passage of the current round the magnet C, the clock is free to go, but when the charging current stops, and the finger falls, the motion of the dials is arrested. The other pieces shown in the figure are similar to those of Fig. 15. Fig. 21 illustrates another arrangement in which the going barrel of the clock is derived from a spring K, which is bent when the lever E is raised, and allowed to expand again into the dotted position when the current fails.

M. Trouvé has recently modified the Sichromate battery to render it fitter for electric lighting purposes. This cell gives off no fumes, is a single fluid cell of high energy, and therefore especially valuable for electric lighting; but it has the great drawback of being inconstant in action. M. Trouvé has obviated this drawback by separating the liquid. He takes 150 grammes of a saturate of potash powder and puts it into litre of water, then, after shaking it, he adds drop by drop 450 grammes of chromic acid. The liquid warms up a little and the salt dissolves. The liquid thus prepared he lets cool, and does not force crystals in cooling. Mean while, it does not form chrome alum crystals when the cell is at work. The superscription of the existing liquid is 1·36 Twaite's view, the cause of the remarkable constancy which is perhaps explained by the absence of chrome crystalsom the carbons. Each element consists of two plates and two carbons supported by electro-platings at their upper part. This supporting consolidates the carbons and diminishes their resistance at the upper part. The zinc is arranged so as to be easily taken from the cell to be amalgamated. The batteries are arranged in sets of six elements placed in cases of oakwood. The carbons and zincs can be raised or lowered at will by a device like that employed in the Wollaston battery. In this way the power of the cell is regulated. With twelve elements ten incandescence lamps can be kept lit for five hours; but M. Trouvé has kept twenty lamps lit for two hours, each giving a light of ten and two. The electromotive force of the cell is 2 volts with good solution, and the intensity of current at the beginning on a short circuit is 110 ampères. The resistance is 0·07 ohms. Four batteries working a Gramme machine have produced 14 kilogrammètres of work during two hours without weakening in power.

Electrical World, Vol. VII.

Engineering, April 29.

Electric Storage Batteries.

One of the most interesting and novel exhibits at the Crystal Palace is the storage battery of Messrs. Sellon and Volckmar, by which the Alhambra counts are so beautifully lighted, through the medium of the Lane Fox lamps. We cannot fairly describe these batteries because the nature of the active material used in combination with the lead plates is at present kept secret: they consist of a series of lead plates perforated with 4 in. holes set very close together; within these holes is closely packed the material instead of being spread over the surface of the plates; by this means the necessity for protecting coverings of felt, asbestos, &c., is avoided, as there appears to be no tendency for the material to fall out of the holes; on the contrary it swells under the action of the current, and tends to tighten. Each cell consists of a number of such plates immersed in solidified water. About sixty hours are required to "form" these batteries, and a low tension machine is not necessary for the purpose, nor for subsequent charging, as those at the Palace are stored by the Brush or Schuckert generators. We are informed that these batteries are the outcome of combined patents of Messrs. Sewn, Sellon, and Volckmar, some of which are not yet published. According to the inventors, one of these cells having a capacity of .33 cubic foot and containing 62 lb. of "metallic composition," will yield when properly charged an aggregate current equivalent to one horse power of electrical energy per hour, giving off from 250 to 400 ampères at any required rate of composition are used; this latter size weighs 30 lb. A 5 horse power of energy for an hour, working up to 40 ampères per hour. Forty of these cells are employed to feed the 200 Lane Fox lights in the Alhambra Court. Of this installation we shall have much to say on a future occasion, for the present we confine ourselves to remarking that it has been admirably carried out by the Electric Storage Company, that the intensity of the light can be perfectly graduated by cutting out one or more of the cells from the circuit, and that with regard to these cells, experiment has shown their durability to be at least six months—experience with them does not extend to an earlier date.

The Sellon-Volckmar Accumulator.

To the Editor of Engineering.

Sir,—Certain statements have lately appeared relating to the above-named accumulators or storage batteries, the patents for which belong to the "Electrical Power Storage Company." With regard to these statements it is scarcely necessary to give any explanation to those who know me, but as many who may be in ignorance interested in the subject do not, I shall feel greatly obliged if you will publish the following particulars.

Having for long given attention to secondary batteries, and having succeeded in obtaining results which I considered of value, I took out in England in *September* last, certain patents, and subsequently later by others, those patents went at the same time have been applied for throughout the world, but for the present of awaiting the completion at my final specifications.

Towards the end of *December*, Mr. Volckmar, whose name is already known for the first time, was introduced to me as possessing secondary battery of much merit, which upon examination I found to contain essential points the same as my invention. The patents in question have been taken out by him in October in many Continental countries, but also in England, and then the position was, that although neither myself in his application for England, the Colonies and America, he had anticipated me for the Continent generally, and no arrangement was therefore made for the amalgamation of our interests.

At this juncture a patent was published, taken out by Mr. Swan, of November, in 1880, which was found to cover all my first specification, and to prevent me from obtaining title-deeds arising in the future. I purchased the rights for this patent from Swan, and from the publication of these patents was free to work.

I need only here detail the features of the Sellon-Volckmar accumulator, further than to say that in the judgment of some of the best scientific authorities in England it is an absolutely new and unique battery, which, if it does not lead us to any an infringement upon the Faure, which I assert is greatly superior in power and durability.

It was the intention of Mr. Volckmar and myself to deal with the question of patents, but a few individuals who were aware of the results obtained expressed the wish to join with us in their development, and to this course we were forced, *the interest arrangements of the Company are the concern of the public, any more than those of a proprietary*, inasmuch as no portion of the public was ever asked to subscribe, or did subscribe, one single farthing.

The Company was formed for the purpose of the patents to the Electrical Power Storage Company only concern those (all of high power) dealing with the Sellon-Volckmar cell first approved of and entered into with them.

The exact facts are that the *sole paid current and other expenditure already incurred*, the whole benefits of which were transferred to the company, and that we, the owners of the patents, who had the full right to sell, have, through the agency of our whole interest and profit in the business dependent upon the success of that, but a small amount of fully paid-up shares, which may, with the probable extension of capital, yield a return of 5 per cent. on the pounds now apply to three-millionths of one per patents *for the whole world*.

With regard to not guaranteeing the validity of the patents, the protective clause referred to is one which is always found in connexion with all agreements for the consent of standing over others the claims of purchasers to their patents, however sure they may be of their validity, and the usual clause, which I have always accepted myself in purchasing patents, was inserted in regular course. The case was, however, altered when applications to subsidize conventions or purchase of patent rights after an extent, and the clause referred to was at once introduced by the Power Company, and it was determined not to allow subscribers to subsidiary companies, against the contingency of no adverse issue by guaranteeing the return at all monies received.

The Electric Carbon Company of Scotland has nothing to do with the "Electrical Power Storage Company" which is the only one referred to in the newspapers. I did no even know of its formation.

With reference to Mr. Volckmar, who I have found to be a gentleman of honour and integrity, the matter has come before the Law Courts. Mr. Volckmar having immediately upon the original publication of the libel, commenced an action; and any discussion thereupon at present would be out of place.

May 25, 1882. John S. Sellon.

STORED-UP ELECTRICITY.

A few weeks since the scientific world in Paris was deeply interested by a paper read before the Société d'Encouragement de l'Industrie Nationale by M. Reynier, upon a new form of battery invented by M. Camille Faure, who, following in the steps of M. Gaston Planté, had succeeded—according to M. Reynier—in devising a battery in which forty times as much electric energy may be stored up, as could be done by the Planté pile, the result being that a large amount of force easily convertible into mechanical work, or adaptable for electric lighting, could be stored up in small and easily portable cells, could be transported from place to place, delivered from house to house, and that the great problem of a domestic electric lighting and power supply was thus solved. We have already in a "Note" (*vide* page 469 *ante*) indicated the arrangement of the extremely ingenious battery of M. Faure, but a more detailed description will find a suitable place here.

M. Faure's secondary battery is an application of a new discovery to the very beautiful and well-known secondary pile of M. Gaston Planté, which our readers will remember consists of two plates of sheet lead separated from one another and immersed in a glass jar of diluted sulphuric acid; if these two plates are connected for a time with the terminals of a source of electricity such as a dynamo-electric machine or a voltaic battery, oxidation and deoxidation take place on the two plates respectively, and after the exciting battery has been removed, the lead cell continues to give off a polarisation current of electricity as long as the deoxidation and oxidation of the lead plates continue by their returning to their normal condition. It was from the first observed that secondary piles of this construction produced better results after having been charged and discharged a great many times, a fact due no doubt partly to the increase of surface produced by the roughening of the lead plates under the decomposition, but chiefly to the formation of lead peroxide in increasing quantities, which was alternately deposited and decomposed as the cell was charged by the battery and discharged by the polarisation current.

M. Faure (whose name is well known in the scientific world as the inventor of the battery which bears his name, and in which the carbon element in a Bunsen's cell is made in the form of a bottle which contains the nitric acid) has recently introduced an important improvement to the Planté cell, by which its capacity is largely increased, so that an apparatus constructed upon his principle is capable of producing a much greater current than that given off by a secondary battery of the old construction and of the same size. As the capacity of a secondary battery, other things being equal, is due to the thickness of the layer of lead peroxide formed upon one of the lead plates, M. Faure conceived the idea of coating each of the plates with a thickness of red lead maintained in its place by a sheet of felt attached to the plate by means of lead rivets. Both plates having been similarly treated they are rolled together into a spiral, the felt performing the two-fold duty of separating the plates and holding on the coating of red lead. This couple is then immersed in acid contained in a cylindrical cell of lead and connected by its electrode to the poles of a dynamo-electric machine or voltaic battery, and after having been charged and discharged two or three times, the red lead coatings of the plates are found to have undergone a change, the one having been entirely transformed into peroxide of lead, while the other has been reduced to the metallic state, and as this result must be due to the oxidation of the red lead on the one plate and the deoxidation of that on the other, it would appear that what may be called the storage capacity of the apparatus depends upon the quantity of red lead carried by the plates.

There can be no doubt that in this way electricity may be "bottled up" and "stored" to an almost unlimited extent, and in this bottled-up condition can be carried in reservoirs to a distance, there to be utilised until it is exhausted, just as a reservoir of compressed air, or a coiled up spring, may be carried for any number of miles, and can be made to give out power whenever required at a distant station. All this is true enough and physically feasible, but the whole commercial success or failure of such a scheme must depend, as all commercial schemes must depend, upon its practical utility.

If electrical energy has to be conveyed from one place to another, it is a matter of small commercial importance in the abstract whether it is conveyed by means of metallic conductors or stored up in reservoirs and carried by road or rail; in this the commercial question involved being very much the same as that of the supplying of water by pipes or by water-carts. There can be no doubt, however, about which system is, save in exceptional cases, the most convenient, and unless it can be shown that the charging and transmission of storage reservoirs offers advantages upon economical grounds, or very substantial conveniences of application over the system of transmission by conductors, we cannot see that its commercial application upon a large scale can be as remunerative to its proprietors as its promoters would wish to make the public believe.

That M. Reynier should have infused an undue amount of enthusiasm into his paper read before the Société d'Encouragement was natural, considering that he was describing for the first time results far in advance of anything of the same nature than had been achieved before, and it was perhaps pardonable that he should, for the greater glory of the Faure battery, have depreciated the capacity of that of Planté. But both in justice to the latter gentleman, and also to arrive at a just appreciation of the real value of the new discovery, careful investigation and comparison between the two have to be instituted. This has been partially done by M. E. Hospitallier since M. Reynier read his paper, and in the last number of our excellent contemporary *L'Electricien* the results obtained are referred to, and the details of the experiments made are to be published in a succeeding number of the same periodical.

Criticising M. Reynier's paper, M. Hospitallier challenges several statements made in that communication. M. Reynier maintained that the Faure battery would give out 80 per cent. of the total power used in charging it. But as M. Hospitallier points out, under the best conditions not more than 90 per cent. of actual work can be transformed from mechanical into electrical energy by a dynamo-electric machine. M. Planté clearly demonstrated that his secondary battery could only give out 88 or 89 per cent. of the power charged into it, and as the difference between it and the Faure battery is one of degree and not of principle, it is not probable that a greater percentage than this could be obtained; possibly it would be less. Finally, a loss of 20 per cent. at least must be allowed for in converting the electrical power in the battery into mechanical force. Making allowances for all these losses it follows that the utmost useful work that can be got from the battery is 52.5 per cent. of the energy employed in charging it, while at the present time it is easy with the ordinary system of conductors to obtain 60 per cent. Passing on to the question of the power which can be stored up in the Faure battery, M. Hospitallier makes an important statement in reply to the assertion of M. Reynier, that this battery can store up forty times as much force as the Planté battery. In conjunction with M. Frank Géraldy, M. Hospitallier has conducted a series of experiments on the Planté battery. The details of these experiments will be published shortly, but the results are given as follows in *L'Electricien*: "Admitting on the one hand as correct the figures given by M. Reynier, that is to say, that a Faure battery, weighing 165 lb., can give out one horse power during one hour, and on the other hand our experiments on the Planté batteries, the storage power of the Faure batteries varies from one and a half to three times the power of the Planté, according to conditions which we shall shortly publish. This result is very far from the forty-fold result given by M. Reynier, who obtained it no doubt from imperfect or badly-proportioned Planté batteries, and these results cannot consequently be accepted."

With this quotation we may for the present postpone further discussion as to the actual and relative scientific value of the Faure battery, and turn to consider the unfortunate use to which an interesting and possibly a brilliant discovery has been converted.

M. S. Phillipart, of European Bank celebrity has acquired the patent rights of M. Faure, and M. Phillipart proposes by virtue of these rights not only to restore the shattered fortunes of the European Bank shareholders, but also to revolutionise industry, and to make millionaires of all those who shall place their confidence and cash in his hands to develop his great company, "La Force et la Lumière." About a month ago this M. Phillipart issued a manifesto to those unfortunates, the European Bank shareholders, which he prefaces by the statement that "the moment has arrived to explain to you my projects, my hopes and yours, and how I undertake to realise them." We have not space to publish this document, which overflows with extravagance and absurdities. Briefly it amounts to this. With a company having a capital of one hundred millions of francs, the Faure battery, and a new electrical machine of M. Reynier are to be developed. "The patents of M. Reynier include the production of electricity by chemical processes, which, while disengaging a great quantity of electrical energy, perform metallurgical processes for a great number of metals, such as copper, nickel, zinc, &c., under economical conditions far surpassing all the processes hitherto employed, and whence results a double profit, metal produced at a very low price, and electricity produced absolutely for nothing." Passing on to a consideration of the profits to be derived from the working of the Faure battery, M. Phillipart makes the following calculation. The whole of the gaslighting of Paris and its suburbs is to be replaced by electricity, and 120,000 horse power for various mechanical purposes are to be absorbed in the same area every day. This will yield at the tariffs charged 240,000 francs a day, or 72 million francs a year. The cost of producing this gross income would be 32 millions, leaving a profit of 40 millions, or 80 per cent. profit per annum on an outlay of 50 million francs for machinery, &c. A part of this revenue is to be set aside towards paying the 20 million francs which the shareholders of the European Bank had lost, and these shareholders are invited to exchange their stock in that unfortunate concern for new stock in the power and light company. Besides the domestic application mentioned there are innumerable others in which the other half of the company's capital is to be invested. Horses are to be superseded, steam power on tramways and railways, on the ocean, even, is to be a thing of the past; there are to be no boundaries to the application of the invention, no limits to its fields of usefulness. In Paris, Bruxelles, London, Vienna, Berlin, and all the capitals of the world, this revolution in industry is to take root. Subsequent to the issue of this document, all the householders in the department of the Seine, almost all the inhabitants of Paris, received a circular of which the following is a translation. "I have the honour to inform you that the Société Anonyme 'La Force et la Lumière,' of which I am President of the Council of Administration, will receive from the 1st May next, at its offices, 5, Avenue de l'Opera, subscriptions for furnishing motive power and lighting at private houses for the whole department of the Seine, at the prices and under the conditions following:

"*Motive Power.*—One franc per hour and per horse power for all powers, from one horse and upwards; 2d. per hour and per 361 foot-pounds for all power, less than 361 foot-pounds, so long as the total price per day of ten hours shall not be less than one franc. These prices include all the cost of installation, comprising the motor, the maintenance and oiling alone of which will be at the charge of the hirer.

"*Light.*—Price, including carbons and electricity. Lamps of 48 candles, ½d. per hour and per lamp; lamps of 96 candles .75d. per lamp and per hour; lamps of 192 candles 1d.; lamps of 480 candles 2d.; lamps of 960 candles 3d. per hour and per lamp.

"The Society will be in a position to fill all orders entrusted to it by the 1st of January, 1883, at the latest, but it will commence delivering in the month of September next, and the earliest subscribers will be supplied first. No subscription will be received for less than two years. All subscriptions for ten years, either for power or light, or both, will be entitled to certain discounts." Then follows the list of discounts varying from 5 per cent. up to 1000 francs a year to 25 per cent. from 100,000 francs and upwards.

It would have been unnecessary to devote space to such astounding nonsense as the foregoing, but for two reasons. In the first place the public in France have been struck by the audacious assurances of the bold financier, and are coming forward readily with their contributions. Doubtless before many weeks are over a similar attempt will be made in this country to float an English company, and possibly with equal success, and we would wish to do all in our power to prevent such an undesirable result. In the second place the collapse of such a scheme as that of M. Phillipart would involve the total or partial loss of an enormous sum of money, would bring serious discredit for a long while to come on sound projects for the practical and industrial utilisation of electricity as a source of power and light, and useful progress thus be partially paralysed, for public confidence would receive too rude a shock to recover hastily.

Admitting all that M. Reynier has claimed for the Faure battery, that (though this is to admit what is utterly improbable) the laboratory experiments he has carried out, may be taken as the standard for every-day practice, and that the programme for storing, distribution, and transformation into power can be fully carried out, the figures in the circular above quoted, carry with them unqualified condemnation of the whole scheme. First, as to power. Undoubtedly if properly organised, a large business might be done with the users of very small powers, but a large proportion of them are all swept out of the account by the stipulation that two years' subscription, that is a minimum of 24*l.* must be guaranteed. For power of one horse and upwards, a charge of one franc per hour is to be charged, the basis being fixed on a period of 10 hours per day, the charge including the rent of the motor. Threepence an hour per horse power appears to be the rate fixed by the company for battery power alone, which leaves sevenpence an hour, or 5*s.* 10*d.* a day, or 87*l.* 10*s.* a year for the rental of the motor. Now a one horse power gas engine would not at the outside cost more than 1½d. an hour to work, and 1½d. per hour of rental for the motor would pay at least 20 per cent. per annum on what it cost. So that on an outside estimate the expense of hiring and working a gas engine would be only three-sevenths of that of the Faure battery and electric motor. For larger powers, of course, the difference would be far greater, especially where the energy of coal could be used direct, instead of passing through a series of conversions with a large loss at each stage. For lighting the proposal is, if possible, still more ridiculous. We will take the conditions for obtaining a light equal to 100 Carcels, that is very approximately 1000 candle power, and to produce which certainly one horse power would be required. The price to be charged for this is threepence per hour, exclusive of lamps, &c. (no indication is given of the nature of lamps to be preferably employed). Assuming a period of ten hours, as before, for the average employ-

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ment of the lights, and accepting the statement that a battery weighing 165 lb. will develop one horse power for one hour, we have in the first place a dead weight of 1650 lb. of batteries. But this weight has to be largely increased, for the power developed by the batteries is not uniform from beginning to end, but is only practically so for about two-thirds of the time, after which it falls rapidly to nothing. As uniformity in power is of the first necessity for an electric light, it follows that only about two-thirds of the charge can be utilised, and, therefore, a large additional weight of batteries must be provided, to say nothing of provision for failures and accidents. It may therefore be fairly assumed that one ton of batteries would be the minimum required. To maintain a light of 1000 candles there one ton of charged batteries would have to be supplied and one ton of empty ones taken away. The mean distance over which this weight must be carried would be, according to the company's prospectus, 24 miles each way. The total charge on the ten lamps would be 25 6d., to include first cost, depreciation, carbons, charging a ton of batteries, carrying them five miles, and arranging them in the house where they are employed. Assuming that any one would submit to the intolerable nuisance of this diurnal landing and unloading, and even assuming that the light worked satisfactorily, how can so much be done for so little money?

While we have thus endeavoured to give a timely warning to the unwary and investing public in regard with the greatest fairness the exaggerated statements of speculators who would trade on the credulity of the uninitiated, we do not wish for a moment to undermine the value of M. Faure's invention, which is not only a valuable contribution to science, but under able and trustworthy commercial management, must have very important industrial applications. It would not be necessary to look as far from home as the other side of the Atlantic for instances of the applications of sound scientific inventions becoming paralysed by the action of speculating adventurers; and it would be hard indeed for scientific men if their reputation and success were necessarily bound up with that of the promoters of companies, of which the Compagnie Anonyme de la Force et la Lumière is probably the most ambitious over yet brought before the public.

Electric Lighting by Batteries.

A very important installation of the electric light fed from voltaic batteries has been made at the Compagnie d'Escompte, Paris. Owing to the number of valuable documents in the establishment the presence of a steam engine was considered dangerous; on account of fire; and loud and property rights were too exclusive to admit of recourse being had to a generating station in the neighbourhood. The engineer, M. Cornuyer, therefore fell back on the single-fluid bichromate of soda battery for the source of current. The liquid is in constant circulation through the cells and air is blown into them to maintain their power. The form of battery adopted was devised by M. Grenet in 1857 and recently improved by M. Jurriast. The cells are stored in the garret of the edifice. Each battery consists of 48 elements in two sets of 24 each. The solution is composed of 30 kilogrammes of bichromate of soda and 75 kilogrammes of sulphuric acid at 50 deg. combined with water to make up a cubic metre of liquid. The bichromate of soda is preferred to the bichromate of potash owing to the higher price of the latter. The negative plate consists of four plates of carbon plunged into a rectangular vessel and connected by a leaden top-piece or head. On this head are fixed two little ebonite tubes which plunge to the bottom of the trough and serve to blow into the liquid, thereby stirring it and assisting the depolarisation of the plates. The positive pole consists of six rods of zinc bound into a sheaf round a central electrode, and plunging into a chamber of caoutchouc containing mercury which amalgamates them. The zincs are so mounted that they can be raised or lowered at will, so as to put the battery in or out of action. The cells are joined up together by proper connexions. The liquid is distributed to the cells from a common reservoir by means of pipes, which fill a row of ebonite mounters by a stopcock at the will of the attendant. When these mounters are filled to a certain amount they tilt up automatically, and each empties itself by an ebonite funnel into the lower part of the cell below. At the same time the solution to a like amount overflows from the top of the cell and runs off as waste into another reservoir. This liquid can be restored to its old strength; but it can be used over and over again before this process is necessary. The air blown into the cells is supplied by the pneumatic apparatus already in the building. The compressed air serves both for the dispatch of messages and the insufflation of the elements. By these means a constant current is maintained in the battery sufficient for electric lighting. The electromotive force of each set of 48 cells is 82 volts, and the intensity of current on short circuit is 24 ampères. MM. Jurriast and Grenet estimate that each battery in good working order is equivalent to a horse power and a half of electric energy, or 112 kilogrammetres per second. The lamps employed are those of Siemens, Gravier, and Sozzi, according as they are best adapted for the department of the building. The cost of the installation is not yet known.

Engineering Oct. 13, 1882.

Electric Lighting.

Mr. A. Reckenzaun read a paper "On Electric Launches." In the first place he described the boat and described in our columns (October 6, 1882). Since that date the two motors with their counter-shafts had been replaced by one Siemens D dynamo connected directly to the screw shaft, upon which was a new propeller with two blades; its diameter was 17.7 in., pitch 21.4 in., and area of blade surface 60 square inches. The boat now only requires 43 ampères of current with 46 volts, the armature making 810 revolutions, and the speed attained being almost the same as before with 57.2 ampères. More recently Messrs. Yarrow and Company, in conjunction with the Electrical Power Storage Company, have fitted up another launch, which has been sent to the Vienna Exhibition. This is 40 ft. long by 6 ft. beam, and can carry forty passengers. The motor is a Siemens D* machine, which develops 7 horse-power with 80 volts, and a current of 70 ampères. The screw is two-bladed of thin forged steel, with a diameter of 21 in., and a pitch of 13 in. The weight of the motor and batteries combined is 2½ tons. During the trial the speed of the boat was over eight miles an hour, the current used at the time being 41.22 ampères, and the counter electromotive force 132.5 volts, with 62 cells in circuit. An account of the trip of the boat from the Temple to Greenwich will be found on page 66 of our present volume.

At the close of the paper another bearing the same title was read by Mr. J. Clark, of Glasgow. The launch he described is a wooden boat, clinker built, 21 ft. long over all by 4 ft. 4 in. beam, and drawing 12 in. of water with three or four persons on board. She is fitted with an electric motor coupled direct to the propeller shaft, and her power is derived from two battery boxes 3 ft. long by 8 in. wide, and 12 in. high, which can be utilised as seats. The batteries require recharging with chemicals about every four hours of continuous use, one battery driving the boat at three-quarters speed, while the other is being recharged. During several runs at Kilcreggan-on-Clyde, a speed of a little over five miles an hour was obtained, the motor running at 600 revolutions per minute. The weight of the boat complete, with batteries charged, is 4 cwt. Clark's electric launches are now being built by Messrs. Gilbert Boyle and Co., of Glasgow, of varying sizes, from 15 ft. long and four miles per hour speed to 30 ft. long and seven miles per hour speed. The author gave no clue as to the nature of his batteries or to the cost of working them. As it may be presumed that the power is generated by the oxidation of zinc, it cannot be doubted that the working expenses are heavy, although there are doubtless many cases in which this item will be more than counterbalanced by the convenience of being able to renew the action of the batteries by the introduction of fresh chemicals, instead of by the more tedious process of recharging by a current from a dynamo machine.

Sir William Siemens said that there were many applications in which the secondary battery would be found useful, but it was a mistake to suppose it could be employed for every purpose. For instance it was foolish to endeavour to adopt them for driving tricycles, but in launches, where the machinery was perforce very cramped, they promised excellent results. The great question was whether the secondary battery would last or whether it would perish. In order to test this point quietly he had put down batteries in his own house last autumn, and he had found them satisfactory so far. He charged them all day and at night he used both them and a small dynamo to feed his lamps. In the case of a launch the machine could not be taken with the boat and consequently the navigation would be confined to short stages. The cost of electricity and steam power under these circumstances would be about equal, but the former would give advantages in weight and space.

Sir James Douglas pointed out that an electric launch was much more easily swung from the davits of a ship than a steam launch, and that it offered greater security at sea. There was no fire to be put out if two or three waves were shipped, and the machinery would work under water. There was also a saving in the number of attendants, one man only being required.

Engineering June 1883.

Accumulators.

An interesting lecture room experiment, for illustrating the action of accumulators batteries has recently been made by Messrs. J. Elster and Hans Geitel, of Wolfenbuttel. It is poles of a dry battery of the Zamboni type are connected with the electrodes of a Holtz induction machine and the pile charged for about ten minutes, it will for several hours act as a miniature accumulator. Messrs. Elster and Geitel used an ordinary tin can, copper pile of 11,000 pairs, with plates of one centimetre square, suspended for convenience on a silk thread. The strength of this pile, which under ordinary circumstances would hardly have been perceptible, was increased so to give sparks of nine millimetres in length, and to work a small Geissler tube. This suggested the use of a dry Planté-Faure battery, which was made by placing lead foil discs between paper discs, of which one was saturated with oxide of lead and some silicate of potash was added to make the plate adhere. The battery worked well in a moist atmosphere and retained traces of its charge for fully twenty-four hours. Another, prepared with salicine and lead oxide paper discs, gave less favourable results.

ELECTRIC ACCUMULATORS.

WHEN, two years ago, M. Faure made public the modifications introduced by him in the secondary battery of Plantè, his hopes, and those of his friends, led him to believe that he was in possession of a new system of distributing electricity which would solve the whole problem of domestic and public lighting by this agency. It will be remembered how, a little before the Paris Exhibition of Electricity, M. Fontaine, then the active promoter of the Faure processes, proposed to the Municipal Council of the city of Paris, to light gratuitously the Avenue of the Champs-Elysées during the period of the Exhibition. This project was never carried into execution; indeed, under the conditions which were then contemplated, it was utterly impracticable, and as we pointed out at the time, it was very similar to a proposal for substituting horse-to-house delivery of water by hand, for the existing systems of main and service pipes. Practice has since that date done justice to such unreasonable expectations; it has been admitted long since that electric accumulators could not be so employed, and although they may be called upon to fill a more modest rôle, the part which is naturally assigned to them is of high importance. Except in some particular cases, it appears amply demonstrated to-day, that every electric installation of importance in which accumulators are employed, must also comprise the use of a motor, and an electric generator for charging them. The obvious advantage arising from the employment of accumulators in such an installation is this: Where the periods for illumination are only a small part of the day, say, five or six hours out of the twenty-four, it is possible to employ in charging the accumulators, a motor and generator of more moderate power than would be required for feeding the lights direct. Leaving on one side the question of price, it is not always convenient, or even possible, to locate machinery of relatively large dimensions in Pearson-top, legislation in the matter of steam power in crowded centres, is very minute and restrictive, and under such circumstances the use of accumulators is of the highest importance. If it is required to maintain a current of electricity over a period of five hours, corresponding to a consumption of energy of fifty horse power, we arrive at a maximum result with a motor of fifteen or twenty horse power, charging the accumulators during the rest of the day. It is possible that under such conditions the cost of the electricity produced may be somewhat times greater than that generated direct, on account of necessary expenditure—wages, coal and wear of accumulators, loss in duty of the latter, and so on. The reduced prime expenditure would thus be attended by an increased cost in working. But in many cases it may well happen that there is no choice between the two methods, and where the use of accumulators is imperative. Again, these apparatus may act as regulators to equalise the flow of the current to the lamps, and thus maintain the irregularities that so often arise from the slipping of a belt, or the accumulators may relieve steam-engines of the temporary stoppages of the motor. We need not carry these considerations further, remarking however that the use of accumulators is only possible where direct currents are utilised.

The real services that can be rendered by this class of apparatus are, it will be seen, considerable. Very naturally the reaction, succeeding the great expectations stimulating the first announcements, led many to deny the existence of any advantage, but since then the opinion of electricians has had time to become established. Careful inquiry has since demonstrated the advantages and the inconveniences of secondary batteries, their good qualities and their defects; if the experience derived from continuous and extensive practice has not yet been secured, at least careful investigations have been made to establish a definite basis for the determination of their efficiency and capability. In this relation we may refer the reader to the valuable experiments made by MM. Le Blanc, Jenbert, Pothier, and Tresca, and which will be found inserted in detail on page 83 of our thirty-third volume.

The greater number of accumulators now in use, are only modifications of the secondary battery of Plantè, to whom all the honour of the invention must be ascribed. The improvements made recently by M. Faure, the construction of whose accumulators is too well known to call for description here, consisted especially in increasing the storage capacity of battery by "forming" them direct with the application of a thick cost of minium on a sheet of lead. M. de Kabath, the inventor of an accumulator which is also now becoming widely known, has endeavoured, on the other hand, to follow as nearly as possible Plantè's method of forming his battery, but to obtain a far higher degree of storage power, by increasing the active capacity, but keeping the weight within moderate limits. The Kabath battteries which are made especially for use in connexion with the Maxim incandescent lamp, are manufactured at M. de Kabath's works, 17, Rue d'Argenteuil, Paris, where we have been enabled to investigate the mode of construction, formation, storing, and discharging. The details of the various processes are embodied in the following article, in preparing which we have also been assisted by a little pamphlet published recently by M. de Kabath as a sort of practical guide to the use of his accumulators.

The principal element of the Kabath battery is shown in Figs. 1 and 2. Let us imagine two series

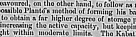
Fig. 1.

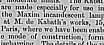
Fig. 2.

of lead bands or ribbons, about 1 millimetre thick, 40 centimetres wide, and having 30 centimetres between the other 60 centimetres long. These latter are passed between two grooved cylinders, where they are rolled and corrugated in such a way that their length is reduced to that of the first series of flat bands (30 centimetres). A flat and a corrugated ribbon are then superposed alternately, and this is continued until a group of 160 or 190 bands has been put together, having a total width of 8.6 centimetres. This assemblage is then enclosed in an envelope of sheet lead, soldered together, as shown in the figure. There opening allow the liquid, in which the sections are immersed, to circulate freely. At the ends, the two faces of the envelopes are brought together and soldered. At one end a strip of lead slightly bent is added to serve as a rephore. Such is a single cell of the Kabath accumulator; finished it presents the appearance of a plate 38 centimetres long, 9 centimetres wide, and 1 centimetre thick; the weight being about 2.2 lb. The strips of lead are set close one against the other, as shown in Fig. 3, but in such a way that the corrugations of the grafted ribbons are not in the least flattened. On looking through the circular openings in the envelope, daylight can be seen between the flat and serrated strips.

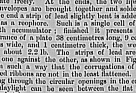
FIG. 3.

Up to the present time these cells have been coupled up in two types of portable and vertical accumulators. One of these, the laboratory type, Fig. 5, is formed of six cells placed in a glass chamber, the whole weighing 6 kilos. (13.2 lb.). The other, the so-called industrial type, is shown in Figs. 4 and 6, which indicate the reduction of elements and the box enclosing them. The type is made up of twelve cells and weighs 35 kilos. (64 lb.). In giving M. de Kabath has acted judiciously, considering that the accumulators are not likely to be moved constantly between a factory and the place of utilisation. In the greater number of cases, these

FIG. 4.

secondary batteries will have to be charged at the place where the current is utilised, and it is essential that they should be strong, durable, and easy of examination.

The two new types M. de Kabath has just put out with this object; are contained in rectangular wooden boxes, lined inside with hard rubber or ebonite, separated from the wood by a thin coat of asphalting mastic formed of arkanson and paraffin. The cells are placed edgeways, as shown in Figs. 6 and 9, parallel to each other; their flattened ends rest

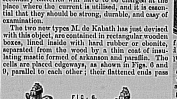
FIG. 6.

between vertical strips of ebonite, which act as guides.

This latter detail is advantageously replaced by glass plates, of the form shown in Fig. 7, having the same height as the box, and provided with two

FIG. 7. FIG. 8. FIG. 9.

grooves as indicated. These plates are placed at opposite ends of the box, and receive two cells forming a couple. Fig. 9 shows such a couple between the two glass guides, the box of course not being indicated. It will be noticed that the lead rephores are alternated, and are soldered to the envelope of the cells. With a metal of higher conductivity, copper for example, bathed in the surrounding liquid, a destructive hydro-electric action would be set up. The ends of the lead rephores are above the top of the trough, and they are united by screwed collars, seen in Fig. 6, and of which one is shown separately on the side of the box. This collar also receives the conducting rod. To avoid any direct pressure of the screw on the lead strips which would throw them out of shape, a small copper packing piece, shown as in Fig. 8, is introduced, on which the end of the compressing screw bears. The enclosing troughs are furnished with handles for convenience of transport. Two types of this new arrangement are in use, a small pattern corresponding to the vertical laboratory type described above, and a large size corresponding to the industrial model. A third and larger

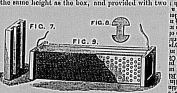
FIG. 5.

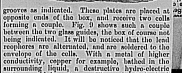
FIG. 10.

FIG. 11.

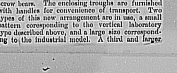
FIG. 12.

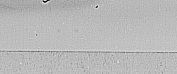
FIG. 13.

FIG. 14.

FIG. 15.

FIG. 16.

FIG. 17.

FIG. 18.

FIG. 19.

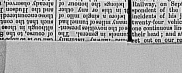
FIG. 20.

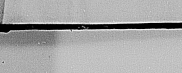
FIG. 21.

FIG. 22.

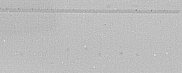
FIG. 23.

BATTERIES AT THE PARIS ELECTRICAL EXHIBITION

The voltaic batteries on view at the Exhibition were almost all modifications of well-known types; but some of these modifications are worthy of being studied. To begin with the Daniell elements, as being the most universally employed and constant in its action, there was in the American Section a novel form which is employed on the Bunkhetead Railway at Turquie. It is the device of Herr Kohlfürst, and consists as shown in Fig. 1 of a glass jar A with a

FIG. 1.

construction *b b* at its lower part. This jar is covered with a cast-iron lid D to prevent evaporation, and a conical plate of pig-iron F, is connected to it by means of a brass pin *c* which is screwed into the lid, and carries at its upper end a terminal *e*. The zinc forms one pole of the battery, and the other is made of an S-shaped plate of lead lying on the bottom of the cell. A gutta-percha insulated wire *f* runs from this plate outside the cell through a hole in the cover, and serves for the other terminal. The bottom of the jar from the lead plate to the zinc barrow rack *h h* is filled with crystals of sulphate of copper, and over the rack is laid a perforated plate of unglazed earthenware *i*. The exciting liquid is a solution of sulphate of magnesia, which is poured into the cell through a funnel-shaped opening *j* in the cover. This is ordinarily kept closed by a cork.

The electromotive force of this element is about a volt, and its internal resistance about five Siemens units. It is stated to be very constant and requires little attendance; once set up it will last for six months however much it is worked, and a year if not in constant use. Meidinger and Krüger's batteries were formerly used on the Bunkhetead Railway, but by employing the battery we have described a saving of some 75 per cent. has been effected.

Another form of Daniell battery, with a reservoir for the sulphate of copper at the bottom is represented in Fig. 2, where the copper plate itself forms the separator between the saturated or copper solution below, and the sulphate of zinc solution above. It is the design of Messrs. Hunt and Little, and is constructed by the Western Electrical Manufacturing Company, of Chicago and New York. The agents of this company in England are Messrs. Latimer Clark, Muirhead, and Co., of Westminster. A very simple plan for keeping the two solutions from mixing in the Daniell cell was exhibited by Dr. Jamin Jenar, now of the Société Générale des Téléphones, Paris, but formerly of London. This plan is fitted with a jar, A, Fig. 3, a long glass (or cork, a cylindrical zinc rod B is inserted to serve for the positive plate, and a disc of copper D is placed on the bottom of the jar as the negative plate. An insulated wire runs from this plate through a hole in the cork as shown. The whole cell is filled with a solution of sulphate of zinc, and crystals of sulphate of copper are dropped upon the copper plate at the bottom, where they dissolve. The solution of

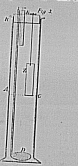
FIG. 3.

sulphate of copper thus formed is, however, prevented from rising into the upper half of the jar, where the zinc plate is fixed, by means of an additional piece of zinc, C, suspended in the liquid. Any sulphate of copper diffusing up as far as this plate is decomposed by the zinc, and metallic copper is deposited on the metal. There is thus a definite line of demarcation drawn between the two solutions at C, the level of the bottom of the suspended zinc. Dr. Jamar's cell answers very well as a standard, and the same device might be applied to the production of ordinary working batteries. When the circuit of a Daniell cell is open there is always a little wastage due to the reaction of the zinc upon the sulphate of copper. In order to suppress this M. Gaiffe has designed the form of cell illustrated in Fig. 4. This consists of a glass vessel B containing

FIG. 2.

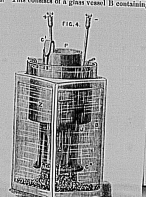
FIG. 4.

a zinc cylinder Z suspended by bent wires from the mouth of the jar; an inner chamber P, the upper part of which, J, is porous, and the lower part, S, is of ordinary glass; and a central cylinder of copper C, contained in the central vase. The copper cylinder is prolonged into a rod *c' c''*, which is bent back into the cell B outside of the porous vase and curved horizontally into a ring *c''*, which encloses the central vase. The cell is charged by a concentrated solution of sulphate of zinc or sulphate of magnesia, and crystals of sulphate of copper B are placed in the bottom of the central vase around the foot of the copper cylinder C. On dissolving, these crystals at first saturate the solution in the lower part S of the central vase, and when it rises to the line J, where the porous part of the vase commences, it permeates the pores and sinks by its density into the lower part of the outer vessel B.

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THE ELIAS ELECTRO-MOTOR.

(For Description, see following Page.)

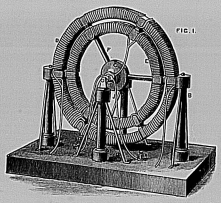


FIG. 1.

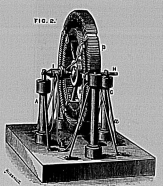


FIG. 2.

This permeation operates very slowly, and works cheaper, during which the circuit is opened, before any deposit of copper can be detected on the zinc. When the circuit is closed there is less internal resistance between Z and C; than between Z and C, hence the sulphate of copper which has sunk to the bottom of the outer vessel is first reduced, and the liquid in the exterior cell soon regains its original purity. The action then continues as in an ordinary Daniell cell. Further, the concentration of the porous pot by copper is avoided by preventing any contact between the pot and the copper plate.

A modified form of Leclanché battery, presenting some new features, was exhibited in the French gallerics by M. Mieche. As shown in Fig. 5, this

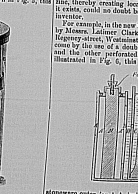


FIG. 5.

consists of a glass vessel A, containing at its upper part a cylindrical porous vase B, perforated with holes, which is attached to the electric cover of the cell. The vase is filled with fragments of plate of carbon; that is to say gas carbon, on which platinum has been deposited. From one of the terminals a platinum wire leads into the carbon and makes contact with the latter. The vase is traversed by an electric stem supporting a circular shelf or tray C, on which are laid two small cylinders of zinc, surrounded with mercury to amalgamate them. A platinum wire from the other terminal descends into the vessel and makes contact with the mercury. The external vessel is filled with water saturated with sal-ammoniac, or water thickened with a trace of its weight of sulphuric acid, or bisulphate of soda. The level of

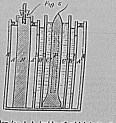


FIG. 6.

that water should not rise much above the level of the upper row of holes in the porous vase. The object of this is to make the greater portion of the carbon bound only by capillary action, whilst the zinc is entirely immersed in the liquid. The metal is therefore less easily dissolved.

M. Mieche claims for his cell that it will last a long time without recharging, and by its high electromotive force and low internal resistance is eminently adapted for working electric bells, or for telegraphic relays in series to, however, that small particles of platinised carbon can escape through the holes in the porous vase by the washing action of the liquid, and deposit on the mercury and zinc, thereby creating a local action. This defect, it is said, could no doubt be readily rectified by the inventor.

For example, in the new Howell battery, exhibited by Messrs. Latimer Clark, Muirhead, and Co., of Regency-street, Westminster, this drawback is overcome by the use of a double diaphragm, one porous and the other perforated, or rather slotted. As illustrated in Fig. 6, this element consists of a stoneware outer jar A A, inside of which is fixed a stoneware cell B B, called the "separator," having a number of narrow slots cut vertically in its wall, but not "through." A "separator" is placed on ordinary porous pot *c c* which contains a zinc rod F, kept sealing, by means of a thick layer of mercury in the bottom of the cell. In the space A' A' between the outer jar and the "separator" is placed a rod of carbon N, fitted in the usual way with a brass terminal for external connection, and surrounding this rod is packed a mixture of graphite and dioxide of manganese, in small pieces, together with some sulphate, or white manganese of commerce. The whole is sealed up with a compound of bitumen, and a small opening is left in the lid for the escape of gases.

The battery is charged with a solution of sulphuric acid in water (one part of acid to four parts of water), which is poured into the middle compartment B' B' formed by the "separator" and the porous cell. The latter is filled up with a solution of ammonic sulphate, made by dissolving 23 grammes of the crystallised salt in one litre of water.

The electromotive force of the combination is about 2·14 volts, or 1·2 per cent. higher than that of an ordinary Leclanché, and its internal resistance 4 from 5 to 6 ohms. This comparatively low internal resistance is attributable to the presence of white manganese, which has a higher conductivity than the black. The battery can be readily cleaned and, the eminent electrician, Mr. C. Hockin, M.A., has reported very favourably of its merits.

In the American Section there was a specimen of Helmuntz of potash cell, which gives good results. It was exhibited by Mr. A. Parti, of Philadelphia and Paris, and its chief peculiarity consists in the shape of the carbon plate. This is made in the form of a hollow cylinder or barrel, with vertical slots cut out of it from near the top to the bottom. It has, therefore, a vertical appearance, and encloses within it the zinc plate, which is also of a hollow cylindrical shape. The exciting liquid is a strong solution of bichromate of potash, and the electromotive force is said to be 1·65 volts, whilst the internal resistance is only 1·6 ohms. The result is a powerful current from a single cell, and hence the battery is well adapted for domestic purposes, such as ringing electric bells, or for actuating telephones.

While referring to the American Section we may also mention a more novel exhibit than in the "litharge battery," of Mr. J. Morgan Eldredge. The battery is of the ordinary form, and the plates are zinc and lead. The zinc cylinder is cast with lugs, by which it is hung from the mouth of the jar, and the lead plate is simply a square plate of lead placed on the bottom of the vessel. Powdered lithargo is strewed upon the lead plate and a solution of chloride of ammonia is filled in. In the chemical action of the cell, oxide of lead, chloride of ammonia, and dust are transformed into lead, water, chloride of zinc, and ammonia. No note of this battery are required, so we cannot speak of its merits, but the employment of lithargo as a battery material appears to be novel.

The element of Signor Piatti, in the Italian Section, is based on the observation made by its inventor that when powdered coke is pressed into a hard mass and inserted between the two plates of a voltaic element the carbon, though almost notably conductive within certain limits of pressure, does not "absorb strength," the cell, but on the contrary, and serves to render the exciting liquid more conductive and powerful. According to Signor Piatti, an element thus constructed lasts relatively longer without polarising than one in which the coke is absent. The cell he exhibited consists of the

Company of Inlays. 2. Experiments with Storing

The second annual meeting of the Faure Electric-Accumulator Company (Limited), was held at the City Terminus Hotel on Tuesday, June 28. M. Philippart presided and addressed the shareholders in French. He stated that his arrest in Belgium had been the result of spite in connexion with certain old questions pending with the Belgian Government. He was now out on bail, and he expected the matter would be decided in a fortnight, and that in a manner favourable to himself. If he were convicted he thought the position of affairs would be difficult, and he did not see how the business could go on in France without him. The enemies of the company — he meant those engaged in electricity, but in different systems, would endeavour to profit by these legal proceedings, but he had taken great precautions and used great efforts, and thus had been enabled to maintain the situation as it was. All the agreements which he was entering into, and was about to enter into, with the Government and others in France, were still remaining to be carried out by him as soon as the question connected with his arrest was finally settled in Belgium. He had been making experiments in Paris upon the propulsion of tramcars by stored electricity with great success. There were about 600 tramcars in Paris costing 60 francs per car per day for horse traction, and this figure, by the aid of their patents, could be reduced to 40 francs, which represented a saving of 500l. a day. What an advantage it would be to the shareholders if they could get the tramway company to enter into an agreement with them to give them a part of that amount! In reply to questions from the meeting, it was stated that the company had nothing further to do in England, the shareholders having approved of the sale to the remainder of the English patents to the Société Company, taking an interest in that company, whose patents were being worked in France, and to which they owed their profits. As to the 25,627 shares which M. Philippart had forfeited, on which 20s.10d. had been paid, they thus formed a set-off against the cost of the English patents and preliminary expenses; 19,600 of these shares had since been re-issued to the Société in Force et in Lumière. They had been issued as shares with 3l. each paid-up. The solicitor stated that M. Philippart was the only creditor and the largest shareholder of the Société in Force et in Lumière. The shares which had issued in St. Philippart's name had really belonged to the Société in Force et in Lumière, which now held at at least three-fourths of the shares of the Faure Company. This company had an interest equal to three-fourths in the French company, whose progress it was therefore very necessary that the shareholders should be informed about. After some discussion the meeting was adjourned to October 10. It is to be doubted whether the shareholders carried away either a clear or a hopeful view of their financial position. In England they have no active existence, and are looking for their profits to another company which they have practically sold to Ibis, a French company holds three-fourths of their shares, while they have an interest equal to two-fourths in the French company, and as if this were not sufficiently confusing, M. Philippart is the holder of shares and shareholder of the French company, and the shares which he has just forfeited to the English company have been returned to the French company, their paid-up value rising from 2l. to 5l. in the process. The shareholders are frankly told that their chances of a dividend depended largely upon the success of electric lighting in Paris, a very difficult problem, and that this was not to be achieved if M. Philippart be convicted. This is certainly the first time that a limited company has been addressed by a bailed-out chairman, and been told that he would carry their fortunes into court with him, and that if he did not reappear at the end of the trial they might consider them lost.

Storing Electricity.

If electricity is to become of general use to the community in the manner now prefigured by ardent electricians, and supplied to houses as gas or water is for a variety of domestic purposes, it will be a great advantage to have a convenient means of storing it up for a time. Secondary batteries are the likeliest apparatus for this purpose, and that of M. Gaston Plante, of Paris, has, up till now, been the best. This consists of two lead plates rolled together yet not touching each other, and plunged in water fortified with sulphuric acid. To increase the capacity of this arrangement M. Plante oxidises the lead by successive charges and discharges of electricity, until a coat of oxide and reduced lead forms on the surface of the metal. This is highly favourable to the production of the secondary current after the battery has been originally charged with the primary current. A single pair of plates of this kind having a surface of about ½ square foot (½ square metre) area, can store a quantity of electricity capable of rendering incandescent a platinum wire of 1 millimetre (·04 in.) in diameter for 8 continuous (about 3 in.) in length, for a period of ten minutes. Plante's battery is, however, too bulky for its power of storage to answer well in the general distribution of electricity which is demanded. Quite recently, however, M. Camille Faure has invented a modification of it which is far more hopeful. In this the plates are of lead and plunged in dilute sulphuric acid as before, but an almost boundless capacity is given to them by covering their surface with a layer of spongy lead, formed upon them by sending a current through them while immersed in the acidulated water. Red lead, or minium, is thus deposited on the positive plate and lead on the negative one, until the whole of the positive plate has been thus transformed. The plates are then enclosed in sheaths of felt kept in place by lead rivets, and the secondary battery is ready for storage. On being discharged again the reduced lead becomes oxidised, and the peroxide of lead on the other plate is reduced until the couple becomes inert. The great capacity of this contrivance for electricity is shown by the fact that one weighing 75 kilogrammes (165 lb.) will store a quantity of electric energy capable of performing a horse power of work for the space of an hour.

The Brush Secondary Battery.

After a long interval Mr. Brush has again appeared as a patentee in this country. His generator and lamp, although brought out in the early days of the revival of electric lighting, have held their own without change or improvement, while many compelling apparatus have been modified or have fallen out of notice. But however eminent the Brush system may be as a current chiefly for luminosity from mechanical development, and therefore it is desirable that it, like other systems, should make provision for the supply of electrical energy, should be supplemented by safeguards which will lessen the inconvenience, the dangers and annoyance of a stoppage of this light. For many months past we have heard that Mr. Brush was working at the problem of the storage of electricity, as a supplement to his method of generation and distribution; but it is only within the last few days that the details of his invention have been made available here. Up to the present time, we believe, his battery has not appeared in this country, and the only information that is available concerning them is to be found in his patent specification. This commences with a short description of the nature and formation of secondary batteries of the Plantè type, and is extremely interesting, from the fact that it appears to furnish a clue to the path along which Mr. Brush's mind travelled in working out his ideas. We shall endeavour to lay before our readers, in as concise a form as is consistent with a clear comprehension of the case, the explanation Mr. Brush gives of the internal processes that take place in a secondary battery, and shall then show how he applies these facts in carrying out his invention.

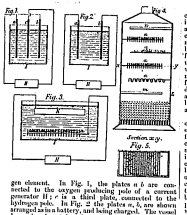
The most common form of secondary battery consists of two sheets of lead placed near together, but not in contact, and immersed in dilute sulphuric acid. When an electric current is passed through such an apparatus water is decomposed, hydrogen is evolved by, or combines with, one of the lead plates, while oxygen combines with the other and forms a coating thereon of peroxide of lead. This exhibits a lead cell being capable of combining with any acid, in practice that by the presence of the sulphuric acid employed. But if the exciting current be removed, it will be found that the apparatus has become a powerful battery, giving a current in a direction opposite to that of the exciting one. But this current is of short duration. If, however, the charging current be reversed from time to time, frequently during the first few days and more rarely afterwards, the capacity of the apparatus will be greatly increased. This constitutes the customary process of "forming" the plates of a secondary battery.

The formation of peroxide of lead on one of the plates progresses indefinitely so long as the exciting current is maintained, becoming constantly slower as the metallic surface becomes more and more protected against further action by the constantly increasing thickness of the coating of peroxide of lead thereon. This coating is a good conductor of electricity, and less oxygen is evolved at the surface of the peroxide coating. Now, if the exciting current be stopped local action, somewhat similar to that in galvanic batteries, sets in between the peroxide of lead and the backing of metallic lead that which it is in contact. By this action the peroxide of lead is reduced to a lower state of oxidation, while more of the metallic lead of the plate is oxidised by the oxygen thus made available. The fresh lead thus rendered doubtless acquires the same condition of oxidation as the original peroxide finally assumes. But the peroxide is never by this action reduced to the state of protoxide, as is proven by the colour of the coating, and the non-action on it of the sulphuric acid. When powerful enough to do so, a current will reverse the action it becomes useless for the development of a secondary current until freshly charged or oxidised. Thus is explained, as far as the oxygen plate is concerned, the cause of the gradual lowering of charge observed in lead secondary batteries. Further, since the conducting power of peroxide of lead hardly decreases as its oxygen is removed, the reason of the high electrical efficiency of the oxidised plates, after long standing uncharged, is also explained. When a plate that has lost its original conductivity is again recharged by an electric current for 24 hours, it will retain a higher charge than before, because all the lower state of oxidation is raised to the condition of peroxide, and thus some of the latter will be present than at the previous time of charging. This explains why the oxygen plates of secondary batteries constantly increase in capacity, even though the exciting current be applied at long intervals.

As the opposite plate of the battery hydrogen appears as the result of the charging current. This is produced at the surface being simply oxidised, or more probably forming a definite, but feeble, chemical combination with the lead. If such a combination exists it is probably a stable one so far as local action is concerned. But because the capacity of the hydrogen plate never becomes at all considerable when it is subjected to this action, it is useless. Hence in practice the oxygen plate soon acquires a far greater capacity, and the charge must be reversed before the hydrogen plate can act upon the hydrogen, and bring it into a spongy condition, in which it can retain a considerable quantity of hydrogen equivalent to the oxygen stored on the opposite plate. Thus it is the oxygen plate for the time being that receives all the frequent reversals of the charging action, the hydrogen plate remaining almost unaltered. This is the reason for the frequent reversals of the charge in forming batteries. When a previously excited secondary battery is discharged the peroxide of lead is thereby reduced to a state of lower oxidation, as already explained. Thus what was at first a good conducting envelope on the metal plate is now a non-reduced lead peroxide, and at the same time pure water is formed within the mass of lead oxide, and presents a perfect barrier to the passage of the current. These two causes account, so far as the oxygen plate is concerned, for the increase of resistance in secondary batteries during their discharge, and especially towards the end of the process, where it is also formed in the pores of the hydrogen plate.

The quantities of forming batteries by this process arise from the fact that the peroxide of lead formed on one of the plates is consecutively acted upon as formed on the metallic lead dish. The covering action does occur in all directions in forming, and to accommodate this the structure of the deposit must be more or less porous, or else the fine lead plates would expand. When the direction of charge is reversed the previously oxidised plate becomes alcoholic. Both the expansion and contraction may be rendered manifest by treating one side only of a plate, the other side being protected by varnish. When such a plate is oxidised the exposed side becomes concave, and when the oxide is subsequently reduced the same side becomes convex. During the processes of charging and reduction the expansion and shrinking does not occur in all parts of the mass at once, hence a thixotropizing action is set up, and the coating eventually peels off. Again, every time the plate is charged it forms a definite quantity of sulphate of lead, is formed within it, expands, and exercises a very deleterious influence, similar to that above, and aiding the disintegration by its separate volume.

The process of forming the plates of secondary batteries which constitutes the first part of the investigation avoids or eliminates the above evils almost entirely, and consists in charging the plates, which are ultimately to constitute the battery, in such a manner that a coating of peroxide of lead of sufficient thickness is formed on both of them. These plates are then associated together in the usual way, and an electric current passed through the apparatus in the manner customary in charging; one of the plates remains unchanged and constitutes the oxygen element, while the other has its charge reversed and becomes the hydro-



gen element. In Fig. 1, the plates *a b* are connected to the oxygen producing pole of a current generator H ; *r* is a third plate, connected to the hydrogen pole. In Fig. 2 the plates *a*, *b*, are shown arranged as in a battery, and being charged. The vessel I may be of metal and constitute the plate *r*, or the latter may consist of one or more previously charged plates which then become reversed, and are then ready to start further treatment to be paired with other charged plates, as usual, in the construction of the recovery cells. Several months of continuous or intermittent charging are required to produce a satisfactory coating of peroxide of lead; but the process of reversing the charge of one plate need not take more than a few hours.

This process of forming plates is applicable, not only to flat plates, but also to those upon which coherent porous lead has been deposited by electrolysis. When such plates are adopted they are first made electrically clean, and are then plated from a solution that will give a coherent deposit, such as oxide of lead in caustic alkali, and not from the sulphate, chloride, acetate, or nitrate, all of which give non-coherent deposits. Corrugated, ribbed, and perforated plates are well adapted to receive and retain the coherent coating, and have their corrugating uniformly filled with the deposit, but if treated in the ordinary manner by electro-plating the greater portion of the metal will be laid on the exposed portions and little in the cavities, in order to reverse this disposition the plate has the hollow portions filled with peroxide of lead, either dry or in a paste, and is then placed horizontally, prepared side upwards, in a solution of caustic soda or potash in a depositing trough as shown in Fig. 3, where *a* is the generator, l the bath, and K a plate to be treated. When the cavities on one side are filled the plate is reversed and coated on the other side, and again treated. Plates of other metals than lead, such as gold or platinum, may be used in the same manner as backings, and though two sources of electric current lose the oxygen by local action. When plates treated with deposited coherent lead are associated together in a secondary battery and charged, the reduced metal or coat of the plates is permitted much faster than ordinary rolled or cast metal, but not nearly so fast as the spongy or non-coherent lead, while the other plate absorbs hydrogen, but not nearly so fast as the former absorbs oxygen. It is therefore advisable to have recourse to the process of "forming" described above.

Another method of coating plates with porous lead is to make use of the metal in the oxide, and effect it by a reducing gas at a temperature insufficient to

cause fusion. Figs. 4 and 5 illustrate this part of the invention. The plates *a a*, whatever may be their form, are placed in a horizontal position in a chamber, and covered to a sufficient depth with lead oxide or nitrate, either in powder or paste. A stream of carbonic oxide, mixed with nitrogen, is then generated from the incandescent fuel on the hearth, and drawn upwards by the chimney, passing in its course downwards and forwards over the plates. The coating of lead oxide is then reduced to metallic lead, differing from those both of sponge lead and of the electrically deposited lead described above. It may be regarded as being intermediate in character between the two, but possessing many of the advantages of the latter, and being free from the disadvantages of the former.

Battery elements, previous to being "formed," may consist of a mass composed of metallic lead and non-oxidizable material which forms a support and active coating, united to a conductor *b*, and stiffened by a stay *c*.

(To be continued.)

Engineering, July 1882.

SECONDARY BATTERIES.

On Secondary Batteries, with special Reference to Local Action.

By Dr. J. H. GLADSTONE, F.R.S.

THE elements of which a (three) battery or cell is composed are modifications mainly see metallic lead, peroxide of lead, and dilute sulphuric acid. The reaction that takes place in the combination of the positive metal with SO_4, forming $PbSO_4$ (plumbic sulphate), and the reduction of the PbO_2 (peroxide of lead) by means of the hydrogen of the water, being also held to PbO (plumbic oxide), with the evolution of sulphuric acid, is also converted into sulphate of lead and water. The energy of the reaction which can be obtained from a cell depends upon the amount of peroxide of lead which is capable of being reduced. Now the arrangement of these secondary batteries is itself an arrangement of lead and lead peroxide, and if immersed in dilute sulphuric acid galvanic action at once sets up. "Local action" is, fortunately, soon diminished by the formation of sulphate of lead upon the surfaces of the lead plate and crystals of peroxide. When the two plates are brought into connection by means of a conductor external between them, but the local action on the positive plate is not stopped. This is shown by the much larger amount of sulphate of lead produced on the negative than on the positive plate. In experiments quoted by the author, the amount of sulphate of lead found on the negative plate was double the amount of peroxide of lead that may be thus destroyed on an average, and if not easily recognised, for the electrolytic force is not sufficient to set the current obtainable in the first instance in motion, local action, though, of course, the same amount of work cannot be got out of the battery. This local action takes place during the formation of a cell. One of the proofs of this is that a small more oxygen is absorbed than could possibly be taken up by the reduction of the minium used in a Faure cell; indeed, in one experiment which was continued for 115 hours, it was found that a large amount of oxygen was being continuously absorbed, though the main action was complete in less than forty hours. This was attributed to the formation of sulphate of lead at the extreme of the lead plate and its subsequent oxidation. This local action impairs the value of these secondary batteries, it hence impairs the value of these experiments which are important problem to ascertain what modification of the present arrangements will minimise if not entirely prevent it.

THE DANIELL CELL.

It is well known that the electromotive force of a Daniell cell falls after it has been in action for a time, and the fall is usually said to be due to "polarisation." The causes of the fall have been studied by Dr. C. R. Alder Wright, F.R.S., who recently read a paper to the Physical Society on the results of his investigations. The experiments on cell he employed contained two pairs of plates, one pair exposing double the area of the other, and the back of the latter being covered with gutta-percha, so that only the exposed surfaces came in action. The cell was of the gravity pattern, the two zinc plates being immersed in strong sulphate of zinc solution, and the two copper ones in a weak solution of sulphate of copper, which floated on the zinc solution. The zinc plates were both in the same horizontal plane, as were the copper plates, so that whether the large or the small plates were used the same compound column of fluid was between them, and hence the internal resistance R was the same. With this apparatus Dr. Wright first found the total fall for increasing current densities; and his results showed that there was no appreciable fall when the current density did not exceed 8 micro-ampères per square centimetre of plate surface (corresponding to a cell exposing 500 square centimetres of surface to a current of .004 ampère). With four to six times this density a diminution of the electromotive force of from 0.5 to 1 per cent. was brought about; and with currents exceeding in density 2000 micro-ampères per square centimetre (1.5 ampère with a cell of 500 square centimetres), the diminutions exceeded 10 per cent. It was further found that little differences was produced by using pure, commercial, or amalgamated zinc, or zinc coated with a film of copper respectively. Amalgamated copper plates gave more rapid rates of fall than electro-coated ones; and with dilute sulphuric acid surrounding the zinc the rate of fall was somewhat less rapid than with zinc sulphate solution. Dr. Wright also made a long series of observations to find out the maximum electromotive force when various qualities of solution were employed, in order to see how far the fall could be accounted for by the migration of the ions causing a stronger solution of zinc sulphate to accumulate round the zinc plate, and a weaker one of copper sulphate round the copper plate, than previously existed. This result shows that with nearly saturated zinc sulphate solution (specific gravity 1.4) and very dilute copper sulphate solution, the maximum fall in electromotive force is developed, it being less than .01 volts. Hence of the total fall in electromotive force produced when moderately strong currents pass, only a fraction can be accounted for by the effects of the migration of the ions. The general conclusion of Dr. Wright is that of the total fall in electromotive force of a Daniell cell on generating a moderately large current, usually referred to under the inappropriate name of "polarisation" only a small portion can be accounted for by the effect of migration of ions in causing differences of specific gravity between the fluids surrounding the plates. Of the remainder the majority is due to actions having their seat at the surfaces of the copper plate, and the rest to actions having their seat at the surface of the zinc plate. As a practical result it appears that the electromotive force of a Daniell cell with zinc and copper amalgamated plates, and either freshly deposited electro-copper, or amalgamated copper plates, is a tolerably readily reproduced standard, and it has this merit over the Clark standard element that a number of such cells will agree more closely among themselves than either forms of Daniell cell or than the Clark elements will do. The limits of variation among such Daniell elements being as ±0.2%, whereas among Clark's cells it is ±0.8, or thereabouts. On the other hand a standard Daniell falls in value in a few hours, or a day or two at most, whilst a Clark cell can be so constructed as to remain absolutely permanent in its indications (at a constant temperature) for months, and even one or more years. In the discussion which followed the reading of Dr. Wright's paper, Professor Clifton, of Oxford, the new President of the Society, stated that he had not found the Clark cell to justify his expectations; but that might be due to some fault in the particular cell which he had in his possession. This remark led Dr. Wright to explain that the electric laps supplied with the cell sometimes deteriorated under the influence of sunlight and became conductive. The cell ought, therefore, to be kept in the dark, or the electrode should be discarded. These cells could be set up by taking a piece of glass combustion tube (which was free from lead) and bending it into a U shape, one limb being very small, and the other thick. Pure mercury is placed in the bottom, and the mercurous paste poured in till the thicker limb is nearly filled, then a square of pure zinc is put on the top; the whole being sealed in melted paraffin. A platinum wire unmoistened by dipping it in sodium amalgam serves for the mercury electrode, and a copper wire covered to the zinc plate for the zinc electrode. Care has to be taken to expel air from the cell, and to keep the paste from shrinking.

Engineering, July 1882.

THE SKRIVANOW BATTERY.

This modification of Dr. Is Ilos's chloride of silver cell consists of a positive pole of zinc in an alkaline solution of 70 parts of caustic soda to 100 of water, and a negative pole of chloride of silver fused into a mass and enveloped in parchment paper. As made up for the pocket the zinc is in the form of a flat U-shaped plate of zinc, which contains in its hollow the chloride of silver packed round a silver plate. The whole is placed in a small wooden case with a close fit having a hole, ordinarily shut up, to allow of fresh liquid being put in when the cell is used. The connections are made all of silver. The weight of the cell thus accoutred is 90 grammes. The electromotive force is from 1.50 to 1.56 volts, a little higher than the ordinary chloride of silver cell. It is to be remembered that this result, like that of every battery extant, is probably 1.3 per cent too high, owing to the calculation used being on a much greater than the true ohm by Lord Rayleigh's measurements. The cell can give out a current of one ampère for one hour, when the liquid must be renewed. After two or three renewals the chloride of silver must be replaced. It of course is therefore an expensive battery; but its portability and cleanliness render it useful in theatrical effects for producing starlights on the heads of dancers. In the opera of La Farandole the dancers have circlets round the head with starlights mounted on them. Wires pass from the circlet to a belt or ornamental cestus round the waist of the dancers. Two Skrivanow cells on each side of the belt chair, form the electric generator. On the belt beside the battery a little commutator permits the corypher to control the light at pleasure.

USE A NEW ELECTRICAL STORAGE BATTERY.

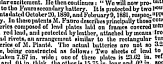
In a paper communicated to the Royal Society by Mr. Henry Sutton, of Ballarat, Victoria, and read before this Society by its President, Mr. Sutton urges that no system of supplying electric force can be considered as perfect until some means is used to so store the force generated that it may be drawn off equally and regularly, and that reservoirs ought to be between the generating machinery and the apparatus of whatever kind, to prevent the apparatus from being influenced by accidental little further, would perhaps not as such accidents in the machinery. Mr. Sutton himself has done a good deal to bring us nearer this aim. In the long series of his investigations, which comprise many different forms of cells, he first largely used lead as the negative electrode can only proceed with a sponge, as a special feature of which he claims that the injurious effect of the hydrogen, generated at the negative electrodes during charging was avoided. A sheet of lead in a porous pot, filled with dilute hydric sulphate formed the positive electrode; the negative electrode, also a sheet of lead, was placed in a solution of acetate of lead. The positive electrode of this cell is peroxidised during the charge, whilst at the negative the hydrogen replaces the lead in the solution, so that metallic lead is deposited on the sheet, and acetic acid, result as products. During the discharge the peroxide is reduced, and the just deposited lead oxidised and dissolved in the acetic acid; thus the original materials are reformed. Amalgamating the positive electrode had a very marked success. The lead is then more uniformly and rapidly peroxidised, and Mr. Sutton found this advantageous with the various modifications of this cell that he experimented upon. He constructed, among others, cells with porous amalgamated cylinders of either red or peroxide of lead as electrodes, also cells with parallel plates and red or peroxide between them. In this latter combination, the red oxide proved useless; perhaps because, as Mr. Sutton remarks in another part of his paper, red oxide of lead is a bad, whilst peroxide is a good conductor of electricity. The cells for which Mr. Sutton finally decided are not different in principle from the one that we described. As positive electrode he retained amalgamated lead; as negative he used zinc, iron, or copper, placed in a solution of their respective sulphates. During the charge the metal of this solution would be deposited, the resulting solution, sulphuric acid, being such that should, on the oxidation of the deposited metal, combine with the oxide and again form the original solution. The results with these cells were not only more powerful but also very constant. Really practical and economical, however, of these is only the copper cell. Zinc was discarded, as the plate would have to be kept amalgamated to prevent local action; and iron was set aside as it oxidised when not in use. The copper cell is free from such faults, and the charge of colour that here takes place during the charge makes it an exceedingly easy to tell when the cell is charged, that Mr. Sutton speaks of this change of colour as a veritable charging gauge. We know that the charge is effected by the blue sulphate of copper being decomposed into metallic copper and colourless sulphuric acid and water; the charge will therefore be completed when the liquid has become colourless, and again the discharge will approach to the end when the deep blue reappears. Mr. Sutton used the two metal sheets rolled up in a spiral, the copper sheet being a little shorter, and both perforated to allow a free circulation of the liquid; rubber loads, cut every ½in, kept the two plates separate from one another. With such a cell, 4 in. deep and 4 in. in diameter, Mr. Sutton obtained over two hours' effective work, in leading to red lead 1 in. of No. 28 iron. As a practical form of this cell Mr. Sutton proposes to fix a series of amalgamated leads in a box in grooves, as in Cruikshank's trough battery, and to fill the intervals between the plates with copper sulphate. He has himself two boxes on this plan, each containing 25 plates, equivalent to 50 cells; they can be charged from 30 Bunsens. It is not advisable, according to Mr. Sutton, to suspend crystals of the blue sulphate in the solution, as they would prevent the oxidation of the lead, it being essential that the solution becomes slightly acid before the peroxide will form. The addition of one or at best be local. It has, indeed, been difficult to discuss this matter sooner, for it was impossible to form any conception of the Faure battery before the public. It has been sold and repeated officially that in a Faure battery a considerable loss of time occurs before the current is sufficiently able to overcome its own back pressure, for one hour, or 3.25 foot-pounds per second per pound of battery. We have only seen an approximate answer to this question, on the Société d'Encouragement. Then it was for four pounds of the small; the battery weighed 220 lb., but instead of giving 1070 foot-pounds per second, it gave 1,200. Now, as the Faure accumulator makes have been working under most favourable conditions; it might have been delay for less than its maximum. We do not wish to draw any deductions from this experiment, which was, however, a very unfortunate one, and we will for the moment accept the 3.25 foot-pounds per pound of battery. We might here to remark that Mr. Tyler has calculated, by an extremely simple method, that a battery weighing 220 lbs. can, according to algebraical calculation which is published in the Transactions of the Academy. This calculation was not—at the Société de Physique—by many reasonable physicists; the principal one being that it was wrong, as it only considers H. Streater having drawn from it being that the more slowly the battery was discharged, the better the result, and in a general as opposed to a particular case. This is true of the ordinary batteries of the Plantè type, and of some primary batteries, as well as of dynamo machines. By using the battery very slowly, therefore, its duty is claimed to be 50 per cent., and as this proposition may be true of the Faure as well as of some other battery, the calculation of Mr. Tyler that the 220 lb. battery of 1000 foot-pounds of discharging energy per weight of battery could represent 14,750 foot-pounds stored up within the battery. This figure is, to a certain point, confirmed by an experiment made at the Société de Physique, where eight batteries, substituted, at a red lead during 1 hour 40 minutes, a platinum wire 12 in. long and .016 in. diameter, which required a current of 20 amperes to make the wire red hot. The battery gave up 252 foot-pounds per second, or 1,848,000 foot-pounds in all. According to M. Raynier, the weight of the batteries was 222 lb., so that the power stored up was equal to 12,541 foot-pounds per pound of battery. These cells have been a slight error here, because, as we have already seen, the useful weight of each battery was not 222 lb., but only 220 lbs., or 176 lb., giving a total of 1849 lb., or 10,910 foot-pounds per pound of battery could represent 14,750 foot-pounds stored up within the battery. This figure is, to a certain point, confirmed by an experiment made at the Société de Physique, where eight batteries, substituted, at a red lead during 1 hour 40 minutes, a platinum wire 12 in. long and .016 in. diameter, which required a current of 20 amperes to make the wire red hot. The battery gave up 252 foot-pounds per second, or 1,848,000 foot-pounds in all. According to M. Raynier, the weight of the batteries was 222 lb., so that the power stored up was equal to 12,541 foot-pounds per pound of battery. These cells have been a slight error here, because, as we have already seen, the useful weight of each battery was not 222 lb., but only 220 lbs., or 176 lb., giving a total of 1849 lb., or 10,910 foot-pounds per pound of battery.

According to the careful experiments we have made the useful storing power of the Faure accumulator battery is 11,250 foot-pounds per pound of battery, so that according to the different weights taken, the value of the latter to the former is 1.30, 1.06 or .55. This is a very long way off the 50 per cent. claimed by Mr. Tyler, and the difference between the two figures is not explained by the 252 foot-pounds per second, as the current must have been an exceptionally low one; then from which we had deduced his expectations had been furnished to him by M. Reynier. If this was the case, we know Plantè cells did but little credit to the renowned maker who supplied. Besides, as a matter of fact the batteries on experiment with were found to have been made by M. Plantè for sale (or rental), and other cases, and we have therefore understood that there are at present no Faure batteries ready for sale, the ones already produced having been made by M. Faure's own hands or under his directions, and it is only just to institute a comparison between the Faure battery made by M. Faure, and the Plantè battery made by M. Plantè.

The results which are given on another page to the exact we have mentioned, and for the reason why a battery in which the red lead is spread by hand, should be, weight for weight, superior to an apparatus in which the peroxide is obtained practically by electrolysis, and experiments can only confirm this deduction. The Faure battery is better adapted for industrial purposes, it is lighter and gives an answerer to most of the questions which we have put to it, but when compared with the Plantè battery it certainly, the Faure cell does not require a preliminary electrical process to render it fit to receive the charge, which is a very great advantage, and besides it offers greater resistance for an equal surface, while it is less liable to damage than the other apparatus, although the Plantè battery has been in existence about 20 years, and has undergone improvement as a secure of experience, is very neat and light, and for several very good reasons, of which we will mention one only—that of transport—which has been treated in the company's prospectus as a detail of insignificance, and referred to only as it were in an

STORED-UP ELECTRICITY.

THE current number of *La Journal Universel d'Electricité* contains some very silly articles by M. Fontaine. Already upon the Faure secondary battery, to which we recently referred (see page 548 ante). From this article we find the queen to make the following extracts: "The positive bearing the words 'Faure and Liglé' is enormous [sic] letters are still visible on the walls; the noisy articles that have appeared in certain journals have not yet produced, however, the bills are beginning to disappear, for the public slightly neat before the peroxide will form. The addition of a few crystals, with the help of which the decomposition and thereby charging might be prevented the apparatus from being influenced by accidental little further, would perhaps not as such accidents in the machinery. Mr. Sutton himself has done a good deal to bring us nearer this aim. In the long series of his investigations, which comprise respect probably, the right proportion between many different forms of cells, he first largely used lead and copper for instance, as the reduction at the negative electrode can only proceed with a sponge, as a special feature of which he claims that the simultaneous oxidation at the positive one. Consequently, a cladding his paper, Mr. Sutton remarks, that as this new method of conserving energy will have a wide field before it and benefit fellow-workers, he gives it freely without reservation and untrammelled by patent rights.



each face thus prepared a sheet of parchment paper is placed, and the whole is introduced into a sheath of thin leather. One plate is thus put on top of the other and rolled up, strips of rubber being introduced between the plates to keep them apart. The roll is then placed in a cylindrical lead sell, the outside of which is strengthened with copper bands, and the inside covered with red lead and lacker, so as to increase the useful surface of the battery. The latter then presents the appearance shown in the sketch, and one of the projecting stems from the lead plates is bent over and soldered to the exterior cylinder, which is ready for use when it has been filled with acidulated water, and the cover soldered on. The complete battery when charged weighs about 220 lb. It will be seen that this differs from the Plantè secondary battery only in the employment of red lead. The material chiefly employed in the same, the mode of construction is precisely similar. It must not be taken the part of the chief objection raised by M. Plantè; it has no merit in itself, to the contrary, it is a very great objection, as the red lead, after charging, is only useful to keep the red lead in place. It is, in fact, the red lead which constitutes the useful element, and gives the special advantage to the apparatus. According to the inventor there are two advantages gained. The long and delicate operation necessary to prepare the Plantè battery is not required. (This operation consists in alternately charging and discharging the cells when copper goes to one plate, and produces a thin layer of peroxide of lead, and hydrogen goes to the other plate). The second advantage claimed is that the battery has a storage capacity much greater than that of Plantè; this proposition, according to M. Reynier, being deduced from numerous experiments, forty times greater with equal weights of batteries. The first advantage claimed does not exist, and the second is not proved, as the practical inspection and tests. The second cannot be admitted, as will be seen from what follows. M. Hospitalier and myself were desirous to submit the Faure battery to precisely the same tests that we have made with the Plantè battery. To do this we first addressed ourselves to the proprietors of the Faure battery, and asked them to send us two batteries for trial; that they would not object to which, but only after some time. Since this communication we have been prohibiting from them. In the absence of these data, we will reason on the figures supplied, and the experiments made by the proprietors of the Faure battery before the

SECONDARY BATTERIES.

As bearing upon this animated and somewhat personal discussion which has been carried on during the last two months between M. Philippart, representing La Force et Lacombe's battery, and Mr. C. Vickmar, on the subject of accumulating batteries, we are requested to publish the following letter. It is the abstract copy of a communication from M. Philippart to Mr. Vickmar, and its truce is as much as possible, and these have not been obtained without trouble. M. Philippart was induced to describe the Plantè battery, which is the only secondary battery, other than that of M. Faure, M. Plantè having, since it was patented long ago anticipated what M. Faure has recently brought forward, and which has been received with so much popular excitement. He then continues: "We will now proceed to the Faure secondary battery. It is protected by two patents dated October 25, 1880, and February 9, 1881, respectively. The first patent refers to the formation of the plates of the batteries, one of lead plates laid on frames covered on both sides with red lead, and protected by leather, attached by means of lead rivets, an arrangement similar to the rectangular batteries of M. Plantè. The actual batteries are quit as such, being constructed as follows. Two sheets of lead are taken 7.87 in. wide; one of three plates is 12.02 in. long, and the other of two plates is 8.26 in. long, and 0.078 in. thick. Each plate is covered on both faces with a layer of red lead reduced to a paste by water, 1.76 lb. being spread over the larger plate, and 1.54 lb. over the smaller. On

"Yours faithfully,

(Signed) "H. PHILIPPART.

"M. C. Vickmar, 7, Station Garden."

We trust that both the inventors and the public will benefit by this alliance.

cause of scrupulous minuteness. In order to furnish a force equal to one horse power during ten hours, ten batteries weighing 165 lb. each must be employed. This is throwing out of consideration the fact that a part of the charge only can be utilised on account of the fall of the potential below the necessary point, which would take at least 15 per cent. off its utility. Making no allowance for this, and for the fact that the battery is never twice, that is to say, 14 lots of battery, would be transported daily, besides all the other expenses, for a motive of 10 horses a day; we have the reader to know its own conclusion. In fact, to maintain that this mode of electrical distribution is more economical than by wires, where they not be used, is to maintain that the present system of distributing gas is not better than the hauling of an enormous gasholder to several places, that is the reverse is always a considerable loss, and that it would be cheaper to substitute a horse-drawn system of water transport by means of isgeneral barrels. But this is a point we do not press. It belongs to commerce and to science, and this journal has nothing to do with money interests. But science suffers when these categories are thus blind. It seems away one, and the love of novelty, sensational, and exaggerated promises unfolded create the public mind to receive favourably almost undeveloped of a capricious nature; the public not having obtained what they looked for turn away and refuse to have anything to do with more modest but useful applications which are offered to them. Will it not be thus with the Faure apparatus? The experience obtained have much interest, the inventor mentions in his letter to the Academy of Sciences, especially for traction, for which the battery may have a special future. But why does not the inventor confine himself within the limits of possibility?

"Whatever future may be in store for it, we are at present inclined to it for having drawn special attention to the study of electrical accumulators. Since the announcement of the Faure accumulator, a number of new others in course of development, all of them more worthy and interesting, and all promising a useful though less sensational future.

"M. Reynier, at the last sitting of the Société de Physique remarked aptly that he did not ignore the relative imperfection of the apparatus at present invented, but both M. Faure and himself had been unable to complete them themselves before bringing them before the public, and he trusted soon to be able to offer far better results than those given by the apparatus of M. Faure. I should undertake no prediction for a day of existence to a himself undertake not pressing without restriction an apparatus of which I cannot acknowledge the electromotive; it is, in fact, a false position, and one which he would do better to avoid."

Engineering, Sept. 5, 1883.

STORED-UP ELECTRICITY.

In the current number of the *Journal Universel d'Electricité* we find a criticism of the recent utterances of Sir William Thomson in the *Times*, on the subject of the Faure accumulator. This criticism, which is by M. Frank Géraldy, we reproduce almost in extenso.

"If the letter that published in the *Times* on the 7th inst.) had been anonymous, or signed by any ordinary name, there would have been no occasion for noticing it, but the illustrious name and high authority of Sir William Thomson demand for it full consideration.

"Sir William Thomson, one of the founders of the directors of the Electrical Exhibition, has not yet had his subjected certain Faure batteries sent to him to exhaustive tests during the last three weeks. He has however only given a single number resulting from his labours. This is much to be regretted, for if Sir William Thomson were able to test the correctness of the figures put forward in France, we had hoped that Sir William Thomson would furnish a series of figures which would entirely clear up the question. A charge of 1000 kilogrammetres per kilo. of battery is announced. The battery contains, we know, 12·5 lb. of useful lead, so that the amount stored is 1177 foot-pounds per pound. This is practically the maximum claimed for the battery by the inventors. Every one is now agreed on this point and it has been sufficiently proved that the Faure accumulator can store up, say, 1500 foot-pounds per pound weight of lead. The experiments of Sir William Thomson show that the Faure battery has been shown to be only slightly less than that in the Faure, the ratio between the two being 1 to 1.25, so that the two apparatus are not very far divorced from each other in storing power. It appears, then, not a little singular that Sir William Thomson, who has been acquainted for the last twenty years with the Planté battery, who has studied it, and exercised in it the praise it justly merits, does not discover the full amount of its merit until the day that it is proposed to him under the title of the Faure battery. Evidently his attention was not powerfully attracted to this latter apparatus. It is still more striking that Sir William Thomson cannot, in his own experiments with the Faure battery, find any of the surprising results then performed by Professor George Barbaeni; now, for two years at least the Planté battery has been used in performing analogous work, and it is chiefly in view of this special application that M. Faure and other constructors in Paris make and sell their apparatus; for example, the Planté battery is employed in the Gramme machine-workshops, telegraphs, &c., made for working with the battery. Its application to the Arlanet electric and other trades may also be mentioned. All these go to prove that the Planté battery can be manufactured for many industrial purposes, and that the Faure battery possesses in the absence of the preparing process preliminary to charging, the one advantage which is of little value in practice. Sir William Thomson does not, however, furnish any conclusions to run away with him. He does not embrace the still proposals of carting power and light from town to house, but putting this proposition on one side he indicates the true function of the battery, that of acting as a regulator in a system of distribution by conductors. . . . The owners of the Faure battery have doubtless felt the necessity of an authorised support based on experiments of the kind made by Sir William Thomson, and the publication of Sir William Thomson; this is all very well, but it appears strange that in order to obtain a certain opinion, they were obliged to cross the Channel. We would have thought that there exist in France, electricians who could have furnished it. It is evident that Sir William Thomson takes a most lively interest in M. Faure's apparatus. Not only has he made experiments with it, but he has given it a second and certainly large one has been made of his letter, they appear in many of the English papers, they are reproduced very incorrectly translated in the *Figaro*, they are printed on fly-sheets and scattered broadcast, &c. He allows one of his collaborators, M. Batholley, to come to France after receiving him in his experiments, and who is now engaged in Paris testing his valuable assistance in improving the apparatus. Shortly after the publication of the letter of Sir William Thomson, and when the accumulator is highly appreciated. For we think without being sanguine, there might have been found in France men of equal value with Sir William Thomson, and whose for scientific progress is not less than his. Judging from appearances one might think that the reputation of the latter is highly of native ability, or preferred to avail it. Doubtless this is not the case, but it is to be regretted that the letter in question has great chances extra for from the realm of action, and veil their affairs with the mists of distance. They illustrate the Latin proverb of which La Fontaine gave the well-known translation,

"'De loin c'est quelque chose, et de près ce n'est rien.'"

Engineering, Sept. 5, 1883.

FAURE'S SECONDARY BATTERY.

The English patent for this electric accumulator and its applications is dated May 26th, and is immediately preceded by another patent for secondary batteries in the name of Mr. Swan, dated May 24th. Full descriptions of the Faure arrangements were however published in France and in our columns before the date of the English patent, a circumstance which may be of considerable bearing on the validity of certain claims put forth in that document. For, may have a considerable amount to patented after it has been explicitly described in the public press. With regard to the employment of the secondary battery in connection with electric lighting, we may mention that Mr. Rapieff, in a patent taken out in 1877, describes a plan for using this apparatus in connection with an electric lamp; and Mr. Edison, in 1879, patented a storage battery for electric lighting, composed of two copper plates immersed in a solution of sulphate of zinc, a combination due in the first place, we believe, to Professors Hosston and Thomson, of Philadelphia. The charging current decomposes this solution of sulphate of zinc, and deposits metallic zinc on one of the copper plates, thereby transforming it into a temporary Daniell element minus the sulphate of copper. When the charging battery is cut off, and the circuit completed, the zinc is oxidised and a polarisation current flows in the connecting wire until both copper plates are clean again, according to the latest report of Sir William Thomson a Faure battery of large size may be trusted to retain 70 per cent. of the original charge, and he says he has quite ascertained that accumulators amounting in weight to three-quarters of a ton will suffice to work for six hours at full uniform rate of one-horse power." Fifteen hundredweight is, however, a considerable weight, a weight which puts the portcrage of electric power from the house to house out of the question. Sir William therefore, points out that where economy of weight is important, as in driving tramcars, economy of energy must be sacrificed. But he considers it very probable that a car arranged to take in, say, 7½ cwt. of freshly charged accumulators, on leaving head-quarters for an hour's run, may be driven more economically by the electric energy then by horses. Meanwhile, we understand that M. Planté has organised a factory for the manufacture of his secondary batteries, which have the advantage of being chargeable by a dynamo-electric machine, whereas Faure's can only be charged by a voltaic battery. It was for this reason that Planté abandoned the use of red lead subsequently taken up by Faure. Planté's battery has been stated to accumulate only one-fortieth of Faure's; but the Count du Moncel estimates that, weight for weight, the electric capacity of the Faure battery is only 20 per cent. greater than that of the Planté.

THE STORAGE OF ELECTRICITY.

M. Faure's "box of electricity," known in scientific circles as a "pile secondaire," started even electricians not a little, and was among them for a time the engrossing talk of the hour. In the rapid strides we are taking in electricity, as in all other departments of science, it is not to be wondered at that efforts are being made to practically utilise each new discovery. Mr. Charles Brush, of Cleveland, Ohio, having for several years been engaged, simultaneously with M. Faure, in devising means for storing electricity, low now not only had his labours crowned with success, but appears to have surpassed his rival. The means by which Mr. Brush stores electricity is also different from that of M. Faure, the latter's procedure, as is well known, being based on the invention of Planté, several years prior. Mr. Brush may or may not have obtained results equal to M. Faure some years ago, as he claims to have done; what is of more importance is the fact that the details of the American invention are quite different from those of either of these French inventors, and do not infringe upon their rights. Although the full details have not yet been published, we are able to state that the storage recevoirs are metal plates capable of receiving a large charge of electricity, and of retaining it for an indefinite time. Being made of varying dimensions, and being quite portable, they may be sent around day by day, and delivered to the consumers from a waggon, in much the same way as milk, bread, and other necessaries of life are now supplied. If only one half of what Mr. Brush's friends say of his invention be true, the application of electricity in a convenient and economical manner to lighting, motive power, and to everything to which electricity is applicable, is now in a fair way of making a rapid approach. We are not of that those who know the inventor owe that he is a man who does not speak of his work until he is satisfied with it, and this is saying a good deal for the value and merits of the present invention. Some inventors talk too loudly and too big, or others do it for them, as we know from quite recent

Engineering, Jan 27, 82.

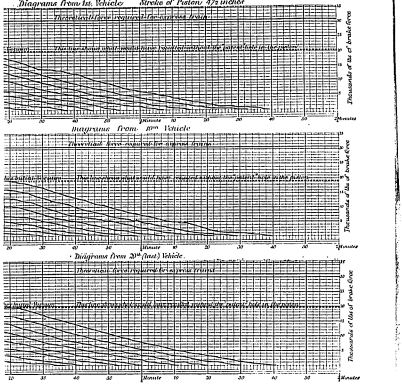
THE SUTTON STORAGE BATTERY.

The latest form of Mr. Henry Sutton's sulphate of copper storage battery has been described by him to the Royal Society. It consists of a flat square copper case or box, similar in shape to the earthenware pot of a Grove or Smee cell. This box is fitted with a lid of parchment wood, from which hangan plate of lead amalgamated with mercury. The lead is supported by being fixed in a groove along the underside of the wooden lid, and its lower end is placed in a corresponding groove along the upper side of a slip of parchment wood resting on the bottom of the cell. The lead plate, which is the positive electrode of the cell, thus forms a partial partition, nearly dividing the cell into two compartments, and presenting a face to each of the copper sides of the box, which form the negative electrode. A vent hole in the wooden cap allows the solution of sulphate of copper to be introduced, and also the state of the charge to be examined by inserting a glass rod and observing the colour of the solution.

.CUUM BRAKE EXPERIMENTS.

(For Description, see Page 13.)

Diagrame from 1st. Vehicle. Stroke of Piston 4½ inches



Diagrame from 2nd Vehicle.

Diagrame from 20th (last) Vehicle.

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times of the Roman occupation and till to-day, the mountain has yielded its inexhaustible treasure. A fire in Eisenerz in 1618 destroyed unfortunately the documents which then existed, carrying back the iron manufacture as far as A.D. 712, and the documents still in existence do not go back further than the twelfth century, a date which —early as it is—is late in the history of the Erzberg.

In our notice of the summer meeting of the Iron and Steel Institute we gave as full particulars about the Erzberg, that we need not here recapitulate them. It will be sufficient to say that for centuries the workings on the mountain have been divided into two sections, the upper part belonging to the Vordernberg ironmasters, the lower to those of Eisenerz. The level of the narrow gauge railway, which takes the upper ore over the Prielsbichl to Vordernberg is very nearly that of the small level shoulder seen on the left slope of the mountain, near where the "Berghaus" is barely visible among the trees. The Vordernberg ore is brought up to this line by a water lift, and carried round the back of the mountain and over the pass to Vordernberg. The Eisenerz ore is brought down the face of the mountain, by the inclined plan shown in the drawing, to the calcining kilns, and thence down to the ore reservoirs, or direct to the blast furnaces.

The nineteen Eisenerz blast furnaces were united into the *Innerberger Hauptgewerkschaft* as long ago as 1625, but the wasteful system of isolated working existed among the fourteen Vordernberg works until so late as 1829, when all but one united their forces, this last only joining with the rest in 1871. The boundaries between the upper and lower workings were regulated carefully in 1871. The lower workings are now carried on by the *Alpine Montan-gesellschaft*, who also have some of the workings, along with several private owners, whose mines have been formerly mentioned. The total production of ore from the Erzberg was 128,700 tons in 1862, 359,040 tons in 1872, and had increased to 512,000 tons in 1882.

We are indebted to the courtesy of Herr Anton Jugovitz, the chief engineer of the Alpine Montan-gesellschaft, for the photographs of the Erzberg which we have reproduced to-day, and both to him and to Herr Kenitz, of Vordernberg, for much information—most freely and kindly given—about the works and workings in Styria, of which our readers have already had the benefit.

THE CHEMISTRY OF SECONDARY BATTERIES.*

Soon after the meeting of the British Association at Southampton, we gave an abstract of a paper read by Dr. Gladstone, before Section A, in which the author related his recent researches on the chemical reactions in secondary batteries with special reference to local action. Dr. Gladstone had ascertained that the local action which corrodes the lead plate supporting the peroxide of lead thus impairs the value of the battery, took place during the formation of the battery, during the repose and during the discharge, and that it therefore becomes an important question to determine what modification of the present arrangements would minimise, or if possible altogether prevent local action. Dr. Gladstone presumed that the sulphate of lead formed in the secondary batteries could be oxidised as well as reduced, to yield peroxide of lead in the former and spongy lead in the latter case, and thus

* See ENGINEERING, vol. xxxiv., page 27.

Chemical News 1880.

NEW MODE OF GENERATING ELECTRICITY.

Mr. J. A. Kendall, F.C.S., has discovered a reliable generator in using occluded hydrogen instead of zinc. The cell is constructed by using a tube of platinum foil closed at one end and connected with glass tubes, by which hydrogen is supplied to the platinum interior. The other element of the cell is an ordinary platinum crucible. Various substances are fused in the platinum crucible at a red heat, and by connecting both the platinum tube and crucible with a galvanometer, by means of platinum wires, a generation of electricity is obtained. Chlorides of the alkaline and earth metals in a fused state give a current; the hydrogen, after passing through the salt and walls of the crucible, is oxidised by the air. Vitreous matters, such as glass, give a better result than alkaline chlorides — even porcelain and earthenware transmitting the hydrogen at a high temperature. The effects were found to be reversible; and the quantity of electricity developed is proportional to the amount of hydrogen diffusing through the apparatus, or, in other words, to the metallic surface. It also increases with the temperature, but the electromotive force is very low. Mr. Kendall also found that the hydrogen made the vitreous substances conductive.

.CUUM BRAKE EXPERIMENTS.

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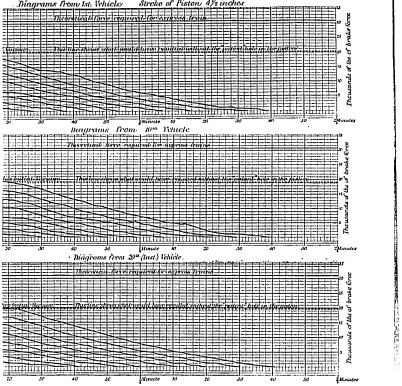
Theoretical line requiring 26 inches Vacuum
Practical line showing vacuum obtained
Thousands of lbs. of brake force
Minutes
Diagrams from 2nd Vehicle
Theoretical line requiring 24 inches Vacuum
Practical line showing vacuum obtained
Thousands of lbs. of brake force
Minutes
Diagrams from 3rd (last) Vehicle.
Theoretical line requiring 24 inches Vacuum
Practical line showing vacuum obtained
Thousands of lbs. of brake force
Minutes

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* See Examination, vol. xxxiii., page 377.

Chemical News, 1880.

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For description of Gaulard-Gibbs Secondary Generator
See Scrap book on Electrical Testing & Apparatus
page 96 (Scrap book No. 6)
Mr Swan
Aug. 1st. 1884.

Copy Sept 1884

PRIMARY BATTERIES.

To the Editor of Engineering.

Sir,—I think that you have done good service to the advancement of the study of home-to-house electric lighting by the publication of the interesting article on Primary Batteries which appeared in your issue of the 11th inst. I, too, regarding my battery, to which you specially refer, I would ask your permission to make an essential rectification. Your reporter recently described it, by error, as a zinc-copper battery, whereas it is a zinc-platinum one. I send you herewith a few words to compare the action of my one-cubic-foot cells with those of a Daniell battery.

You allow that I am right in arguing that "Since a given metal will evolve different amounts of heat in entering into combination with different bodies, it will therefore be assumed at different rates in a battery producing a given amount of electric energy according to the combination which is employed." But you add that "what is that not an indication, in other words, that the consumption of zinc in batteries using different liquid electrolytes cannot be always a constant quantity?

In a zinc-copper battery the heat evolved by the combination of oxygen with a given weight of zinc is very considerably neutralised (as you have shown by the figures taken from Sir William Thomson's paper) by the heat of Mixing of the sulphuric acid, oxygen with the copper; but this does not apply to a zinc-platinum battery. We must therefore, by Sir William Thomson's reasoning, omit the negative quantity 180.0 heat units) from the action in my cells, leaving 7670 heat units instead of only 7850.4 as the thermal equivalent of the chemical action produced by oxygen on zinc standing in dilute sulphuric acid, and this is equivalent to a consumption of only 1.7 lbs. of zinc per horse-power per hour.

Again, the chemical action in my battery is mainly produced by the action of chlorine on the zinc, and thus Sir William Thomson's suggestion would commence with (1) the heat evolved by the combination of one gramme of zinc with chlorine, viz., 1917 units. If to that he should add (2) the heat evolved by the combination of 1 gramme of chloride of zinc, &c., the result as to the consumption of zinc per horse-power would be even less, and certainly closely approximate to Mr. Gaulard's observations.

But, Sir, I entirely agree with your observation that "it is not the cost of the zinc which has hitherto prevented the use of batteries." That can be recovered, perhaps even with increased value, in another form. The nature of the liquids, the unpleasant fumes, the polarisation and local action, and the cost of labour, are, as you say, the mechanical impediments of the cells, and, as you so justly remark, the main obstacles which have to be overcome before primary batteries can be applied as the useful auxiliaries in electric lighting which I have little doubt they may prove in days not far distant. In my battery I trust that I have made some slight progress in that direction.

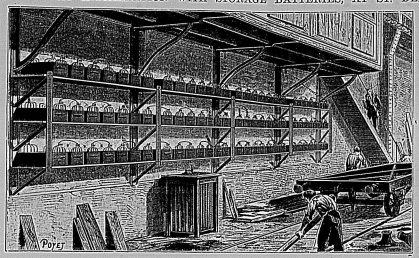
Yours, &c.,
W. R. Ll. Ross, M. Inst. C.E.

[The gist of our article was that the electromotive force of a given cell represents the resultant of the chemical actions within it, whatever they may be. As Mr. Ross says the nature of one of his solutions an entire secret we were obliged to refer to the Daniell battery as an illustration of our meaning.—Ed. E.]

ELECTRIC LIGHTING AT ST. DENIS.

Although electric accumulators have fallen very far short of the sanguine expectations of their original inventors, and the confidently expressed anticipations of those who make it a business to sell inventions to the public, experience has shown that within yet unknown limits they are useful auxiliaries to dynamo-electric generators. These latter can be employed in the direct production of light during the hours of normal requirement, while during the rest of the day they are used to charge the accessory batteries for feeding incandescent lamps when desired. This mode of electric lighting, which enables the highest duty to be obtained from the generating plant, has hitherto been rather talked of than realised, and for this reason the first industrial application of the method, inertia a somewhat detailed description. A notice of the installation has already appeared in some of the French scientific journals, and some of the data now given are obtained from them, the remainder having been given by the engineer in charge of the work. The installation we are about to describe has been made for a number of Weston lamps, and of Maxim incandescence lamps, and it has been carried out by M. Denis Labarre for the Compagnie d'Eclairage Electrique (the latter transformed Jablochkoff Company), who own, under Weston, Maxim and other patents for France. The Compagnie Parisienne du Gaz et Electric at St. Denis is principally occupied with the manufacture of railway rolling stock. The works include, therefore, large stores of seasoned timber, sawmills, and painting shops, which, more than most other factories, demand constant surveillance to avoid fire. For this reason lighting by gas, or by oil, becomes very dangerous, while, properly carried out, electric lighting is quite safe. The directors of the company desired to utilise to its maximum the power available for obtaining as much lighting power as possible. The engine at the works does not develop more than 60 effective horse-power, of which about 45 are absorbed by the various machines, tools, &c., leaving 12 horse power free for electric lighting purposes. Under these circumstances it was not possible to maintain more than 30 arc lamps, which are kept going nightly by a Weston machine. These lamps work under the conditions indicated in the recent report of M.M. Cabel, Joubert, Le Blanc, Pathier, and Tyrrel. We may recall here that that report mentions that the experiments made on a Weston machine feeding 10 Weston lamps, were remarkable from the extreme regularity of the arcs. It points out also that for an effective work of 13 horse-power, the lamps gave a horizontal luminous intensity of 92 carcels, and a maximum intensity of 101 carcels. By employing reflectors to economise the light, it was stated that the intensity of illumination of the lamp may be increased to 160 carcels. Used as they are in this place to the Weston system, which has been already very fully described in this journal (see pages 501 and 572 of our last volume). It will be sufficient to state that in the installation now being noticed the generator is driven at 900 revolutions per minute, producing an electromotive force of 250 volts, and a current of 30 ampères, conditions somewhat inferior to those recorded in the official report, so far as concerns the available electromotive force.

ELECTRIC LIGHT INSTALLATION WITH STORAGE BATTERIES, AT ST. DENIS.



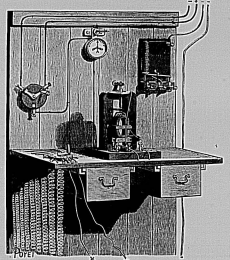


Fig. 1.

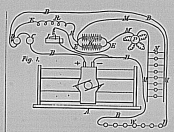


Fig. 3.

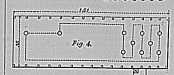


Fig. 4.

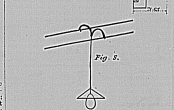


Fig. 5.

During four hours each day the Weston generator is employed to charge 80 accumulators of the Kabath corrugated type, placed about 250 yards from the generator and connected to it by insulated overhead conductors. These accumulators, arranged in two series of 40 each, are able to supply each day during the period of lighting required—about three hours—the current necessary to feed 30 Maxim incandescence lamps distributed over the painting shops and drying sheds. The brushes of the Weston generator can be easily shifted in position with reference to the collector, and the intensity of the current can then be varied within certain limits. But for charging the accumulators it was requisite to easily diminish it still further, and to adopt an arrangement by which the current could be caused to pass to the lamps or to the batteries, without endangering one or the other. With this object no less wire resistance is introduced into the charging circuit, so that the electromotive force may be diminished. Moreover, in this same circuit there is an automatic current breaker. If the electromotive force of the accumulators becomes higher than that of the generator, the batteries would commence discharging; this would be likely to occur, especially at the instant of starting the generator, when the current from the accumulators would reverse the direction of the electro magnets of the generator. The annexed diagram, Fig. 1, shows the general grouping of the machines, accumulators, Weston, and arc lamps. In the diagram A is the dynamo machine; B, the circuit for the arc lamps W; indicated in galvanometer C; and a two-way commutator D. During the day the key of this commutator is set so as to place the generator in connection with the circuit B, E, G, which comprises the 24 Kabath accumulators E E; G, the resistance F, and the automatic circuit breaker K, the resistance F, and the automatic circuit breaker K, the resistance F, and the automatic circuit breaker K

DEC. 30, 1881.]

A NEW STORAGE BATTERY.

In a paper read before the Royal Society on December 15, Mr. Henry Sutton, of Ballarat, Victoria, gives an account of some experiments which have led him to the construction of a new secondary battery for storing electricity. One important fact discovered by him is that the storage in lead cells is facilitated by amalgamating the positive lead plate with mercury. One of his guiding ideas was to employ as a negative plate a metal whose oxide should be soluble in the solution, and could be reprecipitated from it. With amalgamated lead as the positive plate, he employed negative electrodes of zinc, iron, copper, the solution in each case being a salt of the metal composing the negative plate. All gave good results, but the best was obtained from an amalgamated lead plate for positive electrode, and a copper plate for negative immersed in a solution of sulphate of copper. The two sheets are perforated with a number of holes, then rolled in a spiral, separated by rubber bands cut every 5 in.; the holes in the plates and cuts in the bands being to allow free circulation of the liquid. The chemical action during charging is that the oxygen of the decomposed solution combines with the lead, forming an even coat of the insoluble peroxide, and the hydrogen replaces the copper of the solution, leaving the copper deposited on the negative plate. During discharging the peroxide is again reduced, and the copper deposit oxidised, the copper combining with the acid and forming cupric sulphate. The power of the cell is considerable, and it is said to be very constant. It can be made to keep up for hours, the time being dependent on the quantity of cupric sulphate decomposed. By the decomposition and recomposition of one pint of cupric sulphate, Mr. Sutton has obtained over two hours' effective work by heating to a red heat 1 in. of No. 28 iron wire; the coil measuring inside 4 in. deep and 4 in. in diameter. Free crystals of sulphate of copper in the cell prevent the oxidation of the amalgamated lead plate, as the solution should be slightly acid ere the peroxide will form. The No. 28 cell is large enough gives out a peculiar rattling noise, which may be due to the deposition of the copper on the negative electrode altering the form of the spiral. Mr. Sutton constructs a practical form of the cell after the model of Cruikshanks' trough battery, the space between the pairs of plates being filled with the solution. A current of tension sufficient to overcome the contrary electromotive force of the series is used to charge the battery, when the positive plate becomes peroxidised, and copper is deposited on the negative plate. With two boxes of twenty-five plates each, charged by thirty Bunsen cells, very powerful currents are obtained. A number of twenty-five of plate boxes can be coupled in quantity during the charge, and in tension during the discharge. Twenty of such boxes one foot square insulated by measurement will give in series a battery of 500 jairs, one foot square area. It should be stated that Mr. Sutton has taken out no patent.

VARLEY'S CONSTANT BATTERY AND CONDENSER.

At the last meeting of the Society of Telegraph Engineers and of Electricians, Mr. Cromwell F. Varley, F.R.S., described a form of Daniell cell patented by him so far back as 1854 (No. 2055), though strangely enough this patent has been so far ignored that, according to Mr. Varley, the cells which he describes have been repatented three times, namely, by the late Sir Charles Bright, Meritt, Minotti, and by Marie Davy. The cell introduced by Mr. Varley to the meeting consists of a glass vessel in the bottom of which is placed a flat cylinder of sheet copper, having its upper part covered with holes. This is filled with crystals of sulphate of copper, and an electrode runs from it to the outside of the cell. In the mouth of the cell is suspended a conical hank of zinc wool, well amalgamated by mercury and having an electrode attached. The conical shape is given to serve the double purpose of allowing the hydrogen gas which is evolved at its surface to rise more freely upward than in flat plate would allow, and at the same time of allowing the metallic copper deposited on the plate to drop more freely off. A solution of one volume of sulphuric acid to one volume of water is the exciting liquid employed; and a layer of porous matter, such as burnt clay, is spread over the drilled hole in the cover of the copper vessel containing the crystals of sulphate of copper. These crystals dissolve in the liquid and thereby render it heavier than the purer acid solution above. The result is that it tends to remain at the bottom of the cell by its own weight, although this does not prevent diffusion of the copper salt upwards. To prevent the latter as much as possible from reaching the zinc, a syphon is occasionally inverted in the cell to draw off a portion of the liquid below the zinc, and its place is supplied by fresh acid solution. The amalgamation of the zinc, according to Mr. Varley, insures that the latter will keep the potential due to zinc, however its surfaces be contaminated by copper or any other metal. Mr. Varley then described the sulphate of mercury battery, which he asserted as his 1854 patent, and which distinctly anticipated the well-known Marie-Davy cell. It is interesting to note, too, in connexion with this patent, that the use of induction surfaces for storing up electricity for telegraphic and electric lighting purposes is therein claimed. Mr. Varley is a far-sighted inventor, and though the induction surfaces he intends are what in known now as condensers and not "secondary batteries," such as those of Plantè and Faure, it is plain that he foresaw some of the services which accumulators of the electric current would render in electric lighting. The induction surfaces were designed by him to "store up the power and so make a small battery answer the purposes of a large one, and also to act as a measure when telegraphing through long submarine cables." They were composed of sheets of tinfoil separated by sheets of oiled silk, gutta-percha, or other nonconducting substance, and alternate foils were connected to opposite poles of the battery. Their use in submarine telegraphy is now universal, and they have also been employed by Jaibolckkoff and others in electric lighting.

RECENT IMPROVEMENTS IN GALVANIC BATTERIES.

THE greatest of invention in connexion with electric batteries is apparently moving at a very slow rate at present, and so far no one has yet invented a battery which will enable us to light our rooms as cheaply as by gas or paraffin lamps. Amongst recent patents we notice one recently granted to Mr. H. C. Jaeke for an invention in cells and batteries of the kind which carbon, in the form of highly burnt coke of petroleum or wood charcoal, and in the shape of small pieces, is employed in connexion with zinc, being separated from direct contact with the zinc plates by an absorbent diaphragm. Salts of potassium, sodium, or ammonium are used as the electrolyte. The zinc or zinc electrodes are made in the form of plates, and are set on wooden blocks surrounded by a trough of thermometer, which allows the liquid to penetrate to the pieces of carbon in which the zinc or iron cells are imbedded. Hereafter form the patentee coils long strips of copper and zinc on a loom of wood, and separates them by interposing pieces of indiarubber. The wheel or disc thus formed is received by an electromotive, so that the cavities that does not cover more than half the disc at any one moment. Another device, which, however, went no further than the stage of preliminary invention, is the invention of Mr. L. Hartmann, and is thus described: "I employ as the exciting liquid caustic potash or caustic soda in solution, and for the positive electrode I use a mixture of peroxide of copper, which I employ either first, copper oxide, cobalt, nickel, or silver, or gold. By preference I employ silver, and I use the form of network, also cast in combination with fragments, or of fragments alone, although network is preferable, or I use any leaky, organic or inorganic, sheet in the form of network coated with silver by the electrolytical process. I construct the outer cell of a flat shape, like a shallow pan or a plate. I put in the bottom of this I place the zinc by preference in the form of strips, either rolled spirally or otherwise arranged so as to offer considerable surface. Upon the zinc I place a porous diaphragm of cotton-wool, textile fabric, or other suitable material, so arranged as to entirely separate the lower part containing the zinc from the upper part containing the negative plate, and I place upon the diaphragm a plate of negative electrode formed by pressing a mixture of peroxide of silver or iron, or any other form may be used, preferably considerable surface and which is immersed in or nearly dumped by contact with the exciting liquid in which the zinc is immersed."

A more important device which has been fully patented by Mr. J. Boyd, consists of improved elements and improved arrangements. This he proposes to increase the surfaces of carbon electrodes by preparing them from comparatively thin sheets of carbonised and suitably treated organic substances, such as cellulose, perforated or grooved, or heat into zigzag, spiral, cylindrical, or other forms. For the same purpose he uses rods or groups of comparatively thin pencils or rods of carbon, such as gas retort carbon, coke, or charcoal, or graphite, or any form of artificial carbon. These rods may be put up singly or together, or separate with a space between them, all being of course united or metallically bound together so as to make one pole. For the same purpose he uses carbonised organic fibrous substances, such as wood or cotton, flax or hemp, or threads or strands twisted or not, together or separately, or tulle, bobbinet, muslin, canvas, net, lace, and other similar woven or textile materials. These materials may be used separately, or combined with these above mentioned, and in the form of thin rods, sheets, ribbons, threads, or any other suitable form, and grooved or perforated as may be desired.

He states that these substances more strength, elasticity, rigidity, and more particularly electrical conductivity, the patentee carbonising them under necessary pressure and at proper temperatures in closed vessels in presence of carbonifierous or hydrocarbons elsewhere at suitable pressure, or in presence of liquid or solid bodies of the same substance, or in presence of a current of the same, so as to obtain upon them a deposit of the particles or granules of crystalline or metallic or graphitoidal carbon. To decrease the conductivity they may also be covered with thin layers of one or more metals, such as platinum, palladium, lead, indium, silver, &c. The principal aim of these arrangements is to obtain electrodes having a large surface, every part of which is thoroughly connected with the body of the battery. By virtue of such arrangements the patentee says there is a decrease of the local action and depolarisation of the force of polarisation of the electrodes, their connection with the liquid or solid depolarising agent is increased and more intimate, and consequently the conductivity of the current given by the battery is increased.

In the new forms of improved cells which the patentee proposes to construct, he takes lead or other metal for one electrode, solid peroxide of lead or peroxide of manganese, or acid, and, in forming one or more sheets, rods, grains, ribbons, or formed into a vessel. Peroxide or oxides of lead, barium, manganese, silver, iron, copper, or their equivalents, are separately or combined, or mixed with small pieces, roughness or cuttings of lead, shot, pierced or granulated lead, or other metal of which the electrode is made, or carbon or graphite, or other material for the above-mentioned electrode to form a porous vessel, which may be afterwards closed or sealed, leaving apertures for the escape of the gas and the charging and discharging of the cell.

This porous vessel he puts into another vessel of larger size, which may be zinc or other metal, or mineral electrode, and into which he puts another electrode made of zinc, or the large vessel may itself be made of zinc. An exciting liquid or liquids for the charging of this cell he proposes to use a solution of the salts or hydrates or oxides of zinc, ammonia, potassium, sodium, or other alkali metals, ten solution also salts separately or together with the above-mentioned solution. Another liquid he proposes to use is that of chromic acid, but in this case he prefers to use solutions of hydrates of alkalies, hydrochlorides of alkalies, potassium, or other alkalies metal, or solutions of sulphuric, hydrochloric, nitric, or other acids, separately or together. The battery with peroxides or oxides of lead, iron, silver, manganese, a solution of salts, such as chloride, chlorate, permanganate, sulphate, nitrate, carbonate of ammonia, sodium, potassium, or magnesium. Or the said battery may be used as a double liquid battery. Thus for negative cell or vessel where there is electrode of carbon, lead, or other metal with peroxides or oxides of lead, iron, copper, silver, and not manganese and depolarising liquid to be used a rather strong solution, say about 20 per cent. of sulphuric, hydrochloric, chromic acid, or nitric acid, and in this other or positive vessel or cell he puts the zinc in a solution of zinc or several of the salts of zinc above-mentioned, suspension, or other alkalis, separately or a solution of sulphate of zinc. Also as an extra liquid in the negative cell with the said substances, including oxides and peroxides of manganese, a solution of hydrosulphate of ammonia or alkaline metals.

With reference to the new exists of copper battery of Messrs. Lalande and Chaperon, patented on the 5th, 31, Hospitalier gives the following account of a trial made with a cell weighing 1,014 grammes, and containing 250 grammes of oxide of copper, and 500 grammes of a solution of caustic of potash at 40 per cent. The E.M.F. of the cell at first setting up was 0·98 volt, and the cell was able to maintain this for seven days through a resistance, the current thus supplied was, on an average, half an ampère during six days, or 518,400 seconds. The total quantity of electricity supplied was 259,000 coulombs, the weight of the consumed 88 grammes, which corresponds to a theoretical production of 259,000 coulombs. This, says M. Hospitalier, is a most important point, and very favourable to Lalande and Chaperon's battery, for it shows that the local action is practically nil. The energy that the battery is capable of supplying is, therefore, available at will, without any other necessity to disturb the circuit in order to withdraw the zinc from the liquid, as in the indicated case of potash batteries, for example. The useful available energy is 0·92 kilogrammetres.

per account. In my case, therefore, the battery supplied 10,368 kilogrammetres of available electrical energy. This exceeds the results obtained up to the present with accumulators of the same weight: but we must add that the supply is much slower than these latter. It is, however, easy to increase this rendering by increasing the surface of the elements and by diminishing the distance of the oxide from the zinc plate. The capacity thus increases more rapidly than the weight, and we may approach that of the accumulators. The normal constancy of the resistance of the liquid is attributed chiefly to the fact that the product of the reduction of the oxide of copper, which is a good conductor, and that the solution of an alkaline salt of zinc which is formed presents a conductivity almost equal to that of the solution of potash. For a given weight of zinc dissolved, about three times the quantity of salt of potash is required, and a quantity of oxide of copper, equal to 1·25 times the weight of the zinc.

English Mechanic & World of Science
May, 1883.

SOME RECENT IMPROVEMENTS IN GALVANIC BATTERIES.

THE records of the Patent Office show that great efforts are made by inventors to provide "cheap, handy, and powerful" galvanic cells, as well as secondary batteries. Whether any of them will suit the time-honoured standard will have to be proved, but we give here descriptions of a few for the benefit of those who are inclined to experiment in this direction. Messrs. Holmes and Rossiter patent cells in which granulated lead, either in powder or cakes, is placed in a porous pot, and so separated from a zinc or lead positive electrode, the electrodes being interchangeable as regards their position. In another form the negative electrode of platinum or carbon is packed around with a mixture of metallic peroxides, such as those of lead or manganese, and the zinc or positive electrode is mounted in a porous pot. This form may be modified by making the pot itself of a material filling it with a mixture of metallic peroxides and some inert substance. In another form the zinc or positive electrode is packed between the outer vessel and the inner porous pot, while inside the latter is a mass of carbon granules, scraps, or plates of zinc. The rods or plates of peroxide of lead may be surrounded by coiled zinc wire, or strips of zinc, the two electrodes being separated by wood strips. In another form an electrode of carbon is prevented with the metallic peroxide by exposing it to the action of gaseous chlorhydride, then impregnating with the salt, which is afterwards decomposed by heat or chemical reaction. The zinc electrode may also be built up of layers of perforated zinc sheets. That cell is also described in which *in situ* specification shows an advantage of the present Patent Law.

Mr. G. U. D. Ross has also patented an improvement in the ordinary combination of zinc and carbon, in which the carbon-rod is packed round with broken coke. In the zinc compartment is the exciting solution in a 1 per cent. solution of hydrochloric acid, and in 2 per cent. solution of hydrochloric acid is placed the carbon cell in a mixed liquid composed of 1 volume of hydrochloric acid, 3 volumes of sulphuric (or hydrochloric) acid, and 4 volumes of water. The patentee also mentions nickel-plating, instead of amalgamating, the zinc.

M. G. G. Shrimpton, of Paris, has also patented further improvements. He covers a carbon plate both sides with chloride of silver, and immerses it in a solution of hydrate of potassium or sodium, the hydrate being in the proportion of 30 to 40 per cent. of the weight of the water. A plate of zinc is immersed in the same solution close to the carbon, which may, however, be wrapped in asbestos cloth or placed in a porous cell. The battery may be revivified by plunging the carbon plate in a bath composed of nitric acid and hydrochloric acid, or chloride of sodium dissolved in water, or chlorochromate of potassium and nitric or sulphuric acid, the object being to chloridise the metallic silver. The hydrates may be dissolved in glycerine if the battery is exposed to frost.

Amongst portable batteries may be noted one recently patented by Mr. J. MacGovin, which is a modification of the chloride of silver arrangement. A short piece of copper tube has one end closed by a plug of the same metal, and, the interior being coated with silver, is subsequently covered with a layer of fused chloride of silver; the other end of the tube is closed with a cap of some insulating material through which passes a zinc screw, holding in the centre of the tube a cylinder or tube of zinc, extending nearly to the bottom of the cell thus formed. The exciting liquid is sodium chloride (common salt), or sulphate, or zinc chloride. The wires are attached respectively to the zinc screw and to the exterior of the copper tube.

M. E. Hunt's peculiar battery, which consists of a bath of melted nitrate brought into contract with heated coal, carbon, is described in specification No. 4276, 1882. We think it is of interest only from its singularity.

The English Mechanic
AND
WORLD OF SCIENCE AND ART.

FRIDAY, JUNE 22, 1883.

THE STORAGE OF ELECTRICITY.

THIS change of electricity is a subject which naturally attracts great attention at the present time, which may without much exaggeration be described as the talk of electric circles, and thanks to the letters of Sir W. Thomson, the public has been led to believe that a great and wonderful discovery has been made, which is to give us light, power, and heat for next to nothing. The statement that a million foot-pounds of energy had been stored in a box and conveyed from Paris to Glasgow seems to have astonished the newspapers, especially the supposed magnitude of a "million foot-pounds." Those acquainted with the rudimentary data of mechanical science know that large as a "million foot-pounds" looks upon paper, it really represents very little in the shape of power—just about as much for instance as one little gas-engine would give out at the cost of one halfpenny! The really important point is that M. Gaston Planté and Faure, experimenting on the lines laid down by M. Planté, have invented a modification of the chloride of silver arrangement, by which pieces of copper tube can be coated by a plug of the same metal, and, the interior being lined with silver, is subsequently covered with a layer of fused chloride of silver; the other end of the tube is closed with a cap of some insulating material through which passes a zinc screw, holding in the centre of the tube a cylinder or tube of zinc, extending nearly to the bottom of the cell thus formed. The exciting liquid is sodium chloride (common salt), or sulphate, or zinc chloride. The wires are attached respectively to the zinc screw and to the exterior of the copper tube.

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M. E. Hunt's peculiar battery, which consists of a bath of melted nitrate brought into contract with heated coal, carbon, is described in specification No. 4276, 1882. We think it is of interest only from its singularity.

galvanic cell capable of decomposing the dilute sulphuric acid, or practically of liberating hydrogen and oxygen, the reservoirs of the gas battery become replenished. It is not unlikely that, before long, a useful secondary battery, working on the principle of the Grove gas-battery, will be invented; but the latter is practically of little use as a reservoir of electricity, and just at present no more encouraging results in the direction of storing electricity have been obtained with the modifications of the durieux which Jüttner was the first to employ. About 20 years ago, M. Gaston Planté took up the study of the subject where Jüttner had left it, and after experimenting with a number of metals, he found that electrodes of lead immersed in dilute sulphuric acid gave the best results. He, in fact, invented the first real accumulator of electricity—a cell which, charged by a weak source, would yield a powerful current for a short time. The Planté cell consists of two sheets of lead, cut so as to leave a long tongue projecting at right angles at the end of each; these are separated by two sheets of canvas, and are rolled up loosely, so as to fit into a battery-jar containing dilute sulphuric acid. The canvas is merely for keeping the two sheets of lead from touching; bands of rubber and other materials have also been used, felt, for instance, being employed in the Faure battery. The lead plates being connected with an ordinary battery, oxygen and hydrogen are liberated, the former attacking the surface of the plate and forming peroxide of lead, while the hydrogen, at first probably to a great extent occluded by the other plate, the surface of which becomes a peculiar spongy texture. When the plates are brought to this state the secondary battery is fully charged and ready to receive a charge, and in the shape of electrical work done will store up a considerable amount of energy which it will give up again in the form of electric current, less a certain percentage. The current furnished by the secondary battery is, as a rule, far more intense than that employed to charge the accumulator; for instance, a battery of half a dozen Planté cells, about tin, high, may be charged by a couple of Bunsens, and when, so to speak, saturated, will yield a current capable of melting a knitting-needle, or of producing a brilliant electric arc for a time, counted by seconds rather than by minutes. A reference to the indices of our back numbers will show that a form of secondary battery have been devised, but practically, M. Planté's is the most successful. In the exception of the most recent modification by MM. Reynier and Faure. Instead of charging and recharging, including reversing the action, in order to get the lead plates into the proper condition for receiving the charge, M. Camille Faure coated the plates at once with a film of minium or red-lead, the ordinary compound of which is represented by the formula, $2\,PbO,PbO_2$, whereas the peroxide formed by the charging and recharging of the Planté battery is PbO_2. The plates so coated by layer of felt or rubber are rolled up just as are those employed in the Planté batteries, and according to the accounts published in Paris, the results are surprising. There seem to be no doubt that the use of the red-lead or minium is a decided advantage—to what extent is not at present known, and that therefore the Faure modification of the Planté accumulator is more likely to be useful than its predecessor. It must be clearly remembered that the Faure battery creates nothing; it is a receptacle for electric energy, which it stores in the shape of chemical work, and gives out again in the shape of electric current, with more or less of loss—how much remains to be seen.

Referring now to the famous letter that appeared in the *Times* (see p. 231), and taking the statements there given by an enthusiast—a box containing four of the new batteries, each about 40in. in diameter by 30in. high, weighing some 70lb., and holding nearly one million foot-pounds of "power," conveyed to Glasgow in 72 hours —we may well ask what is the fact that has been made so much talk and paper to be wasted? The new battery enables us to "store electricity" in such a form that we can use it just when we want it; it enables us, therefore, to use electricity where before the invention of the accumulator we could not conveniently or comfortably employ it as agency; but as a source of power, from an economical point of view, the secondary battery is practically nowhere. To utilise it as power we must have a Gramme-machine, and that costs rather more than a gas-engine, while at the same time rather more than a million foot-pounds could be put into a box having a capacity of a cubic foot, in the shape of the common, well-understood, and cheap coal-gas. It is pointed out that the wonderful box pondalened no more energy than exists in an ounce and a half of coal; but then, unfortunately, we have never been able to utilise more than about one-tenth of the energy of the coal, whereas from the experiments of Sir W. Thomson it seems probable that we may fairly count upon recovering some 90 per cent. of the energy put into a battery, and it is obviously less many applications where lumps of coal would be simply useless. But the Faure battery weighs 60 times as much as its actual mechanical equivalent in coal, or 30 times as much as the theoretical equivalent. Suppose, then, we find some means of utilising the energy of coal in a more economical manner, as compared with the theoretical value; where then is the wonderful battery which, according to Scottish specialists and newspaper scribblers, is to revolutionise the industrial world? As the accumulator, to obtain the energy practically available, has to cost as much as coal, we must have 40 tons of coals, we must have 40 tons of lead plates and battery jars, and all these have to be detended, whether it is more convenient to use an electric current, or employ the more familiar appliances of steam or gas-engines. The Faure accumulator is large under these, say, a Daniell's battery, because it has to be used to employ the current generated by the latter under more favourable circumstances—under conditions in which a Daniell's battery would be useless. In fact, it is practically but another method of storing energy, and if the conditions of work are adopted to insure economy it will do that with a loss of only 10 per cent. of the energy imparted to it. Accumulators weighing three-quarters of a ton (16 cwt.) will work for six hours on one charge at the uniform rate of one horse-power, giving a high economy, probably fully 90 per cent. of the energy put into them; but if applied to driving tramcars, where it is necessary to reduce the weight to 5 cwt., Sir W. Thomson thinks that accumulators weighing 7½ cwt., and

PRIMARY BATTERIES AND ELECTRIC LIGHTING.

In a recent lecture delivered in the hall of the Society of Arts, Mr. J. Probert entered into the relative cost of dynamo and battery lighting. He took as the basis of his calculation a house lighted by 100 incandescent lamps each requiring 1 electrical h.p. and as electromotive force of 100 volts. Each lamp would therefore require 75 watts, and the whole 7500 watts, or 10.05 horse-power. Supposing the dynamo to have a commercial efficiency of 80 per cent., then the actual horse-power required would be 10.05 × 1.25 = 12.55 horse-power. A horse-power requires in the steam engine a consumption of 4 lb. of coal per hour = 50 lb. Therefore 50 lb. of coal would be required to generate the 12.55 horse-power, and this would be coal. Assuming that the lamps were to be alight to burn 1000 hours a year, or five hours a day, the annual cost of coal would be 65l. The price cost as of a suitable dynamo and engine with boiler would be, say, 700l., the interest on which at 4 per cent., would be 12l., and the annual depreciation would be 10 per cent., or 70l. The cost of attendance would be 60l., so that the prime cost would be 200l., and the total annual cost 147l., or 1l. 9s. 6d. per lamp.

On the other hand, with a voltaic battery the energy would require to be produced at a rate between 25.05 and 30.1 horse-power, since the efficiency depends on the ratio between the internal and external resistance of the circuit. Supposing the ratio to be such that the efficiency is 80 per cent. To liberate a horse-power of energy a quantity of zinc must be oxidized equal to 2.022 lb. divided by the electromotive force of a single cell. The highest electromotive force obtainable in a single saturated cell battery is 2.248 volts, but from this must be taken the energy absorbed in depolarization. The amount of reduction depends on the nature of the depolarizer; with nitrate of soda or sulphuric acid it is .708 volt, with bichromate of potash it is .943 volt, with fuming nitric acid it is .794 volt. Assuming that the latter is the depolarizer the net electromotive force would be 1.454 volts, and this corresponds, by the above rule, to a consumption of 1.39 lb. of zinc per horse-power hour of energy. To liberate 12.55 horse-power-hours, 12.55 lb. (say 13 lb.) of zinc must be used. The price of zinc is taken at 21l. per pound, the zinc used per hour costs 2s. 8¼d.; but the expense does not end here. Sulphuric acid, the usual oxidizer of zinc, costs 2d. per pound. To oxidize a pound of zinc 1½ lb. of sulphuric acid is required ($Zn + H_2SO_4 = ZnSO_4 + H_2$). To oxidize 13 lb. of zinc requires 19½ lb. of acid, and this costs 3s. 3d. This added to the cost of zinc makes 5s. 11½d. To give the best return the electromotive force must be high, and if we suppose the nitric acid produces N_2O_4, the amount of acid required is shown by the equation $2\ HNO_3 + 3\ H_2$ (equivalent to $3\ Zn$) $= N_2 + 3\ ZnO + H_2O$. It follows that the solution of every pound of zinc is accompanied by the dissolution of ⅓ lb. of nitric acid. In the production of 12.55 horse-power-hours of energy, 8½ lb. of nitric acid will be dissolved, the cost of which at 6d. per pound is 4s. 4d. This added to the cost of zinc and sulphuric acid gives 10s. 3½d. as the cost of materials. Neglecting the waste due to scrap zinc and partially spent solutions, this rate for 1800 hours per year amounts to 740l. 10s. for cost of materials only. The prime cost of the battery would be 120l., the interest on which at 4 per cent. is 5l., and the annual depreciation at 10 per cent. is 12l. Neglecting cost for attendance, we get a total of 759l. 10s., or at the rate of 7l. 11s. 8d. per lamp, as against 1l. 9s. 6d. for dynamos.

Mr. Probert considers rightly enough from these figures that for a large installation batteries are out of the question as compared with dynamos, at least until they are greatly improved; but for small installations, where dynamos are unsuitable (and there are many openings for such) the battery has a future before it. The use of lead or iron in place of zinc, or some cheaper oxidant than chromic acid, may considerably reduce their cost; and the utilizing of waste products, a subject which Mr. Probert yesterday spoke of in little moment, may effect still further economy. "It may be interesting to notice," said Mr. Probert, "that in the Telegraph Department of the Post Office, no money is ever thought worth preserving, except the 'black mass' (technically so-called) from the Daniells, which contains a very large percentage of pure copper in the metallic state. Last year there were 30,322 Daniell cells in use, and the sum realised by the sale of the copper as 'black mass' was 1,200l., or rather more than 4d. per cell per year. An idea may be formed from these figures of the magnitude of the sum likely to result from the sale of the zinc residues—which in the Post Office are thrown away worthless—in the case of very ordinary household using some ten or twenty cells."

Indeed, if we are to go by the results of the Post Office in this matter, the return from waste materials in batteries for electric lighting would be very small, and probably the plan adopted of throwing them away as worthless would be adopted. The German Imperial Telegraph Department acts on a different system, and the waste material is carefully more favourable terms, for according to figures recently published by us (see Electrician, vol. xxxv., page 606) the department recovered no less than 2½ per cent. of the total materials consumed in their batteries. During the year 1881-2 Mr. Wunsch tells us that 12,300 cwt. of zinc, and 127,105 cells in use in Germany, and 27277, or about 22 per cent., was recovered by the sale of battery residues consisting of lead, copper, and zinc salts. As compared with this insignificant sum realised by our own Post Office, the difference is very striking. The normal cell in the German telegraph service is also a form of Daniell, and we have therefore forced to conclude that it is by no merely saving up, instead of throwing away, the zinc solutions and other materials, as well as the copper "mud," and disposing of them in a proper market, that the striking difference exists. English chemists are within their rights when as well as the German ones, if the matter were brought before them. It will then be seen that Mr. Probert has been unfortunate in his example of the return to be expected from waste products. Moreover he has apparently overlooked two very important factors in the problem. He has overlooked the fact that electric light batteries, working at a high pressure so to speak, and supplying powerful currents, consume much more materials than telegraph batteries, working comparatively feeble currents through a high external resistance, and working intermittently. His own figures may be brought forward to show how much the waste of materials in a lighting battery is. Suppose for example that 25 per cent. of the 700l. 10s. expended in his battery for 100 lights were obtained for waste products, the sum would be 167l., which is almost the exact figure realised by the "black mass" of the whole 30,000 cells of the Post Office. And this estimate of 22 per cent. is not too high for other batteries than Daniells, which are also very properly utilized. For some electric light batteries now in the field it is much too low. We are acquainted with one which, in a chemist's hands, returns much more than 50 per cent. of the original cost of the zinc alone. This brings us to the other matter overlooked by Mr. Probert, namely the utilization of the depolarizing solution, as well as the oxidant solution, and also the gases liberated. For example, in the Holmes-Barke battery, the nitrous gas can be utilised by forming nitrate of ammonia solution with it. Indeed, the whole matter is in its early stages, and there is ample room for enterprise in the chemical utilization of waste battery products. When the matter has been properly studied, as it will be, if batteries are used for lighting, it is very possible that a considerable percentage of the cost of materials will be returned from the utilisation of the waste materials. At one time the residuals from gas manufacture presented a more hopeless problem.

Recent Improvements in Voltaic Batteries.

It is evident that the advent of the dynamo-electric machine and its wonderful progress as a generator of current have not unfairly arrested the attention of scientists and inventors from other and older methods of producing current. For a time the dynamo-electric machine seemed to be encroaching largely on the broad territory covered by the voltaic battery, and to many it seemed that it would eventually replace the latter in nearly every case. But there seems to have been a kind of reaction, and now the field of the voltaic battery is wider than ever, and its success most promising. Not only does it hold its own in every application where it has long since been useful, but it even promises to fill a new want. Between the dynamo-electric machine and the voltaic battery a gap exists which recent improvements in the latter are striving to fill.

Thus the voltaic battery is now being used quite extensively in operating small motors. Its use for electric lighting on a very small scale has been but a matter of experiment thus far, but those who are apt to speak of it as something that will soon be forthcoming. The result is that more interest is felt to-day than ever in the study of the voltaic battery, and the improvements are multiplying in a manner that promises to effect a solution of the problem.

We have been anxious to contribute to this important development by supplying readers of THE ELECTRICAL WORLD with every new detail of information bearing on the subject. The many letters which we receive from various parts of the country show that in doing this we are providing useful intelligence. We can say, for this very pleasure, therefore, in giving extended space to some recent experiments with voltaic batteries, which we hope will be interesting to all our readers.

A new form of single liquid battery, possessing several features of merit, has been recently patented in France by MM. de Lalande and Chaperon. The elements of the battery are copper and zinc, and the exciting liquid is composed of water, containing 30 to 40 per cent. of caustic potash. With such a combination there is necessarily a tendency to the evolution of hydrogen at the copper plate in consequence of the decomposition of the water that furnishes oxygen to the zinc plate. To obviate the consequence of the presence of hydrogen on the copper plate is polarization, and thus the available electromotive force is reduced. In the battery under notice, this difficulty is provided against by a depolarizing mixture of manganese dioxide and pulverized carbon. The manganese liberates the oxygen which combines with the hydrogen evolved at the negative plate. MM. de Lalande and Chaperon have also provided a depolarizing agent, namely, oxide of copper, which is placed near the copper plate, and furnishes oxygen to the hydrogen evolved, by electrolytic action.

Fig. 1 shows a simple form of this battery which results somewhat the gravity cell. At the bottom of the glass jar F is placed a thick cake of the depolarizing mixture of copper D. An insulated wire C connected with this cell constitutes the positive pole of the battery. The battery element consists of a large rod of zinc oxided into a spiral form B and suspended to the cover E and provided with a binding post F. A rubber tube G covers the zinc, the action of the zinc so as to prevent its being worn off at the level of the surface of the liquid. A rubber tube like the ordinary "crowfoot" zinc used so extensively in this country would answer equally well, the upper portion being suitably insulated by rubber cement or other means.

To avoid the inconvenience of handling the potash the quantity of the substance in the solid state necessary for each cell is placed in the steel iron vessel used to hold the oxide of copper and the vessel closed by a cover kept in place by an India rubber band. It is necessary to set up the battery then is to open the vessel containing the potash and to place in the bottom of the glass jar. The vessel is then filled with water and the oxide of copper in the form of a powder is thrown in and settles in the vessel. The inventors have included a Leclanché "prime" battery for forming prime of their depolarizing oxide in certain ways. The best method of doing this is to mix the oxide of copper with some oxychloride of magnesia in the form of paste, so as to form a thick cream that is then placed in metallic oxide, where it "sets" in a short time, specially made thin hollow cones of zinc, which are held by India rubber bands. The positive binding post C is attached to the cover. This is the same as used in the Leclanché battery and passes through the centre of the cover, it being kept from contact by a rubber tube D, the joints being made air-tight. The cover is also provided with another rubber tube H, which is split, and forms a kind of valve. The vessel may be hermetically closed by means of a piece of India rubber placed over the neck and cover as at H. This potash used for the solution is either used in the glass jar or in separate short-iron box. The writings also contemplate a cell having only one prime, but this occupies a very small space. The use of vessels is a great item or copper, which remains unaffected

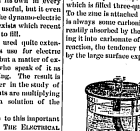


FIG. 1.

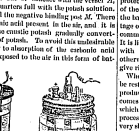


FIG. 2.

tory is prevented by pouring a thin layer of heavy petroleum oil, which has previously been boiled with caustic potash, on the surface of the solution.

The electromotive force of the batteries of MM. de Lalande and Chaperon is of the usual order, but as the internal resistance is extremely low. With plates ten centimetres square, the resistance would not be above ½ of 1 ohm. The volume of current which they produce is consequently very great. Other types can give the same results in short circuit, and the large type can give easily from 15 to 20 amperes. Two of these cells give more current than one large size Bunsen cell.

These cells give a remarkably constant constant. The inventors state that after 24 hours' continuous work, despite the surface of zinc acted upon, the battery can work without appreciable polarization, and it is almost completely exhausted. The reactions which take place in the solution as it becomes charged with zinc do not change the internal resistance materially. The solution is not acted on, and it is done principally to the gradual reduction of the oxide of copper to the metallic state. The solution has no effect on copper oxide, but by its reduction and transformation into metallic copper its resistance increases. It follows that the copper oxide battery can give a current of considerable volume in a circuit of low resistance while, as is well known, the Leclanché battery would become polarized rapidly under the same circumstances. The battery is entirely free from all local action, however, the solution has no effect whatever of itself on amalgamated zinc and copper. The zinc is therefore consumed and the oxide decolorized only while the battery is in use.

The energy contained in the oxide of copper and potash

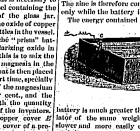


FIG. 3.

battery is much greater than that "stored" in an accumulator of the same weight, while the delivery is much greater than that of the Leclanché battery. The potash used in solutions concentrated to 20, 40 or 60 per cent. will not dissolve the oxide of zinc formed, the zinc resulting from a quantity of zinc of over one-third its own weight. The quantity of copper oxide to be used is about one-fourth higher than the weight of zinc consumed in the reactions. These data enable the necessary constituents of the battery to be condensed into a relatively small space.

The oxide of copper batteries have given interesting results, as regards the telephone. Indeed, the fact that it is exempt from polarization, while it presents all the merits of the Leclanché battery, would suggest it as specially to repositions theoretical performances as a distance, it is necessary to provide five or five separate batteries of Leclanché cells, in order that the one in use may be re-

placed by another the instant it becomes polarized. A single series of the oxide of copper elements will suffice in such a case, because it is free from polarization. The inventors state that three cells were used each day for working some fifteen carbon button transmitters for more than three months without materially weakening. The cells can be worked for hundreds of hours on low resistance circuits, and this efficiency can be obtained from them at any desired moment, for example, many months after they have been set up. The only precaution necessary in order to maintain them in this state is to add enough potash to protect the solution from the access of the carbonic acid of the air by a current of caustic soda may also be used for the battery instead of caustic potash. It has the advantage of being much cheaper, being readily obtained in commercial form and not being of a deliquescent type. It is likely, however, that the electromotive forces obtained with this substance is a little lower, and the potash is otherwise much to be preferred, because it is less apt to give rise to the "climbing salts" which are so disagreeable.

When the oxide of copper battery is exhausted, it may be restored without difficulty. The copper oxide used is a product of all establishments where copper is worked. It comes off the surface of the copper in the form of scales, which have to be reduced again to the metallic state by a process of annealing. The expense of the oxide may be very slight in those regions where it is to be had. But the saturated oxide of the cell may be used for metallized gilding easily. It will become spontaneously oxidized on exposure to damp air, or else it may be heated in an oxidizing flame. Another method is to charge the exhausted cell as if it were an "empty" accumulator, by which operation the positive conditions of the cell are restored to their primitive condition. The copper now appropriates all the oxygen, while the oxide of zinc is reduced to zinc by oxygen, and becomes metallic in the form of a spongy deposit. The zinc is not sufficiently coherent in such a case, and would need to be reset, unless it were deposited on a well amalgamated zinc plate, the mercury of which would cause it to adhere to the zinc surface.

The battery presents interesting qualities, as a whole, and we should not be surprised to find it soon replacing the Leclanché and the gravity cell in many instances.

Some experiments with one of the cells of MM. de Lalande and Chaperon have just been made at the laboratory of the Industrial School of Physics and Chemistry at Paris, by M. E. Hospitalier. The results obtained are without doubt of interest. The practical results of this battery and we reproduce M. Hospitalier's report from *L'Electricien* as being of great interest in this connection.

"The weight of the element was thus distributed:

	Grammes.
Glass jar	454
Zinc, brass box and conductor	1,000
Zinc and slate lid	432
Oxide of copper	1,000
Commercial potash — 1 portion as at per cent.	300
Total	1,764

"The battery, the initial electromotive force of which, one hour after being set up, was 0.78 volt, was left in circuit for six whole days through a resistance of German silver wire of 8.8 ohms. The difference of potential at the terminals of this resistance was by means of a Thomson reflector Sir W. Thomson. Thus the external resistance R, and the difference of potential E, at the terminals of this resistance being known, it is deduced from them the intensity of current, the quantity of electricity supplied, and the corresponding chemical energy.

"The current supplied was, on an average, half an ampere during six days, or 261,936 coulombs. The total quantity of electricity supplied was 252,000 coulombs, the weight of zinc consumed 98 grammes, which corresponds to a theoretical polarization of 260,000 coulombs. This is a most important point, and very favorable to de Lalande and Chaperon's battery, for it shows that the local action is practically nil. The energy that the battery is capable of supplying is therefore available at will, without it being necessary to disturb the elements in order to withdraw the zinc from the liquid, as in the bichromate of potash batteries, for example. The useful, available rendering is 0.67 kilogrammetres per second. In six days, therefore, the battery could raise 11,008 kilogrammetres of available electrical energy. This exceeds the results obtained up to the present with accumulators of the same weight, but we must add that the supply is much slower than with these latter. It is however easy to increase this rendering by increasing the surface of the element and by diminishing the distance of the oxide from the zinc plate. The result then increases more rapidly than the weight, and tends to approach that of the accumulators.

"The remarkable constancy of the rendering must be attributed chiefly to the fact that the product of the reduction is metallic copper, which is a good conductor, and that the solution of an alkaline salt of zinc which as formed presents a conductivity almost equal to that of the solution of potash. For a given weight of zinc dissolved, about three times the quantity of solid potash is required, and a quantity of oxide of copper, equal to 1.25 times the weight of the zinc. In our experiment the consumption of zinc being only 98 grammes, required in the reaction only 250 grammes of solid potash and 112 grammes of oxide of copper, i. e., the battery was exhausted at about two-thirds of its capacity."

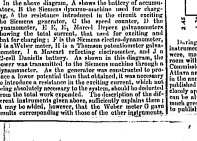
In the same number of our French contemporary, M. H

1124

THE FAURE ACCUMULATING BATTERY.

A series of highly-interesting experiments has lately taken place at the Conservatoire des Arts et Metiers in Paris with the Faure accumulating battery. These experiments, made under the exclusive direction of a committee so eminent as that who carried out the experiments with the Planté battery, and of which the Abbé Moigno was subsequently the Paris Electrical Exhibition, as chairman of the Conservatoire, have been of a kind to leave no doubt as to the conclusions, leave little to be desired to make their conclusions. We append a translation of some remarks on the trials furnished us by the *Société Forez et Lumière*. They extended over five days, during which time all the special features of these accumulators were examined, such as the construction of stored electric energy and the quantity and actual efficiency of the same, the loss of energy, and results generally, so that these characteristics appear sufficiently to those described by Sir William Thomson some months ago. The members of the Commission were M. Tresca, President, and MM. Polier, Jaubert, and Alfred, with the assistance of M. G. Trasenx. M. Gérard watched the experiments on behalf of M. Bolgiato.

The accumulators tested, in all, were of 46 cells, were of the laboratory type; they had a theoretical value of 0.94 in. in the laboratory type; they had a theoretical value of 0.94 in. in the laboratory type; they had a theoretical value of 0.94 in. with the combined value. The electrical resistance of this type is high, and this caused a rise of potential in charging and discharging, somewhat greater than is the case with the industrial type, such as would be employed for tramways when the period between charging and discharging would be necessarily short. It is important to note the cause of this difference, as it is due to the fact that the former others are spiral at bottom. It is well known that the accumulator consists of two formation plates, on which are applied the materials which by the subsequent process of "formation" become the active agents in the battery, such as oxide of lead, spongy lead, &c. The Planté battery is rendered active by the disintegration of the plates themselves. M. Faure, while retaining the surface of his formation plates, adds materials to great extent, and thus increases the capacity of the battery, but save on the absolute storage capacity, which depends only on the thickness of the spongy lead applied to the plates, and as these points affect largely the cost of production, he made batteries either of high or low resistance for different purposes. The Planté accumulators used at the Conservatoire were formed of two plates rolled spirally. The positive plate was 28 m. in thickness, and the negative 1 m. The former was 22 m. thick; the negative plate was 28 m.; both were perforated with holes 2½ m. in diameter, and they were covered with a paste of minium in the proportion of 100 lb. per square foot of plate. Annexed is a diagram showing the connections of the apparatus used in these experiments, which were commenced on Wednesday the 23rd inst. However, before the actual experiments were made, resistance coils for testing the batteries' internal resistance were carefully constructed. This is the case for the secondary, and lasted over six hours, during which was noted towards the end, the fall of the potential with an average current, in working as a unit the potential of the two end terminals of the 35 elements in series, and the voltage also the luminous intensity produced. This preliminary experiment was necessary, though it had nothing to do with the question of the storage capacity of the battery, or rather the efficiency between practical limits during which the lamps would give a uniform and satisfactory light. These measurements marked the limit of the experiment, which, moreover, was fixed as in its conclusion by the rapid falling off of the luminous intensity.



In the above diagram, A shows the battery of accumulators, B the Siemens dynamo-machine used for charging, C the resistance coils, D the Siemens dynamo, E the Siemens dynamometer, F the speed counter, H the dynamometer, G G, E, Marcel Deprez galvanometers showing the total current, that used for exciting and that for charging; F is the Siemens electro-dynamometer, G is a Weber meter, H is a Thomson potentiometer galvanometer, I a Marcel reflecting electrometer, and J a 62-cell Daniells battery. As shown in the diagram, a power was transmitted to the Siemens machine through a counter-shaft, and the intermediate gear enabled to produce a lower potential than that obtained, it was necessary to introduce a resistance in the exciting current, which, although absolutely necessary to the system, should be deducted from the total work expended. The description of the different instruments given above, sufficiently explains them; it may be added, however, that the Weber meter G gave results corresponding with those of the other instruments.

The electromotive force of an accumulator was found to be 2.15 volts, and in reading the figures of the potential column obtained on the Thomson potentiometer, it must be remembered that the deflections obtained by this instrument are proportional to the tangents of the deflection and not directly proportional to the sines of the angles. Some small correction will be needed in the figures of the Table given below, but as they require delay to check, and as the work will be published by the Commission with all detail, it is preferable to give them, though not absolutely exact; they show the average results as nearly as time permitted them to be obtained:

No. of Hours.	Total Foot-Pounds.	Foot-Pounds per Square Foot.	Total Current Ampères-Hours.	Average Current.	Potential Used.	Days.
5.30	17,505,800	44,091	95	17.15	35	Wednesday.
7.30	22,780,200	57,351	126	17.15	30	Thursday.
7.30	22,780,200	46,031	99	7.89	32	Friday.
2.45	6,175,900	46,031	17.5	6.48	32	Saturday.
23.45	68,241,600	49,559	193.5	8.5	31.75	Mean.

The resistance mentioned above as having been introduced into the exciting circuit of the generator, on account of the low resistance of the electrics, was measured, and it was calculated that 6216 foot-pounds per minute represented the mean of the work thus uselessly expended, so that the average useful work per minute was 43,343 foot-pounds. The mean potential reading of 31.75 corresponds to 27 volts for the battery of 35 elements, and the charging equal to a mean effective electrical energy of 10,701 foot-pounds per minute, or 0.247 horse-power. The 27 volts, however, expended, and consequently a duty of 74 per cent.; this might evidently have been higher, and is partly explained by the great speed given to the machine—1050 revolutions—and the low duty demanded of it.

The operation of discharging the batteries was performed at twice with an interval of thirty-six hours between the two processes. It was commenced at 11 A.M. on Tuesday January 1, and was continued until 10 P.M., the same evening, when the potential descended at 10 o'clock the following Tuesday morning and was finished at 2 P.M., though it virtually concluded at 1.30 P.M., judging from the luminous indications. During the operation of discharge the desire to approach practical conditions as far as possible, and to obtain a uniformity in the power given off, led to some slight approval conditions, which, while perhaps not absolutely correct in principle, were sufficiently practical considerably the practical results. At first the discharge was made with thirty cells, the five others being successively added with the intention of increasing the uniformity; these additions were made by the manipulation of a commutator. The second stage of discharge was effected similarly, commencing with thirty cells, and then rising to thirty-two and thirty-five. The following curve will be easily calculation with regard to how were the curve of discharge if the three [illegible] five cells had been used at once; this curve is shown in dotted lines in the annexed diagram.

During the period of discharge the arrangement of instruments resembled that used for charging. There were, moreover, eleven Meslin lamps placed in a dark room with the photometer placed at the disposal of the Commission; the measurements were made by MM. Allard and Leblanc. We must point out that the figures in the annexed Table are not absolutely correct; they are the average results of the tests made, and they will be sufficiently approximate averages of the absolute results that can be always obtained. The number of readings was much greater than the space at our disposal will allow us to publish.

Result of Discharges a Faure Battery of 35 Cells with 11 Maxim Lamps.

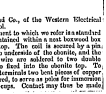
Time.	Current, Ampères.	Potential Reading.	Remarks.
2.45	0	37.8	30 cells discharging, Saturday, Jan. 7.
2.45	16.37	34.2	
4.30	16.	33.	
6.30	16.08	32.5	
8.	15.79	32.3	
9.30	15.89	32.3	32 cells discharging.
10.	16.84	31.5	
10.	0	28.5	32 cells on Monday, Jan. 9.
10.15	16.81	30.9	
11.30	16.39	29.7	
11.55	17.71	27.9	35 cells.
12.30	16.15	26.	
1.15	15.95	25.2	The experiments practically ended here.
1.	13.05	23.8	
2.30	13.53	21.9	
3.	12.64	21.	

The above figures speak for themselves, but we may add

Engineering, March 9, 1882.

A STANDARD OHM.

IN the engraving below we illustrate what, in the electrical apparatus, may justly be considered a novelty, recently designed by Messrs. King,



Hendilson, and Co., of the Western Electrical Works, Ireland.

The instrument in which we refer is a standard ohm coil, contained within a neat boxwood box with ebonite top. The coil is secured by a pin, and rest to the underside of the ebonite, and the ends of the wire are soldered to two double terminals, also fixed into the ebonite top. To both of these terminals two best pieces of copper rod are soldered, to serve as poles for immersion into mercury cups. Contact may thus be made through the mercury cups, or by placing the terminals under the terminal screws. Each coil connecting wire under the terminal at the Current-in compared with a standard issued at the Current-ish Laboratory, and a certificate guarantee given that its resistance is correct to within one-hundredth part of an ohm as defined by the International Congress.

To science teachers and others engaged in experimental electrical work such an instrument as that described is invaluable, as affording means of testing resistance of conductors, batteries, &c., or of measuring resistance coils with a correctness hitherto unobtainable, except by means of standards out of the reach of many on account of their high price.

Engineering - Jan. 7/80 125

THE PENRHADD ACCUMULATOR.—Messrs. A. R. Sennett and Co., of St. Buttolph-street, London, are the manufacturers of the Penrhadd electrical accumulator, which has been in use for some time in various electric installations. They have modified it for use as a private lamp, and have combined it with a magnetic switch. This switch must be operated by a powerful electro-magnet to alter the connections for charging, and, therefore, is proof against all attempts on the part of the misers themselves.

We illustrate above a new form of movable and self-emptying street mud-bin which has recently been introduced by Mr. William Heath, of No. 17, Tintern-street, Brixton, and Whitehall-place. The arrangement is very simple, and consists of an iron or steel receptacle which is attached directly to a hydraulic ram, as shown. The ram is worked by the pressure in the water company's main and fills the receiver sufficiently high to command the scavenger's cart. A door in this opened at the side and the contents fall by gravity into the cart, sliding along the sloping bottom of the cage; or if required the latter can be tilted on trunnions. The waste water from the hydraulic cylinder passes into the sump in the pit in which the receiver is placed. The way in which the ram is guided in the base is very simple. A fork on the gaffe is cast on to the interior of the case, and this fits a corresponding notch in the ram, the latter being prevented from rising nearly as large as the case, and so arrives at the same time a stop by coming in contact with the top bar.

Our present method of removing street refuse or domestic garbage is offensive and uncleanly, so that any practical improvement by which the operation could be performed should receive every attention.

Engineering, Aug. 29, 1879.

THE INTERNAL CURRENT IN A VOLTAIC CELL.

*On a Galvanometer for Demonstrating the Internal Current transmitted through the Liquid within a Voltaic Cell.**

By Conrad W. Cooke, C.E., M. Inst., T.E.

It is of course well known that when the external circuit of a voltaic cell is closed a current of electricity is transmitted through that circuit, and at the same time a current of equal strength is transmitted through the liquid within the cell from one plate to the other. These two are in reality but portions of the same current, and are for convenience known as the external or internal currents respectively, to distinguish that portion of the main current which flows through the external conductor from that portion which is transmitted from plate to plate within the cell. The former of these is detected by its electro-magnetic and electro-chemical effects, producing deflections in galvanometers and electroscopes and sounds in telephonic instruments, and is utilised in all the applications of voltaic electricity.

As far as the author has been able to find out, there has not hitherto been any satisfactory means in the hands of the demonstrator of physics by which the existence of the internal current within a single cell can be made apparent. Faraday, in the course of his early researches, made the following experiment; he suspended a magnetic needle by a silk thread and lowered it into the liquid between the plates of one cell of a voltaic battery, so that its length should lie in a plane perpendicular to those of the plates, and he observed that when the needle was just below the surface of the liquid it was deflected the moment that the external current was closed. On lowering it still deeper (the current being maintained complete) its deflection gradually diminished as the depth of immersion was increased, until it reached a position about half the depth of the liquid, when it returned to zero, and after passing this depth it was again deflected, but this time in the opposite direction, its amount of deflection in either case increasing as its distance from the neutral or central point was increased. The cause of this phenomenon is obvious from the following considerations: If a wire carrying an electric current be held above and parallel to a magnetic needle, the latter, obeying Ampère's law, will be deflected with an angular displacement dependent upon the strength of the current and its distance from the needle; and if the same wire be held below the needle, the latter will be similarly deflected, but in the opposite direction. Now the flow of electricity through the liquid in a voltaic cell may, for the purpose of this explanation, be looked upon as made up of an infinite number of currents transmitted in a horizontal direction from one plate to the other; and when a magnetic needle is immersed just below the surface of the liquid, all these currents are flowing in one direction below it, and a corresponding deflection takes place; when, however, it is lowered deeper into the solution a certain number of currents are flowing below it tending to deflect it in one direction, and a certain number are flowing above it tending to deflect in the opposite direction, and its permanent deflection is due to the electro-magnetic effects of the difference between the two. When these become equal, as they are when the needle is at the middle of its depth, their effects on the needle are balanced and neutralised, and no deflection takes place, and when that point is passed the currents above the needle are in excess of those below it, and a corresponding deflection in an opposite direction is given to the needle. This is an interesting experiment, but is very difficult to repeat on account of the feeble and unconcentrated nature of the electric currents above and below the needle, and the resistance offered to its motion by the liquid in which it is immersed.

Professor Hughes, by placing in the current of a battery an apparatus, such as a clock microphone, or a key by which an intermittent or undulatory character may be given to its current, and holding one side of a rectangular coil of wire in circuit with a Bell telephone over one of the cells of his three-cell battery, induced a secondary intermittent or undulatory current in the coil by that portion of the primary circuit transmitted through the cell, and a corresponding ticking was heard in the telephone.

In both these experiments, however, the effects observed must be attributed rather to the external current of the other cells than to the internal current of the cell under experiment; and the author is unaware that any successful attempt has hitherto been made to construct an instrument which shall utilise the whole of the internal current of a single voltaic cell for the production of electro-magnetic effects. While engaged in some experiments a few years ago it occurred to the author that if a voltaic cell were divided into two portions, having the zinc element in one portion and the positive element in the other, and the solution contained in the one portion were connected to that in the other by a tube filled with the same liquid, the tube being coiled round a magnetic needle, a deflection of the latter, due to the current within the cell being forced by the convolutions of the tube to circulate around the needle, would be produced when the two elements were connected together, and the apparatus shown on the diagram was constructed. This will be seen to consist of two glass tubes closed at their lower ends with perforated corks through which the ends of the coiled tube are inserted. Within the rectangular coil of the tube was suspended a magnetic needle, and the whole having been filled with diluted sulphuric acid, a plate of zinc was placed in one tube and a stick of carbon in the other. On making connexion between them by means of a wire, a slight deflection took place, but owing to the feebleness of the current, the directive action of the earth's magnetism and the friction of the pivot, the instrument was not sensitive enough to be satisfactory, and the author therefore designed the instrument which is exhibited on the table, which consists of two glass test-tubes united together by a small tube about 2 ft. long, and convoluted into two circular coils after the manner of a Thomson's reflecting galvanometer. Within the coils is suspended an astatic system of magnetic needles of which the upper carries a light mirror by which its deflections may be made apparent by the movement of a spot of light on a screen. It may therefore in this respect be looked upon as a Thomson's reflecting galvanometer, coiled with liquid instead of with metallic wires. The elements are placed one in each of the little cells, and may be connected by a key; or, by placing a reflecting galvanometer in the external circuit, both currents may be simultaneously indicated on the screen and their independence or identity be demonstrated. The first instrument constructed by the author was made by connecting the two cells by means of a tube of india-rubber coiled round two cardboard cylinders, but through the kindness and unrivalled skill of his friend Mr. Gimingham, whose name is now inseparably connected with the splendid researches of Mr. Crookes, he was able to produce the instrument on the table, in which the tubes and coils are of glass, all in one piece, and it is a very beautiful specimen of accuracy of glass blowing. Below the base of the instrument is a fine slightly magnetised sewing needle, which can be rotated on a vertical axis through a small angle by means of a little lever, and by which the instrument may be adjusted to zero.

The author has been induced to bring the instrument before Section A of the British Association in the hope that it may be useful, not only for science teaching, but for aiding investigations connected with the physical action of the voltaic battery.

* Paper read before Section A of the British Association at Sheffield.

Engineering, Nov. 23, 83.

DISTRIBUTION OF ELECTRICITY.

The National Company for the Distribution of Electricity by Secondary Generators have lately completed the lighting of a portion of the Metropolitan Railway, seven miles in length, from a central station. The system adopted is that of Messrs. Gaulard and Gibbs, which we illustrated and described at the time of the Aquarium Exhibition (see page 207, vol. xxxv.). The chief apparatus now employed, although identical in principle with the former, differs greatly from it in appearance, and has developed from a scientific instrument into an industrial plant, capable of application in connexion with all forms of electric lighting. The distinctive feature of this system is that the electric current generated at the central station does not pass through any of the lamps which owe their light to it, but circulates in a closed circuit, which, starting from the primary generator, traverses the whole district to be lighted, carrying the energy developed by the engine and absorbed by the generator, into every part of it. The visible manifestation of this energy in the form of light is due to the secondary generators, which give the name to the company. The first current is an alternating one, and, in the secondary generators, induces at each reversal of its direction a momentary current in wires lying beside the one it is traversing. The intensity and electromotive force of the secondary current depend upon the relation of the two wires, and consequently the apparatus will, if suitably designed, give currents of any desired quality, either for arc or incandescence lighting, or for other purposes. The qualities of the primary current are not determined by the conditions under which the lamps will burn, because it is only a carrier of energy, and consequently it is in the power of the electrician to select those conditions which are the most economical both as regards the first cost of the conductor and the loss due to its resistance. The size of the conductor and the loss depend entirely upon the intensity of the current, and consequently in this installation a moderate current of 10 ampères with a high electromotive force of 2000 volts is employed.

The central station is at Edgware-road, where the primary current is generated by a Siemens W_8 alternating machine. Although the tension of the current is, as we have said, 2000 volts, yet any part of the circuit may be touched without inconvenience so long as the insulation in the other parts is maintained perfect.

The total length of the primary circuit is fifteen miles. It consists of a copper strand of No. 8 B. W. G., carried on insulators fixed to the brickwork of the tunnel, and is visible from the carriage windows on the right-hand side going westwards. There are at present four stations lighted, Aldgate, Gower-street, Edgware-road, and Notting Hill Gate, the total number of lamps being about 100 Swans and 6 arcs. At each station there is a secondary generator, placed in a cellar or vault or in any odd corner, as it requires no mechanical power or attention. It occupies a floor space 4 ft. square, and stands about 5 ft. high, and consists of 16 vertical columns. Each column is composed of an iron core wound with a cable formed of a central wire of No. 8 B. W. G., surrounded by 48 fine wires, each separately insulated, and all connected together at their ends. The terminals of both primary and secondary wires are led to ingeniously and well-arranged switch boards, by which the columns can be grouped together in any desired order to obtain the required conditions. For instance, one group of four columns can be arranged in series to feed a number of Jablochkoff candles, also arranged in series. Another group may be arranged parallel to drive a powerful arc lamp, while the remaining eight columns may be put in compound parallel groups of two each to supply high resistance incandescence lamps. Minute variations are obtained by raising and lowering a copper shield, which covers a portion of the iron core of each column. With a primary current of 10 ampères, each secondary generator will absorb 8 electrical horse-power, the loss being stated to be only 10 per cent. The power required to overcome the resistance of the primary conductor will be one-quarter of a horse-power per mile, with a wire of 4 millimetres diameter and a current of 10 ampères, and as long as these conditions are maintained the loss is constant for any power that may be transmitted.

Thus in the present installation four electrical horse-power are consumed in driving the current through the primary circuit, but if another hundred lamps were added in the stations, or if other stations were lighted, there would be no increase in the loss, as additional circuits would be brought into play in the primary generator, or its speed would be increased until the difference of potential at its terminals was sufficient to maintain a current of 10 ampères in the line as before.

It is impossible not to be struck by the novelty and singular adaptability of Messrs. Gaulard and Gibbs's system. The main already laid is sufficient to stretch round the whole underground circuit, and if the electromotive force of the current were adequately increased, it would carry energy to light every station without greater actual loss on the way than occurs already. To what extent the potential can be raised is a moot question, but appearances tend to prove that it can be multiplied to several times its present figure if the insulation be carefully attended to. The cost of a conductor to carry the current directly for lighting by incandescence on a circuit of fifteen miles would be perfectly prohibitory to any scheme.

Iron – Jan. 18, 1884

The Coad Primary Battery.—This battery having undergone several modifications and improvements of late, an exhibition of its powers has been given at the offices of the Universal Inventors and Patentees' Company, 30, Finsbury Pavement, London. The patents not being quite completed, we are unable to describe its construction. We may, however, state that it is said to be of small capacity for its power, inasmuch as two batteries of ten cells each are contained in a case 3 feet high by 2 feet wide and 20 inches deep. The battery has a specially prepared zinc immersed in a special liquid, one feature being that the zinc is not removed from the bath during non-use, there being, it is said, no waste. Each ten-cell battery is equal to the supply of one incandescence Swan lamp of twenty candle power, and it is stated that the battery will give a full light for forty hours, after which it has to be re-charged with the liquid. Each cell has an E.M.F. of 1·95 volts, or about 20 volts for each battery, and each lamp has a resistance of 13·3 ohms, requiring a current of 1½ ampères. The cost of maintaining a battery of ten cells for forty hours is put at 1s. 3d., and each cell yields a large quantity of chrome. The incandescence lamps exhibited gave an excellent light, and so far as it went the demonstration was very satisfactory.

Engineering.
Nov. 28, 1884.

SECONDARY BATTERIES.

To the Editor of Engineering.

Sir,—In the report upon the electric light at the "Healtheries," which appeared in your last issue, you refer to the exhibit of Messrs. Parker and Elwell in the following terms:

"The secondary battery is distinguished from the Faure and the Sellon batteries, by being made of cast-iron lead only. The plates are cast in a mould, after which they receive the proper coating, and are then roughly formed by the passage of a current. By this method of manufacture, which was patented in this country independently by Messrs. Parker and Elwell, and by M. Planté, the difficulty arising from the peeling of the oxide is avoided."

As manufacturers of electrical energy are destined to play so important a part in the future, we consider how-ever, that the above is not a correct description of the matter in question, and I therefore venture to ask you to place on record, for the information of those of your readers who may be interested, the subjoined statement, free from any patent specification of September 10, 1881, the other from that of Messrs. Parker and Elwell of August 4, 1882. I would also mention that I called attention to the same matter in connection with M. Gaston Planté's patent of July 11, 1879, in my letter in the *Electrical Review* of September 20, of that year, immediately after the paper by M. Gaston Planté (which appeared in the *Comptes Rendus* of the French Academy of Sciences in August, 1879) was seen by me.

It is not my intention here to enter into questions of patent law, nor into the merits of the various types of secondary batteries upon which I may, if permitted, have more to say hereafter; I simply wish to call attention to the following facts, in respect to the chemical *process or means described and claimed* by M. Gaston Planté and Messrs. Parker and Elwell in their respective patents, that each action by the acids on lead has been a matter of common knowledge since the early days of chemical science, and that their employment in the manner in which any ordinary laboratory lead would adapt it to form a piece of lead to the condition specified by me.

Sellon's, September 10, 1881.

"The plates of the lead may also be employed as one or both sides by means of . . . any chemical process . . . in such a manner that to a suitable depth on each side of the plate a *spongy layer or porous mass or mass or fibres* are produced, whilst the remainder of the thickness of the material between is left *a non-porous, solid core, or homogeneous lay of the surface, whereby the plate is made capable of having formed upon it, and retaining when so formed*, a larger proportion of active material than during the action of the battery than if the plate were employed with its surface in the originally smooth condition."

Parker and Elwell's, August 4, 1882.

"The plates . . . are thereby rendered . . . more readily adapted *to facilitate their development* under the action of the electric current, by placing them in a dilute solution of sulphuric acid or other suitable acid. The plates are then washed, and subjected to the action of a current of electricity, whereby the material becomes in the main converted into peroxide of lead, *a more rapid formation of the plate* if used without such packing."

I am, Sir, your obedient servant,

JOHN S. SELLON.

The Hall, Sydenham, November 24, 1884.

ELECTRIC LIGHTING.

The promised memorandum of the Board of Trade, to serve as a guide in the framing of provisional orders or licenses for electric lighting projects, has appeared, and is an embodiment of the views already expressed by the Board, and to which we referred in our last issue. As the interest of promoters it is to be regretted that this memorandum did not appear six months ago; but it does so the list of orders would have undoubtedly been shorter, and a great deal of labour and delay would have been spared the promoters of the more serious schemes. Probably the Board of Trade did not feel qualified to issue the memorandum till it had acquired the information contained in the classes of the various provisional orders and licenses, and had learned the views held by the advisers of the different local authorities interested. The provisions now issued, refer to six of the principal points that have to be considered in preparing any scheme for public lighting, together with some of the auxiliary considerations growing out of the main questions. The first point refers to the area to be scheduled by the undertakers. It is evident that this area should be so selected that it may afford a fair chance to the undertakers both for developing their schemes and realising a profit on their investments, and it is very wisely suggested that while in the commencement a limited area should be allotted to the undertakers, they should have also prospective rights over a second area, to be exercised after a reasonable delay, or else resigned. As regards area, it is presumed that no order that the good faith and financial ability of the undertaking company would be practically demonstrated, that the company should be required within six months from the date of obtaining the order to set apart by special resolution the capital required to carry out the work, or else be immediately deprived at least half the money necessary for works to be executed in specified areas within two years after commencing. In the same way fresh deposits would be required for subsequent extensions, all such sums being approved by the Board of Trade.

As for the source of supply, the memorandum proposes that a system of parallel circuits should be adopted, and that in no case other system should be demanded, either by local authorities or private consumers. It may be mentioned that the whole of the model rules appear to apply specially to incandescent lighting, it being stated "that if it is desired to supply at high tension for arc lighting or other purposes, he may be done under special regulations." Subject to a period of six months immediately after commencing to work, the supply of current must be continuous except where it is otherwise arranged between the undertaker and the authorities. This is very essential obligation, though one that is likely to tell somewhat hardly on the undertakers, and probably cannot always be objected to serious fines for failing to fulfil their part, of the contract. The question of price is to be changed to consumers, and limit of profits, the Board of Trade is reserved, and naturally so, for the first especially is full of difficulties. No satisfactory mode of measuring the quantity of energy used by the consumer at present exists, a charge for a maximum supply would probably be objected to by the public, and a charge for an average consumption would probably result in loss to the company. Time and experience will undoubtedly bring measuring instruments, as well as data on which fair charges can be based, and in the mean time companies and authorities will probably be compelled to accommodate each other. The question of discussing the limitation of profits to the companies is, we think, a little premature.

In order to popularise certain leading ideas, by comparing them one with others, likewise to the public, the Board of Works lay down certain definitions: "The 'working pressure' will be to say, a system under which electricity used by each consumer is drawn off from a double system of mains (in this Order referred to as the positive and negative mains) in connection respectively with the positive and negative poles of the immediate source of supply, by means of service lines forming a series of parallel circuits." The term "standard pressure" is defined by the following sentence: "The potential at corresponding points of the positive and negative distributing mains shall differ at each point by a constant difference (in this order termed "the standard pressure.)" This standard pressure is to be allowed to range between the limits of 30 volts and 200 volts for continuous currents, and 60 volts and 100 volts for alternating currents. Probably the lowest limit contemplates the introduction of an incandescence lamp not yet in the market, adapted for a very low electromotive force, with regard to the higher limit, although it is a reasonable maximum for currents flowing through wires within houses or otherwise exposed, it appears liable to hamper supply companies as regards the utilisation of their main conductors. It is also probably with an idea of some alternating current machine not yet in signal, that it is provided that "the number of alternations per minute of alternating current shall not during the hours of supply be less than 600, or such other number as may from time to time to be fixed by the undertaker and sanctioned by the local authority." Although this sentence begins a very elastic interpretation, this seems to be that the speed of alternations shall be at least such as to secure a continuous and not an intermittent light, which would be produced if the number of extinctions and re-illuminations, in the case of an arc lamp, were not sufficient to maintain the effect of a permanent light to the eye.

The following is a brief synopsis of the Board of Trade propositions for regulating the condition of supply to a consumer. The undertaker shall be compelled on demand to furnish a current to any premises situated within 25 yards of the conductor, by the proprietor or occupier of such premises paying the cost of all service wires on his premises, and for any distance beyond 30 ft. from the mains. The would-be consumer must state to the undertaker the maximum current he requires, and must contract for a period of two years to receive the supply, giving security for payment if required, and binding himself to pay for the supply at least 20 per cent. per annum of the charge incurred by the company in laying lines, &c., for furnishing him with the current. The undertakers shall be bound to furnish a current "not exceeding what may be reasonably anticipated as the maximum consumption on his premises," and they have also an option of a limitation, by the increase or diminish such maximum, upon the consumer paying the expenses attendant on the alteration. It is of course absolutely necessary that the undertakers should have every possible protection afforded to them, but the necessity of entering upon a costly experiment for a period of two years, combined also with the giving security for charges to be incurred, will double many, otherwise attractive schemes, and will be a serious disadvantage.

The prices to be charged by the undertakers to the consumer—unless special agreements are made—shall be based either on the quantity of energy contained in such supply, or the actual quantity of electricity supplied, or the number of hours during which the supply is used, and the maximum current with which the consumer has agreed to be supplied. Either of these modes is attended by many difficulties; the last-named appears the simplest, though probably not the least complicated to the consumer, who would nevertheless be under the disadvantage of paying for the full amount of current though he might have only one light burning. This point leads to the Board of Trade remarks upon meters, which are wisely confined to generalities, as the "certified meter" which is to receive official approval has not probably been constructed. Such a meter is to register the energy contained in any supply of electricity to a consumer, or the quantity of electricity supplied, or the number of hours for those amounts being defined as the "value of supply."

The regulations as to safety appliances appear to be well considered and complete so far as present experience goes. They refer to the proper insulation and enclosure of conductors, to limit of temperature allowed to flow through a given section of wire; the means of testing all the current mains (in this Order referred to as the positive and negative mains) in connection respectively with the positive and negative poles of the immediate source of supply, by means of service lines forming a series of parallel circuits." The term "standard pressure" is defined by the following sentence: "The potential at corresponding points of the positive and negative distributing mains shall differ at each point by a constant difference (in this order termed "the standard pressure.)" This standard pressure is to be allowed to range between the limits of 30 volts and 200 volts for continuous currents, and 60 volts and 100 volts for alternating currents. Probably the lowest limit contemplates the introduction of an incandescence lamp not yet in the market, adapted for a very low electromotive force, with regard to the higher limit, although it is a reasonable maximum for currents flowing through wires within houses or otherwise exposed, it appears liable to hamper supply companies as regards the utilisation of their main conductors. It is also probably with an idea of some alternating current machine not yet in signal, that it is provided that "the number of alternations per minute of alternating currents

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Iron – Nov. 12, 1884.

A PORTABLE MINING STORAGE BATTERY.

At a recent meeting of the Engineers' Club of Philadelphia, Mr. C. Henry Roney exhibited a portable storage battery for mining and exploring purposes, with small incandescent lamps. The battery was a modification of Planté's, devised by Dr. E. T. Starr, of Philadelphia, the electrodes consisting of V-shaped plates of sheet lead arranged over each other, the convexity downward, with a slight interval between them, their ends being attached to a lead frame by burned joints, the interstices between the plates being filled with finely divided metallic lead, exposing a large surface to oxidation and reduction when subjected to dynamic electric or voltaic energy, and, in turn, giving off a large percentage of the stored energy to incandescent lamps placed in the circuit. The battery is 3¼ inches long, 2⅝ inches high, and ⅜ inch thick, and is said to maintain a small two-candle incandescent lamp at incandescence for about one hour. A battery sufficiently large to run an eight-candle lamp for ten or twelve hours would, consequently, not be too large or heavy to carry conveniently for mine or other underground exploration.

Iron – Jan 27, 1882

Electrical Storage.—On January 13, Mr. J. W. Swan delivered a lecture on "Electrical Storage," in the hall of the Literary and Philosophical Society, Newcastle. The lecturer alluded to the large amount of public interest taken in the question of electrical storage, or, as it had been generally termed, "the storage of electricity." He showed that to produce any of the practical effects now demanded of electricity, such as lighting of houses or driving machinery was beyond the power of electricity stored in any manner, and that the term, storage of electricity," was a misnomer. What was meant was the storage of energy by means of electricity, and in such a form as to be immediately capable of reproducing electricity. Coming to the question, In what form could they store energy to be available for the production of electrical effects? they found that there were only two forms in which energy could be so stored as to be dormant, and not liable to leak out or waste. The one form was as mechanical energy, and the other as chemical energy. The lecturer then proceeded to explain these two forms of storage, illustrating his remarks by the exhibition of various kinds of cells and experiments in lighting by means of stored electrical energy which he had in some of them. Amongst the cells shown were those of Daniell, Plante, and M. Faure. After explaining the chief characteristics of these cells, the lecturer proceeded to refer to the paper on "A New Electrical Storage Battery," communicated by Henry Sutton, of Ballarat, Victoria, to the Royal Society. This paper, he said, described various experiments in electrical storage, and spoke of the great effectiveness of an arrangement which was a sort of a cross between Daniell's and Plante's cells. Mr. Sutton stated that in process of charging the cell the lead readily oxidised to a great depth, the peroxide forming a regular layer on the surface. From experiments which he (Mr. Swan) had made he could fully confirm Mr. Sutton's statement as the facility with which a thick crust of peroxide formed on the mercurialised lead in his cell, giving it large capacity of storage. The discovery of this means of rapidly forming a thick coating of peroxide was invaluable. While experimenting with Sutton's cell he (the lecturer) found a troublesome tendency in the copper deposit to spread and form a connecting link between the copper and the lead plates, which quite destroyed its efficiency. It therefore occurred to him to discard the copper solution and the copper plate after the coating of peroxide had been formed on the lead, and to use the oxidised coated lead plates alone with diluted sulphuric acid. He therefore rearranged the oxidised plates in this manner, and he was glad to say he had obtained the most excellent results with the cell thus modified. The storage capacity was large, and the cell worked well in every way. Mr. Swan proceeded to describe and illustrate the results he had obtained with Sutton's cell, and also with the modification he had described. The hall was lighted up from thirty cells which he had brought ready charged. A portable case containing cells and having a lamp connected with it, such as could be easily carried into a coal mine, was also shown, the light being very much superior to that of the ordinary safety lamp. The lighting of railway carriages and of towns under systems of electrical storage was discussed, and the lecturer also alluded to the probability of electricity being applied to the production of motive power. At the conclusion a vote of thanks was accorded to Mr. Swan.

Eng. Mech. & World of Science
May 9, 1884.

PRIMARY BATTERIES FOR ELECTRIC LIGHTING.

[22693.]—A short time ago, the writer was able to obtain, through your valuable paper, some useful information, and determined from that time to become a subscriber.

He has noticed, in almost every issue, inquiries re primary batteries for electric lighting, some of them exceedingly absurd; others evidently from amateurs who had bought so-called electric light batteries + the supposed necessary scientific and practical information how to work them, but probably — even comparative after-success.

Electric lighting by means of primary batteries is not such a myth as some of your readers may imagine. It can be done with perfect success; but you must go beyond quart jars and the apparatus usually bought by amateurs. Cells of large capacity must be constructed and made to stand permanent use, with arrangements for charging and discharging by simple mechanical means, thus obviating the continual connecting and disconnecting of terminals, and the necessary liability to bad contacts, and probably unestimated introduced resistance, and wear and tear of same. Again, the proper proportions of quantities of inner and outer cell solutions must be determined or known; they must be coupled up to give the results which are most economical, and which may vary with the type and number of lamps required; they must, of course, have the smallest possible internal resistance. Another difficulty is to get a really good porous pot. Very pure and well amalgamated zincs should be used, also the best plate carbons; nor should the coupling-up connections be exposed to the fumes arising from the chemical action of the majority of batteries.

The writer has used, often, and with the greatest success, a modification of the Bunsen battery made well after the above description. They are preferably made like a trough, divided into six or eight cells or compartments, about 12in. by 12in. by 6in. broad, or 9in. by 9in. by 4in., each cell containing a porous pot and two zincs and two carbons. The E.M.F. is 1·85 to 1·9 volt, and the internal resistance ·03 of an ohm. From 60 to 70 ampères are obtained on short circuit. With 30 such cells coupled, two parallel, I have run, considerably over their candle power, 20 10-c.p. Swan lamps 4½ hours per night for two consecutive nights without recharging, and the battery was not then exhausted. Again, I have run 10 10-c.p. lamps (giving at least 12 to 14-c.p. light each) for 14 hours consecutively off 12 cells in series.

The cost would be under ½d. per hour per lamp, calculating zinc consumed and solutions requisite.

Again, with another battery of the bichromate type, and of somewhat similar construction, the internal resistance is ·025 ohm, and the E.M.F. 2·25 volts; when joined in simple series, no perceptible polarisation occurs if not more than 8 ampères of current be used for lamps; by coupling them two or three parallel more than two or three times, 8 ampères can be continually utilised in lamp circuit. These batteries run for three or four nights without recharging, the "endosmose" being slight owing to both liquids being approximately of the same specific gravity. This battery costs more to run than the former one, but has the advantage of not fuming to any serious extent. There is again a battery of iron and carbon, which gives very fairly economical results; but the writer has not made the same practical tests as with the former types.

From the above it will be seen that this mode of lighting can be successfully carried out; the cost of maintenance is naturally higher than the gas supply in large towns; but this is not always an absolutely essential point. Again, a certain amount of time must be devoted to them for charging, cleaning, &c. With the above mentioned batteries kept in proper order, 50 lamps of 10 c.p. each (Swan) can easily be run, and have been run for lengthened periods. The above-mentioned figures have all been obtained from the actual working experience of an Electrical Engineer.

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STORAGE BATTERIES.

In an article in last week's *Nature* over the initials "O. J. L." (those of a well-known professor) the writer takes a more favourable view of the future of the storage battery than is held by practical men generally. Referring to the main objection—that storage involves a loss of some 50 per cent.—he says there are many cases where the convenience of storage outweighs the evil of waste altogether, as, e.g. (1) where the power of the source would be otherwise so completely wasted that every fraction of it stored is clear gain—terrestrial water-power for instance; (2) where regularity and continuity of supply is needed, while the source of power is irregular and fitful—wind and wave power; (3) where the available source is weak but continuous, while the supply is needed only for a short time at intervals—small water-power, for instance, or a small steam-engine which can be used during the daytime to store up a supply of current for light at night. The following remarks on what may be termed the practical history of storage batteries will be useful to many, but there are not a few electricians who will ask whether, after all, Planté's old form of secondary battery is not quite as useful as any of the newer and patented forms.

The first form of manufacture, says "O.J.L.," consisted in rolling up sheets of lead and composition with trousering to keep them separate. The difficulties found were that the coatings would not adhere, but became detached in large flakes; that the trousering got corroded through and permitted short circuiting; and that, free circulation of fluid being impossible, the acid became exhausted in some places and concentrated at others, and thus every sort of irregularity began. Now regularity or uniformity is of the most vital and fundamental importance in any form of battery. If any part of a plate is inactive, that part is better away; if any plate in a cell is inactive, it is better away; and if any cells of a battery are inactive, they are infinitely better away. The rolling or coiling up of the sheets being found awkward in practice, and liable to detach the coatings, flat plates came to be used, then perforated plates, and then cast grids; these last having such large hole space that they held enough composition, and held it securely enough, to enable the trousering or intermediate porous material to be dispensed with. This was an evident step in advance; free circulation of the liquid became possible, and could be assisted by stirring; there was nothing to corrode except the plates themselves, and the composition, being in the cells or holes of the grid, might be reasonably expected to adhere. So far, expectation was not altogether belied. The adhesion was not perfect, it was true, and pieces of composition sometimes fell out of the holes, especially if too powerful currents were passed through the cell, but still it was much better than it had been; and if the plates were filled, properly formed, and fairly treated, the composition adhered extremely well and securely. The circulation of the liquid was not automatically perfect either, but mechanical agitation could be readily applied; without it the acid near the bottom of the cells tended to become more concentrated than that near the top, not by reason of gravitation undoing diffusion, which is impossible, but because during each charging fresh acid is formed, and in great part falls to the bottom in visible streams. Another great advantage was that some amount of inspection of the plates became possible, and experience as to the actual behaviour and appearance of the plates began to be accumulated. And painful varied that experience was. Every variety of extraordinary behaviour which could be suggested as probable, and a good many which no one could possibly have imagined beforehand, made their appearance. The hundreds of tons of batteries made at this period doubtless enabled these unpleasant experiences to be more rapidly acquired than would have been done on a small scale, but it was a costly series of experiments.

The main difficulty now experienced was how to keep the plates from touching. They might be put in wooden frames, or elastic bands might be stretched round each of them, and if they would only keep flat it was impossible they should touch unless the composition should drop out of the holes. Sometimes the composition did drop out of a hole, and bridge across the interval between two plates, but the more common and more fatal experience was that the plates would not keep straight. In a few months the positives were found to swell, and as they swelled to buckle—to buckle and twist into every variety of form, so that elastic bands, wooden frames, and every other contrivance failed altogether to prevent short-circuiting. The cause of the buckling is of course irregular and one-sided swelling, and the cause of swelling is apparently the gradual peroxidation and sulphating of the material of the bars of the lead grid, which occupy less room as metallic lead than as oxide of salt. As the bars swell they press on the enclosed composition, occasionally driving it out, but more frequently, and with properly made and treated plates universally, distending themselves and stretching the whole medial portion of the plate. The edge or frame of the grid is stronger than the middle bars, and is not so easily stretched; in a good and uniformly worked plate it does stretch, and an old positive plate is some quarter of an inch bigger every way than a new one, but if one face of the plate is a trifle more active than the other, it is very plain that the most active side will tend to become convex; and buckling once begun very easily goes on. To cure it two opposite plans have been tried: one is to leave the plates as free and unconstrained as possible, hanging free it may be from two points, thin, and with crinkled or crimped margins to allow for expansion; the other is to make them thick and strong, with plentiful ribs for stiffness, and besides to clamp them up to one another as tightly as may be, and thus in mechanical ways to resist buckling and distortion. I do not know that any one could say for certain beforehand which of these two plans would be likely to answer best, but practice is beginning to reply in favour of the latter, and well-braced plates of fair thickness show no unmanageable tendency to buckle. It must be remembered that no material can buckle with a force greater than that necessary to restore it to flatness, and this force in the case of lead is very moderate. Hence it may be fairly hoped to overcome and restrain all exuberances by suitable clamps and guides arranged so as to permit flat and even growth, but to check all lateral warpings and excrescences.

Uniformity of action is still essential, especially if all the plates in a cell are clamped together. Plates mechanically treated alike ought to be electrically so treated also, and it is impossible to keep a set of plates working satisfactorily together unless the contact of each is thoroughly and equally good, so that each may receive its fair share of current. Defects of contract have been a fruitful source of breakdown and irregularity. Clamps and screws of every variety have been tried, but the insidious corroding action of nascent oxygen exerted through the film of acid which by spray and creeping forms and concentrates on the lugs—this corroding action crawls between the clamped surfaces, gradually destroys all perfect contact, and sometimes produces almost complete insulation. Contacts on the negative plates give but little trouble; contacts on the positives have taxed a great amount of patience. Lead contacts "burned," i.e. melted, not soldered on, are evidently less liable to corrosion than brass or copper fittings, or than any form of clamp, but they are apt to be somewhat clumsy if of sufficient conductivity, and moreover they are awkward to undo again, and somewhat troublesome to do. However they have proved themselves so decidedly the best that now no other contacts will be used, and their reintroduction has been followed by a marked improvement in the behaviour of the cells. So long as contact with one plate was better than with another, a thing quite possible to happen without any difference being perceptible to the eye, so long was it possible for one or two plates to remain almost wholly inactive while another one or two received far more than their share of current, and became distended, warped, overcharged, and ultimately crumbled away. If one or two plates in a cell are black, and giving off torrents of gas, while the rest are brown and idle-looking, it is pretty fair evidence of irregular and insufficient contact, or else of some great discrepancy in the age or make of the plates. This point also is one that was not attended to in the early stages of manufacture; plates were made for stock, and cells were made up with plates of all ages selected at random from the store. Directly uniformity is perceived to be essential, this is recognised as obviously bad. Plates intended to work together should be of the same age and make, and, inasmuch as keeping does not improve them, the best plan is not to make for stock, but to keep material ready, and then quickly make up as wanted. Plates in work deteriorate slowly, but they are wearing out in the fulfilment of their proper function; plates in idleness deteriorate as quickly, and they are rusting out in fulfilment of no function at all. Worn-out plates, however, are by no means valueless. Lead material has a well-recognised price, and if attention were given to the subject, it is probable that decrepit and useless plates might be made to yield a very large percentage, if not the whole, of their original lead. For it must be remembered that plates deteriorate not by waste but by accretion: an old plate contains as much lead as a new one, but it contains it with the addition of oxygen and sulphion; no longer a tenacious coherent frame, but a crumbling mass of incoherent powder.

The age of plates is a point of vital interest, though but little is known as to the possibilities in this direction at present. A year may be regarded as a fair average age at the present time; but this is a low rather than a high estimate. Thick plates are found to last far longer than thin, which is only natural when it is remembered that the wearing out is due to corrosion, that corrosion proceeds mainly from the surface inwards, and that the internal portions of a thick plate are to a great extent protected by the mass of superincumbent material. If it can be shown, as we understand it can (1), that the cost of materials is far more than the cost of manufacture; (2) that the worn-out material has a market value not incomparably less than the original; and (3) that the frequency with which plates have to be renewed is not such as to cause much inconvenience, then we hold that the first stage of the durability difficulty has been overcome. Much more may be hoped for in this direction as experience increases, and it is not extravagant to hope that a well-ribbed, properly-clamped, and fairly-treated thick plate may last as long as five years before it becomes disintegrated.

It is evident, however, that in a region where pure experiment is pre-eminent, and where the units of time are months and years, instead of hours and days, the accumulation of experience is a slow and tedious process. It is no use making statements involving periods of five years when no one has had the present improved form in use for so much as six months. Nevertheless it is possible to see that the present cells are better than their predecessors; and as their predecessors have lasted in good condition for a year and more it is not presumptuous to indulge in well-founded hopes. Many of the difficulties connected with the early forms of battery were aggravated by Utopian notions concerning internal resistance and compactness. The internal resistance of a cell was so beautifully small, that the manufacturers were tempted to diminish it still further by putting the plates far too close together. An eight or tenth of an inch interval is well enough if the plates had been hard rigid slabs of perfect flatness; but it was madness to pack flexible lead plates full of composition certain to swell and liable to drop out so near together as this. Security and dependableness were sacrificed to a natural desire for sudden and Utopian perfection. We may hope that those lessons have been profited by, and that the manufacturers perceive that confidence and security are the first conditions of success, and that minutiæ as to the number of noughts before the significant figures in the specification of resistance begin, though those also are of importance in their turn, are yet of quite secondary consideration. Moreover, this packing of the plates so closely did not really do much to secure the result desired; the greater part of the resistance of half run-down cells is not in the liquid between the plates, but in the surface or scum separating each plate, and especially each negative plate, from the liquid, and hence putting the plates a safe distance, say a quarter or one-third of an inch apart, exerts an effect on the total resistance which is certainly far more than compensated by the ready opportunity thus afforded for access by both sight and touch. The old opaque boxes chock full of plates, with slight indiarubber bands between them, were started and left to Providence. No one could see what went on, nor could one readily get at anything to rectify what was wrong. In the present glass boxes properly arranged on accessible shelves with only plugs or studs between the plates, clear vision through the cell in any direction is easy, and accidental obstruction not only very seldom occurs but if it does it can without difficulty be seen and removed. But it must be granted that these boxes are less compact than their predecessors, and for some purposes, such as locomotion, compactness is of the first importance.

We have spoken mainly of difficulties connected with the positive plates, and have said nothing concerning the negatives. It is not that these are not susceptible of improvement, but their faults have been of a less imperious and obtrusive nature. They are not perfect, but they do fairly well, and there has been little need to worry much about them, until the extraordinary behaviour of positives had been taken in hand and checked. The time is coming to attend to these also. They fail not from exuberance, but from inertness. As they grow old they do not swell, and warp, and burst, and crumble, like the positives, but they grow quietly hoary, and serenely decay. The composition in a worn-out negative consists of white sulphate through and through, but the frame remains intact, and it consequently never falls to pieces, nor does it swell. Impurities in the acid used tell upon a negative plate—nitric acid is fatal. Acid much too weak or very much too strong is also deleterious, and idleness is bad. The difficulties connected with negatives mostly depend on their aggravating property of always requiring a quite opposite treatment to positives. The less a positive is formed and overcharged the better. A negative delights in complete formation and frequent overcharge. In recognition of this it is now customary to form them separately, and to give the negative a thorough dose of hydrogen without commencing the corrosion of the positive by an overdose of oxygen. When the discharge from a cell begins to flag, it is the resisting scum of sulphate that has formed over the negative plate which is responsible for the flagging. The true E.M.F. of a cell is wonderfully constant throughout the whole discharge; but the internal resistance is all the time increasing, at first very slowly, ultimately, towards the end, with a rush. One such run-down cell in the midst of a lot of others therefore obstructs the current terribly. If only a series of cells could, with certainty, be made to work together uniformly, if a series of cells could behave as well as some of the cells in it, no one would have cause to complain.

Carpets after being beaten and laid, will be brightened if plentifully sprinkled with corn meal mixed with coarse salt and then sweeping it off.

tain other persons whose heads were often carelessly exposed to the sun's glare without any adequate covering. The need of care which these ailment has since much increased. Field-workers and holiday-makers have multiplied ten-fold, and with one and all the weather, and how to meet it, is the first consideration. The fact is that sunstroke is natural. Thus, while we trace the continuity of causes, we first look after direct exposure to the solar rays, we next consider the fact that more concealed heat, intensified and aided by confinement in small or imperfectly ventilated spaces, is equally efficient to the same end. Various circumstances predispose to latent heat. Prominent among these is the nervous and generally sensitive habit of many stimulants to quench thirst. The object of drink is to satisfy water. The natural object of diet in the summer is therefore simply to make good this loss with as little stimulation of tissue as may be. Such stimulation tends to raise temperature by needlessly provoking chemical change, and is therefore mentally prejudicial. He who would enjoy fresh air and sound sleep must live very much on vegetable food, and drink as lightly as possible. Over-stimulating alcohol, by, and actually, at bed-time, is the very bane of the rock, in particular, proves to be suitably covered. Many inconvenience exist for this purpose. The tropical custom of wearing a damp handkerchief within the hat is occasionally useful. Puggaree should be light-coloured, such as linen or thrum, to allow of free respiratory movements. All such impediments to the healthful circulation, provides a condition favourable to heat-stroke. For the same reason excessive exercise or work is dangerous, through the exhaustion which follows it. Allusions in these columns to this have lately been adopted for the employés on the Metropolitan Railway. It would be well if such a precaution, which in fact were minimised, as far as practicable by other companies, and on the Government services. Associated with preventive measures, cold bathing in moderation must not be forgotten; for prevention, there is even more valuable than the free exposure of actual electricity, for which it forms a chief therapeutic agent. The latter, however, must not be taken into the body should not be overlooked by prolonged exercise or other cause.—*Lancet.*

FORMATION OF COLOURING MATTERS BY ELECTROLYSIS.

As long ago as 1875 M. Goppelsroeder announced to the Industrial Society of Mulhouse that, while studying the action of the galvanic current upon organic bodies (and principally those of the aromatic series), he had observed a large number of interesting results, among which were those that demonstrated the fact that, through the electrolysis of benzol, colouring matters were formed at the positive or negative pole. He was precluded that by the use of a cheap generator of electricity colouring matters might be cheaply manufactured by means of different bodies of the aromatic series. Gerard and Lairo have undertaken a process by means of which aniline blue is prepared without the use (as usually) of chlorine of vitriolline. In this process the product employed is diphenylamine, which is prepared by the reaction of aniline upon its hydrochloride, and which, to convert diphenylamine into blue, it is mixed with concentrated sulphuric acid, and kept at a temperature of from 100° to 120° for three or four hours. To this but this reason, a similar but cheaper result is the same blue is obtained by a simpler and cheaper method that is through the electrolysis of a solution of diphenylamine. The blue is then obtained at the positive pole. In order to produce the current he employs either a bi-acetic bichromate of potash, or a multi-cellular pile on a Bunsen one. To prevent as much as possible the diphenylamine from upon the effect of the other, he employs porous clay cylinders (such as are used in the Bunsen pile) filled with the part of the liquid which is not to furnish the principal electrolytic product, and into which is immersed the secondary electrode (Fig. 1); or else he divides the electrolytic liquid between two vessels, and connects the two currents one with the other by means of forcible inverting-paper, its use employs, as a constructing cell, a glass cell of cotton wicks (Fig. 2) covered with parchment paper from the surface of the liquid, so as to prevent the drying up of the conducting fluid. In the same way, he has used asbestos paper or cardboard, instead of parchment. Fig. 3 shows a cell with two electrolytic fluid, &c. If necessary, he increases the conductibility of the liquids by the addition of a little sulphuric or hydrochloric acid. The conducting fibres become more less evident, as one pole by weight of benzene will in about 20 parts by weight of water, or filled with some alkaline liquid. In this latter compound the benzol element, separated from the other two by a porous partition, is filled with a solution of potassic bichromate, containing concentrated sulphuric acid of from 1·3 to 1·4 specific gravity. The object of the inventors was to find an improved constant cell, and they claim that the results which they have obtained by the above patent it may be assumed that the results they have obtained by the above factory as they describe.

Several devices have been patented in which peroxide of lead is employed in secondary voltaic cells, one of the most promising being probably that of Messrs. Sellon, Volckmar, and H. Jones. In that the negative element consists of lead or carbon in contact with peroxide of lead, each portable being preferably obtained by the electrolysis of a solution of oxide of lead, or by the conversion of spongy lead into peroxide. When carbon is employed as the negative element, it is very advantageously to in the form of small fragments of coke, or of graphite, or of any one material, or other variation of the carbon fragments being filled with lead peroxide. Sulphuric acid is used the lead peroxide may be mixed with a solution of chromic acid obtained electrolytically. As the positive element, the inventors employ lead in a highly porous condition, as obtained by a granular or rare degree of compression of the metal reduced from its oxides or salts by chemical decomposition or by electrolysis. In this case a precaution of lead is a state of minute subdivision produced by mechanical means. As the electrolyte they use dilute sulphuric acid, preferably imbibing in addition a small proportion of sulphate or tartrate of ammonia.

In constructing a voltaic the three metal, iron, zinc, and peroxide, separated by the intervention of cells of porous material, it is they have covered with a thin layer of cotton wool, or other fibrous material. Thus, Mr. F. H. Vowles patented a battery composed of elements such as iron and zinc for a material in solution of caustic soda or potash. One of the patents of the present year is that obtained by Messrs. J. S. Spence and J. E. Chester, which we have previously noticed under the head of "Domestic Primary Battery," p. 108, as the cell which is to give current for striking, &c., copper-zinc battery, in which a solution of caustic alkali is used as the exciting liquid, and the depolarising substance consisting the copper in oxide of copper, the inventors find that if the spent or partially spent solution be withdrawn from the cells the zinc therein contained can be obtained as the oxide of zinc of commercial purity, by passing into the zinc solution carbonic acid, which throws down the zinc as the white carbonate. The resulting carbonate of the alkali is then boiled with fresh portions of zinc, when collected, washed, dried, and ignited, gives off carbonic acid (which can be used again in another portion of the spent liquid), and leaves behind the pure oxide of zinc. The caustic alkali obtained by this process may be evaporated to dryness, and of alkaline carbonate obtained in the manufacture form, but it is preferred to boil the alkaline carbonate with caustic lime, so as to convert it into caustic alkali, which when evaporated sufficiently is decanted from the carbonate of lime formed by the double decomposition in the cold, and is used over again for acting upon a fresh quantity of zinc in the galvanic cell.

Another of the patents are those in which the inventors seek to regulate the consumption of the zinc and prevent waste when the cells are not in use by Mr. Courtenay will serve as an example.—The zinc or other positive metal is, as usual, in rods or cylinders, is coated with asbestos paper, the same being previously prepared with a saturated solution of glue in, or other substance which contains, after which the zinc or other metal is carefully coated with one or more layers of the prepared asbestos paper and dried, the object of which is to regulate the consumption of zinc or other metal during the time the metal is in the exciting fluid, by preventing wasting action on the zinc. The negative elements are carbon, preferably platinum or other suitable metal can be used as one cell. The level of the liquid in the porous cells, the inventors preferably use the following strong acid, the middle cell containing water, or water and a small quantity of common salt, or the equivalent of any substance to render the water of greater conductivity in exciting the immobile action of the batteries, the outer cells being charged with compound oxide or any other suitable compound salt. This latter device is becoming very much in favour, protection evidently consider there is an advantage in making cells with three divisions.—Thomas Wood, of Vienna, patents a "voltaic cell," which consists of a vessel of impermeable non-conducting material, divided by porous partitions into three compartments. In one of these compartments is placed the positive element of platinum, carbon, or the like, immersed in nitric acid of 20° to 30° Baumé. In another of the compartments is placed the negative electrode, preferably zinc, immersed in a solution of salt (such as sea salt) of about 15 to 20 of water or in other suitable liquid, which is preferably between the two compartments containing the acid, and contains sulphuric acid of 10° to 20° Baumé.

Amongst recent improvements in secondary batteries we may refer to Mr. A. Rhodin's, in which the battery is built up of a number of alternate lengths of glass, porcelain, vulcanite, or other insulating material, having two partitions of zigzag form, dividing the section of each cell into two compartments, the zigzag branches of the one compartment being interposed with those of the other. In each of these compartments is placed a plate or a number of corresponding zigzag plates, the latter in the one compartment being covered with a coating of peroxide of lead, and in the other compartment with a layer of a compound of lead such as an oxide. The plates of these cells are preferably made very thin, especially their middles being raised a little from the bottom of the trough. Over the sheets is poured the exciting liquid of sufficient depth to cover the partitions, and sometimes, one sheet, each such sheet, form the electrodes of the cell.' Instead of using sheets of lead or copper, the inventor may use wire or the two compartments may be separated by a perforated zinc plate, which is covered with a layer

one-fifth, so that with a scale derived from equal quantities of heat, when an air thermometer showed 200°, chlorine would give only 155°.

As a result, if we imagine two air thermometers graduated—one, as usual, by equal increments of expansion, and the other by equal additions of heat (which would be the same thing if the specific heat were constant), the two would agree at 0° = 200°, and would gradually differ so that when the first = 4,500°, the other would show 8,816° as the number of units of heat required to produce the expansion. M. Berthelot contends that this result shows that the actual grouping of the atoms of gases is much more complex at the ordinary temperatures than the ordinary chemical formulæ recognise, and that the effect of increased heat is to resolve these groupings into more simple forms.

This subject, once thus opened, must needs be thoroughly examined. It may be suggested as possible that just as dissociation takes place in compound gases, as, for instance, ammonium chloride, which slowly doubles its volume, or, as in ozone, O_3, which is reduced to the oxygen molecule O_2, at moderate temperatures, so at very high temperatures, and partially, perhaps, at low ones, the molecule may break up into its constituent atoms, and the increased heat required may be the necessary energy of decomposition.

PRIMARY BATTERIES FOR ELECTRIC LIGHTING.

THE history of primary batteries for electric lighting was very well recounted the other night by Mr. Isaac Probert before the Society of Arts, and with Mr. Probert in the chair, and all the inventors of the new batteries of which we have lately heard so much present, it was certain that a good many statements would be made which may or may not have been reasonable. Mr. Probert placed the facts clearly and forcibly before his hearers, and concluded by expressing the hope that the many inventors present would favour the meeting with fuller details of their batteries than he had been able to give in his paper. As a matter of fact, the inventors did give a great deal of information in the shape of assertion, but not much in the form of actual detail as to the working expenses of their batteries; and Mr. Preece was not difficult in pointing out that they claimed rather too much, although he acknowledged that he did not take so pessimist a view of the future of primary batteries as some people, for there was plenty of room for them, not only where dynamos and secondary batteries are out of the question, but also on the second economy. Still, it is quite clear that Mr. Preece does not believe in batteries which cost nothing, never require recharging, and the residuals of which are of great value. He has too many new batteries submitted to him to believe altogether in the statements of their inventors, and no doubt knows very well within what limits it is possible to make improvement. In commencing his paper, Mr. Probert alluded to the fact that the electric light was first produced by the aid of a battery more than 30 years ago, and that although it was produced much more economically by means of dynamos, there are many thousands who nowadays desire to revert to the old plan and confine their installation to the simple, if expensive, battery. There is some doubt as to who was the first to obtain the electric arc; but it has been commonly accredited to Sir Humphry Davy, who had a battery of 2,000 cells. Children constructed a battery of 20 cells with double plates 4ft. by 2ft., and obtained a very brilliant light; but as he used points of wood charcoal, because the modern hard carbons were then unknown, the light was unsteady, and the points quickly gave out, while as regulators were not then invented, the light was voted more trouble than it was worth. No progress of any importance was made until in 1836 Grove devised his nitric-acid battery; but the first great advance was made when Smee invented his constant battery, which was followed by Daniell's, to this day the best cell where a constant current is wanted.

With the invention of the Grove cell, the electric light received a great stimulus, and from that time to the present the electric light has been commonly used by lecturers and others for experiments. It was in 1831 that Faraday made the great discovery which is the foundation of all the modern dynamo machines, and with the introduction of the Gramme machine, the patent for which has now just about expired, electric lighting entered on a new phase. The Gramme was patented in 1870, and was then practically as good as now—an instance of how long it takes the owner of a valuable invention to make his discovery a profitable one, when he has to create a public demand. Since the introduction of the Gramme many dynamos have been devised; but, as for all purposes of practical utility they require power to drive them, history is repeating itself, and for the last two or three years there has been a more or less ardent search after batteries which should yield current without much trouble and at a comparatively small outlay. Those who are acquainted with the rudiments of the subject know very well that no battery can compete as to economy with a dynamo, unless the residual products are of commercial value, and even then they must be of such importance as to pay for the collection and the labour of charging the battery. According to Mr. Probert, making all necessary deductions and allowances, the quantity of zinc required per horse-power-hour of energy is 1·21lb., or for, say, 12½ horse-power-hours, 13lb. of zinc is needed. That at 2½d. per pound will cost 2s. 8½d., and the sulphuric acid required to oxidise it will cost at 1d. per lb. 2s. 3d. Add to the total expenses for the material necessary to charge the battery will be 1s. 11d. If nitric acid be used the cost will be, reckoning the acid at 6d. per lb. (p. 198), or, taking the Bunsen or Grove cell as the cleanest employed, the expense for acids and zinc amounts, on paper, to 8s. 6d. for 12½ horse-power-hours. But that is not all: a battery cannot be charged and kept in action until every bit of zinc is oxidised and every drop of acid is utilised. Mr. Probert says experience teaches that not more than 70 per cent. of the acid can be utilised. It is not, however, necessary to go minutely into the figures he gave. The best battery known to electricians for producing the electric light is the nitric-acid cell, and that we have seen costs 8s. 6d. (on paper) for the raw materials with which it is charged to give 12½ horse-power-hours. As a matter of fact, in practice it costs more, for the reasons above given; but take it at 8s., and compare it with a gas-engine which will give 12½ horse-power per hour for certainly 1s. 6d., and we see at once where the battery is in the scale of economy. It is not worth while to go into questions as to the cost of dynamo and the relative running expenses for different and smaller; for, as Mr. Preece regards the former, we may take it as about the same, and for the latter, the attendance on batteries will certainly cost more than on an engine and dynamo. However, taking the round numbers, the cost per lamp per hour, according to Mr. Probert, is 27 11/16d. 9d. in one case, and 47 9/16d. 5s. in the other. It is obvious, then, that where an engine and a dynamo can be employed, batteries are altogether out of the question; but we have reason to recognise the fact that many persons are desirous of employing the electric light on a small scale, and these of course are prepared to pay for it; hence it is an important question to inquire whether it is possible by any means to reduce the cost of primary batteries. As Mr. Probert said there are four ways in which it may be possible to accomplish that much-desired result: 1, by the employment of a cheaper oxidiser than sulphuric acid; 2, a cheaper oxidiser than sulphuric acid; 3, by the use of conductors for more completely exhausting the solutions; and 4, by the production and sale of useful residuals. In the first and the last of these methods it may be possible to do something to cheapen the battery current; but three is little scope for a possibility of improvement in connection with the second and third. Zinc is almost universally employed as the oxidisable substance, because it is, all things considered, the most efficient and convenient; but both lead and iron have been used, and Slater's iron cell is well known if rarely used. Hydrochloric acid has been employed in place of sulphuric, but with doubtful advantage; several methods of more completely exhausting the solutions have been tried, but as to the actual economy we know no knowledge; and as to the production and sale of residuals, it remains to be seen what is the price they fetch and what effect their production in quantity will have upon the market. The only novelty preserved by the Post-office is, we believe, the "black cell" from Daniell batteries, which contains a quantity of pure copper in the metallic state; but fromnearly 30,000 cells the sum spent last year by the use of the "black cell" was £67 14s., or a fraction more than a halfpenny per cell! As Mr. Preece pointed out, however, the battery is almost only relied on for the labour power employed by the Post Office, and the cells are only used when the gas or the dynamo fail. The actual supply of current required for telegraphic work is so small compared to that needed for lighting. Several of the batteries practically now batteries were shown at the meeting, and were described in the inventors' words by Mr. Probert. Those by Holmes and Burton battery, which we believe is engaged by some of the electric light companies, is noticeable for the facility with which the cells are charged and discharged, the cells being connected by siphons; for the former it is claimed that they are not liable to freeze; and for its cheapness, the cost of the solution being about 6d. a gallon, which is said to furnish 720 to 800 ampère-hours, at 1·5 volt, or M.F.D. 1·0 volt. The solution is prepared by dissolving nitrate of soda in saltpetre acid, and nitric acid is produced as required by the decomposition of the salt. Mr. Holmes's battery has carbon plates dipping into dilute hydrochloric acid as "Eureka," the zinc being in common salt. The cell of Oliver and Rice, which is a two-fluid bichromate, having zincs coated with a thin film of gold before amalgamation. The chairman, Mr. Preece, stated that no fewer than 150 patents for primary batteries had been taken out within the last three years, and specially mentioned that of Mr. Skrivanoff (see p. 82, Vol. XXXVI.) as remarkable for compactness and power. Mr. Holmes exhibited a model of his battery, and stated that the fumes from the nitric acid were converted into nitrate of ammonia by a solution of the sulphate, or were absorbed by a solution of sulphate of iron. Mr. Rice stated that any domestic servant could manage his battery without difficulty, for it is necessary only to daily remove about one-seventh of the solution and replace it by fresh acid, which is done by raising and lowering a tube, the battery working from two to three weeks without any more attention than that. The liquid is very cheap, being mainly water and hydrochloricacid, with a small quantity of a solution, the nature of which was a secret (hyponitric acid, see p. 209, Vol. XXXVII., p. 422, Vol. XXXVI.) Mr. Burt, in describing the battery made by his firm, states that the cost of zinc was "hardly worth considering" (!) The carbon cell is charged with a solution of 3½ parts by weight of bichromate of potash, 1 sulphuric acid, and 10 of water; the zinc cell has water only with about half an ounce of chloride of mercury. It would seem that the cloths made for this battery is that by its means water itself is oxidised (!), at least, so it was stated by Mr. Wharton, who also said that so bad used a battery on many occasions for real practical work and had found the useful and for superior to accumulators. All the statements made as to the capabilities of the batteries are to be taken with large grains of salt; for, as Mr. Preece said, batteries, though very nice for many purposes, are "expensive luxuries." His advice to the inventors, to apply experience to their batteries and bring forward the actual results, must have sounded rather ironical to the gentleman who can produce electricity for a mere trifle, but who do so only on paper.

Irene March 8.

The Engineer—Jan. 9, 1885. 135

NEW ELECTRIC ACCUMULATORS.—It may interest those who have been looking forward to a practical application of electric lighting to private houses and to a possibly general use of the enormous forces which, by the aid of electricity, are produced under costly circumstances in that great impediment have recently been made in electrical storage or accumulators. It is stated that these improved batteries store at one time the durability and possess 2½ times the storage capacity of those known as the Faure accumulators, and that they are of such a practical construction that they can be readily renewed at a trifling cost without waste of material, while their first cost is less than that of the Faure. Each cell, of about 43 lbs. of gross, will contain, and consisting of about 60 lbs. of metallic materials, is capable of containing 400 ampères, and of delivering during eight hours a current of 50. Each cell, in fact, represents over 1 horse-power of energy for one hour. Public demonstration will be made very shortly, and it is stated that probably within a few weeks, at the Crystal Palace Electrical Exhibition, 500 incandescent lamps will be shown running upon one set of 25 large cells of this new zinc carbon.—*Times*.

SECONDARY BATTERIES.

SIR,—On the 10th ult. you published an article on the electrical locomotive recently built by the Storage Company, in which you gave certain figures as to the weight of the cells, which are likely to be misleading. You say that owing to the designs lately introduced, the useful output for a given weight of cell is almost without limit—my way meeting the durability and but, that the durability has been increased by the new designs, and that the cells used for lighting purposes would depreciate in the same ratio, which is far from the case.

The type of plate manufactured by the Storage Company enables the conductor and the active material to be disposed for the best advantage, but the properties are varied according to requirements. The accumulators supplied for lighting purposes are made with a view to large output, and are usually supplied with a high effective return, whereas in the locomotive the first consideration is a rapid discharge from a minimum weight of cell, and the active material is distributed where most needed, but the same durability cannot be expected as with cells designed for lighting or other purposes where weight is of minor importance. We have every reason to believe, that Mr. Reckenzaun's allowance for depreciation is not at all too much, as the cells which were first made have been in constant use for over three months and show no signs of deterioration.

It is impossible to say definitely what the 25s will be of the plates manufactured for lighting purposes with the latest improvements, but it may be mentioned that with the older types the positive plates have lasted eighteen months, and there is little doubt that this will be exceeded when the new plates are supplied.

The depreciation is another element entirely open to criticism, and the company has already made arrangements with their customers in this respect by quoting a special price for renewal plates.

BENJAMIN DAVIES,
Managing Engineer Electrical Power Storage Company.
January 5th.

Plattsburg Sentinel
Plattsburg, N. Y. May 1, 1885

THE ELECTRICAL ERA.

A JOURNAL DEVOTED TO THE DEVELOPMENT OF THE SCIENCE OF ELECTRICITY.

VOL. I. NO. 6. PHILADELPHIA, PENNA., JUNE 6, 1884. [6 cents per copy $2.00 per year]

UNDERGROUND CONDUITS.

Views of a Practical Electrician and Telephone Manager.

Cincinnati is negotiating the placing of telegraph and telephone wires in that city underground. In a recent interview in the *Times-Star* of that city, Captain G. N. Stone, the General Manager of the Bell Telephone Company had this to say on the subject:

"We are all interested in the subject of underground conduits, not only for the reason that legislators have undertaken to compel telegraphic and telegraph companies to make use of them, but because, also, that they would be a great saving to us in the care of our wires and in rendering the use of expensive poles unnecessary. The trouble is that no conduit has yet been devised which meets the requirements.

"A year ago the Legislature of New York passed a law making it obligatory upon all telephone and telegraph companies to conduct their wires through the large cities of the State beneath the surface of the ground, and provided for the appointment of a committee of 100, to consist of the Governor of the State, the Mayor of New York City and the most eminent electricians in the country, to recommend to the Legislature a suitable plan by which wires should be so stored for. The committee was organized and various sub-committees were appointed, and one of them has just reported the result of an investigation made of all the devices for underground conduits patented. They say that they examined over 600 devices, but did not find a single one which was entirely satisfactory. In the report it is said:

"'As regards a conduit, the principal requirements are that it be cheap, water-tight, have sufficient capacity, to permit (without disturbing the pavement) the insertion, removal and addition of wires, and allow access for repairs and testing.

"'No system submitted or investigated by the committee seems to fulfill all the requirements as satisfactorily as a properly constructed tunnel of sufficient size to admit the passage of workmen and access to the wires within it. Connecting with this tunnel, conduits of sufficient capacity for lateral wires could then be constructed as described. The multiplicity of subterranean structures in this city might tend to operate disadvantageously, if not to prohibit the construction of such a tunnel, unless the same were arranged to accommodate the gas, steam and other systems, as well as the electric wires. The deteriorating influences of steam and gas would, however, be met, by destroying or impairing any system of insulation, or the conduits in the lower portion of the city questionable.'

"You see that the nearest approach to perfection is the tunnel, which would be very expensive and practicable, and would probably not answer even then. In fact, I do not think the tunnel system would do at all. I have received advices from a gentleman in London, England, in whose statement I have entire confidence, that all the telephone wires in Paris, France, which were carried through the enormous sewers of that city, have been taken from them and are now strung along the tops of the houses. So we have no recourse except to the poles. It is not right that legislators should attempt to force us to carry our wires underground until some way has been presented by which we may do so. Speaking for my own company, I can say that it is willing to resort to conduits when a satisfactory one shall be offered, but we must not be arbitrarily ordered to put our wires underground until then. It would not be just to compel us to spend our money in making experiments. Why, it costs us yearly many thousands of dollars to keep our wires in proper condition. Wires get rusted and broken, poles rot and have to be replaced, and men must be employed. We keep a standing force of twenty-five men whose duty it is to repair the lines. All this expense would be obviated by a reliable conduit."

Steam Engine Tests at the Electrical Exhibition.

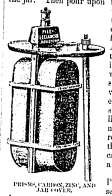
The Franklin Institute has tests proposed for steam engines at the International Electrical Exhibition. The conditions of exhibition and test are very simple and, on the whole, likely to give satisfaction. Exhibitors desiring quantitative tests made of their engines must send in formal application before July 15. Competitive tests will not be made, save on the joint application of two or more parties desiring them, and the competing manufacturers must, previous to the tests, agree on the rating of the various points of the engine, subscribing to the code and agreeing to abide by the decision of the judges without appeal. The code is in two sections: conditions of exhibition and test; and preparations for the tests.

The Leclanche Battery.

The accompanying cuts illustrate the Prism Battery, designed and patented by the Leclanche Battery Company, of New York, and which may be fairly said to be the most standard telephone battery of the world, over 1,000,000 being in use in Europe, and over 500,000 in the United States. The cause of its great popularity is that it has been found to completely fill the need created by the telephone for an efficient working battery for open circuit work. The introduction of this battery was simultaneous with that of the telephone but the Leclanche Company have added many improvements from time to time, and it is those which we illustrate. The latest of these is a new form of jar and cover for the well-known Prism Battery. The cover rests

PRISM BATTERY, COMPLETE.
Size of Jar: 6x3(3/4 inches; height, 6½ inches.

upon a shoulder inside of the jar which is oval in shape, the rims of the jar above the cover being concave in shape. The cover when in place, closes the jar sufficiently tight for ordinary purposes, but if desired, it may be hermetically sealed. To do this: soften a little paraffine wax to about the consistency of putty, and with it fill in any space between the cover and the jar, and also around the carbon and zinc, in order to prevent the melted wax from running down into the jar. Then pour upon the cover melted wax, which will spread over the cover, settle in the concave rim, and effectually seal the jar. After sealing, raise the zinc rod, to loosen it in the wax. This will leave sufficient space around it for ventilation, but not enough to permit the slopping over of the liquid. Whenever necessary to clean or renew the Battery, the sealing material can be removed with a knife-blade.



PRISM, CARBON, ZINC, AND JAR (OVAL).

The Leclanche Prism Battery possesses the unquestionable advantage of dispensing with attention during long periods of service, provided: that it be used only for those purposes for which it is suited and for which it was intended. It is an Open Circuit Battery, and is not intended for Closed Circuit work. By Open Circuit work is meant that requiring the closing of the circuit temporarily and for short periods only, such as services on Telephones, Call Bells, Gymnasium Work, Burglar Alarms, etc., etc. No internal action takes place in the Leclanche Battery unless the Circuit is closed, so that when not actually at work there is no consumption of materials, and the Battery will last indefinitely. As the highest use of the Battery the length of the periods during which the Circuit may remain closed, without injury, varies with the amount of resistance in the Circuit.

The less the resistance, the greater will be the tax on the Battery, and the shorter the time required to exhaust the elements. The greater the resistance, the less will be the tax on the Battery, and the longer will be the term of service.

With a high resistance it may be used for purposes requiring the closing of the Circuit for a half hour or more at a time.

The same Company also manufacture the Leclanche Plaque Cell, which, until the introduction of the Leclanche Prism Cell, was the best open circuit battery made, and the one most generally in use both in this country and in Europe. It is still used to some extent, and, as made by the Leclanche Battery Co. of the best materials and with care and skill, is an efficient and useful battery. It has, however, defects from which the Prism Cell is entirely free and is fast being superseded by the latter.

The Leclanche Batteries are made by skilled workmen, of the best materials, and these facts together with the able business management of the Company, have won for them their present great popularity.

The instruments of the Anti-Bell Telephone Company of Boston are sold outright, not rented. Being mechanical, they do not infringe on the Bell patents. They work satisfactory for a mile.

from a potash or ordered from a druggist. The potash makes them [illegible] Also, one end of the upper [illegible] cell must be inside [illegible] Case is for placing it in the daily [illegible] of [illegible] paraffine wax.—Give [illegible] Stopping for the man the former gets only [illegible] half as long. [illegible] between the two with iron fittings [illegible] It is not convenient to [illegible] cells, tacks, scraps of [illegible] of lead wire, etc. No metal but [illegible] must come in contact [illegible] with a solution of caustic potash [illegible] not to let it touch the [illegible] be sorry. Keep it in a dish [illegible] rubber vessel. Use then a thick [illegible] of zinc. The upper end of it [illegible] off thin and sharp, so that when [illegible] the inner cell this place can [illegible] through the tight cover of the [illegible] shows the thin end of the [illegible] passes up through the cover of the [illegible] cover over. This cover must [illegible] and very tight fitting, to [illegible] perfectly air-tight. The jar in the shape of [illegible] Instead of a piece of sheet [illegible] potash solution, as shown in the [illegible] m, cork tight, and seal around and [illegible] top of the cork with wax or [illegible] The covering must be perfectly air [illegible]

[illegible] is ready. The clay cell is now [illegible] and the potash solution passes [illegible] the wall and mingles with the zinc [illegible] the outer cell. It eats up the zinc [illegible] quickly that is dipped into it, and this [illegible] al action in connection with the molecular [illegible] produces the electric current. [illegible] a copper wire to the loop of the zinc [illegible] the other end of the wire [illegible] for use. The circuit must be completed by returning the other end of the wire [illegible] ver rod, or by connecting it with [illegible] coil. Coil in the middle of it, as shown [illegible] e where the electric current is to be [illegible] and utilized. You see in the picture [illegible] cords passing from two connected [illegible] The more cans or cups you have the [illegible] e the electric current will be. Join [illegible] er coil of one with the inner coil of the [illegible] ext as so. The battery may be [illegible] upon the floor, and wires made to [illegible] the wall to a bracket holding the [illegible] lamp. The lamps shown in the picture [illegible] 16 candle power, and for candles [illegible] candles of carbon burns about [illegible] ft an hour. Any number of [illegible] lights is produced by the use of [illegible] rough these points. To make a [illegible] this sort will be a great work for the [illegible] One battery, consisting of an inner [illegible] er coil, costs about 25 cents. The [illegible] of potash and the zinc plate will need [illegible] from time to time.

[illegible] Gazette
[illegible] Mass.
May 17 1884

ELECTRICITY.

[illegible] to Make a Cheap Ba.

[From the Burlington.]

[illegible] night, which is now occupying most [illegible] the world is certainly [illegible] by. The capabilities of this mysterious [illegible] are only beginning to be understood. [illegible] ite, indeed, that before many years elapse [illegible] will furnish four-fifths of the motive power [illegible] taking the place of horses, steam and gas. [illegible] can be found to generate it cheaply [illegible] it can be applied to the running of [illegible] machinery, saving machine to the [illegible] of at least 50 per cent.

"It will certainly be of interest to the reader of [illegible] how [illegible] electricity is obtained. There are [illegible] ods of generating it—by friction and by [illegible] chemical action. The latter method [illegible] ed in [illegible] ing, and consists in the use of [illegible] combinations, the insulation of which is [illegible] by chemical action. In the process of [illegible] heat and electricity are produced. How [illegible] ed, and how applied, can perhaps best be [illegible] the [illegible]

Anybody living away in the country [illegible] not see an electrical generator, can make one [illegible] this description? He can perform all neces[illegible] ments with [illegible] and [illegible] and [illegible] ing [illegible] and [illegible] ing, and cleanse [illegible] from [illegible] ing [illegible] ing [illegible] ing

The Electric Ballet at the London "Empire."

Cerberus at the gates of Hades, says a reporter of the *Pall Mall Gazette*, is not a more terrible monster than the stage-door keeper at the Empire Theatre. He is a Cerberus worthy the name. Let those who are ambitious to "go behind" beware of him. He softened, however, when I told him that I had permission from Mr. Hitchins to see the working of the new electric ballet, so I was allowed to wait until my cicerone arrived. At last M. Levy, who directs the electric ballet arrived. "I have come to ask you a few ques-

...n exceeding 600 miles. As to the machine ... that the observer sees is a copper boiler, ...s two-gallon capacity, mounted on the ... a sewing machine. Underneath the ... a coal oil lamp, which is burning with ... flame used to partially illuminate a sick ... It has been burning continuously for ...s and nights, except when being replen... ...d had consumed less than twenty cents' ... oil. In front of the boiler is a guage ...arked 100 degrees of heat. Inside of the ...ero scraps of metal protruding from a ...bstance that might be flour or plaster of ... Attached to the boiler is an automatic ...r.

...ponse to questions as to the nature of his ... the inventor said that it had long been ... scientists that the juxtaposition of cer... ...als would generate electricity and that ...ess of generation would be accelerated by ...lication of heat. This knowledge had, ... remained inapplicable to practical pur... ...om three causes—first, the amount of ...uired was so great as to cause rapid frac... ...the combined metals, and this rendered ...chine previously invented shortlived and ...ntly expensive; second, the current of ...y generated was uneven and unsteady; ...e high degree of heat involved a great ...ure for fuel. That he had overcome the ...ficulty was apparent. That he had over... ... second he held to be proved, for tele... service requires a perfectly uniform and ...urrent of electricity, and this he had ...ed for nine days. Whether the other ... had been overcome was now being ...nd the test would be continued for thirty ... the end of that time all is well with the

...from three thousand to seven thousand words a minute. A few days ago, in Boston, another improved plan of sending messages was exhibited, being an application to telegraphy of the musical notation system. Of course, with such facilities, telegraph companies can profitably reduce their tariffs to one cent a word. That will be the usual rate in our country before long.—*The Current.*

TELEGRAPHING is dangerous work when it becomes too personal. An Austrian countess, Madame Pongratz de Metternich, recently sent the following brief but expressive despatch to Governor Passinger, at Neustadt: "You are a blackguard." The Governor, who is said to have no idea of gallantry, summoned his fair enemy before a magistrate and she was sentenced to a fortnight's imprisonment and three hundred florins fine.

WITH all the existing cables between this country and England and France in operation, with the addition of the new Bennett-Mackay line and still another from Portugal to some place on the Southern coast, it is plain that there is to be no lack of telegraphic communication with the outside world at large. The Portuguese concession will probably not be immediately used, but that it will help to increase the general effectiveness and cheapness of the service cannot be questioned. With all the improvements in electrical methods and the eagerness of capital to find investment, facilities for communication bid fair to find indefinite extension.

The Delaware and Atlantic Telephone Company intends laying a cable between Bristol, Bucks County, and Burlington, N. J.

Plattsburg Sentinel
Plattsburg, N. Y. May 1, 1885

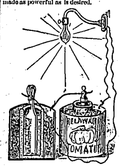
How to Make a Cheap Battery.

The subject which is now occupying most attention in the scientific world is undoubtedly electricity. The capabilities of this mysterious agency are only beginning to be understood. It is possible, indeed, that before many years electricity will furnish our light, heat and motive power, taking the place of horses, steam and gas. If a method can be found to generate it cheaply and steadily it can be applied to the runnin[g] of all conrivances, from a sewing mach[ine] to the trip-hammer of an iron mill.

It will certainly be of interest to the reader to know just how electricity is obtained. There are two ways of generating it—by friction and by chemical action. In the illustration below is shown how a light current of electricity may be got at very small expense. When two substances unite to form one, different from either of the two constituents, the combination is said to take place by chemical affinity. In the process of this union heat and electricity are produced. How? That no man knows. Can anybody tell how the grass grows? The battery shown below produces electricity by chemical action.

Anybody living away in the country, who never saw an electrical generator, can make one from this picture and description. He can perform all kinds of experiments, and make a small electric light or run a little engine, and illustrate to his own perfect understanding how machines are run by electricity. By detaching the wires from the lamp, slipping small wooden tube handles over the ends, and tying bits of sponge to the extremities of the wire where they pass through the wood, the experimenter will be able to apply electrical treatment medically to any part of the body, or to pass the current through a bath tub and have an electric bath.

One point is to be remembered: The current from only one cell, or two of them, as shown in our illustration, will be weak. Thus probably two of the cans would not produce much of an electric light. But by increasing their number, the current may be made as powerful as is desired.



THE BATTERY, WITH SMALL ELECTRIC LIGHT.

You see the illustration. Now for a description of it. A large tin fruit can will do as well as anything to contain the chemicals. Take a can that is well tinned and sound. Wherever solder has been used in the seams or joints cover with melted pitch while the can is warm. The inner cell is of unglazed red earthenware. This inner cell appears in the engraving within the outer one, on the left of the picture. The inner clay cell can be got from a pottery or ordered from a country merchant. The potters make them of all sizes. About one-third of the upper part of the clay cell must be made non-porous. Coat it by dipping it to this depth into a bowl of melted paraffine wax. Give it two or three coats, dipping for the next one after the former gets cold.

Set the clay cell inside the tin one. Fill the space between the two with iron filings and cuttings, or, if it is not convenient to get these, use small nails, tacks, scraps of iron and pieces of iron wire. No metal but iron will do, however, and it must not be galvanized. Next come the chemicals. Fill the clay cell with a solution of caustic potash. Be careful not to let it touch the skin or you will be sorry. Keep it in a glass or glazed crockery vessel. Get then a thick strip or plate of zinc. The upper end of it must taper off thin and sharp, so that when it is put into the inner cell this thin piece can pass upward through the tight cover of the cell. The picture shows the thin end of the zinc as it passes up through the cover of the inner cell and loops over. This cover must be of cork or wood, and very tight fitting, to close the cell perfectly. It is in the shape of a cork or stopper. Insert the piece of zinc into the potash solution, as shown in the illustration, cork tight, and seal around and over the top of the cork with wax or hot pitch. The covering must be perfectly air tight.

Now all is ready. The clay cell is very porous, and the potash solution passes through its wall and mingles with the iron filings in the outer cell. It eats up the zinc plate rapidly that is dipped into it, and this chemical action in connection with the moistened iron filing produces the electric current. Fasten a copper wire to the loop of the zinc above the cover, and that end of the battery is ready for use. The circuit must be completed by returning the other end of the wire to the outer cell, or by connecting it with another cell. Out in the middle of the wire circuit is where the electric current is to be caught and utilized. You see in the picture the two ends passing from two connected cans. The more cans or cups you have the stronger the electric current will be. Join the outer cell of one with the inner cell of the next one, and so on. The battery may be placed upon the floor, and wires made to pass up the wall to a bracket holding the electric lamp. The lamp shown in the picture is the ordinary one used for electric lighting, consisting of a carbon horse shoe enclosed in an air-tight glass globe. The glow of light is produced by passing the current through these points. To make a battery of this sort will be grand work for the boys. One battery, consisting of an inner and outer cell, costs about 25 cents. The solution of potash and the zinc plate will need to be renewed from time to time.

Evening Gazette
Worcester, Mass.
May 1/85

ELECTRICITY.

How to Make a Cheap Ba[ttery]

[From the Saratogian.]

The subject which is now occupying most attention in the scientific world is undoubtedly electricity. The capabilities of this mysterious agency are only beginning to be understood. It is possible, indeed, that before many years electricity will furnish our light, heat and motive power, taking the place of horses, steam and gas. If a method can be found to generate it cheaply and steadily it can be applied to the running of all contrivances, from a sewing machine to the trip-hammer of an iron mill.

It will certainly be of interest to the reader to know just how electricity is obtained. There are two ways of generating it—by friction and by chemical action. When two substances unite to form one, different from either of the two constituents, the combination is said to take place by chemical affinity. In the process of this union heat and electricity are produced. How? That no man knows. Can anybody tell how the grass grows?

Anybody living away in the country, who never saw an electrical generator, can make one from this description. He can perform all kinds of experiments, and make a small electric light or run a little engine, and illustrate to his own perfect understanding how machines are run by electricity. By detaching the wires from the lamp, slipping small wooden tube handles over the ends, and tying bits of sponge to the extremities of the wire where they pass through the wood, the experimenter will be able to apply electrical treatment medically to any part of the body, or to pass the current through a bath tub and have an electric bath.

One point is to be remembered: The current from one cell, or two of them, will be weak. Thus probably two of the cans would not produce much of an electric light. But by increasing their number, the current may be made as powerful as desired. Now for a description. A large tin fruit can will do as well as anything to contain the chemicals. Take a can that is well tinned and sound. Wherever solder has been used in the seams or joints, cover with melted pitch while the can is warm. The inner cell is of unglazed red earthen-ware. The inner clay cell can be got from a pottery or ordered from a country merchant. The potters make them of all sizes. About one third of the upper part of the clay cell must be made non-porous. Coat it by dipping it to this depth into a bowl of melted paraffine wax. Give it two or three coats, dipping it for the next one after the former gets cold.

Set the clay cell inside the tin one. Fill the space between the two with iron filings and cuttings, or, if it is not convenient to get these, use small nails, tacks, scraps of iron and pieces of iron wire. No metal but iron will do, however, and it must not be galvanized. Next come the chemicals. Fill the clay cell with a solution of caustic potash. Be careful not to let it touch the skin or you will be sorry. Keep it in a glass or glazed crockery vessel. Get then a thick strip or plate of zinc. The upper end of it must taper off thin and sharp, so that when it is put into the inner cell this thin piece can pass upward through the tight cover of the cell. The thin end of the zinc passes up through the cover of the inner cell and loops over. This cover must be of cork or wood, and very tight fitting, to close the cell perfectly. It is in the shape of a cork or stopper. Insert the piece of zinc into the potash solution, cork tight, and seal around and over the top of the cork with wax or hot pitch. The covering must be perfectly air tight.

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Providence Journal
May 2, 1885.

ONE OF THE ELECTRICAL PROBLEMS.

In his investigations relating to storage batteries, Mr. Edison has discovered, it is said, nevertheless that, at present, little is known in regard to the age of plates—that a year, only, is considered a fair average, this being the time in which they are found to last for service. Think plates are found to last for much longer than this, which is quite unusual, considering that the wasting out is due to rust also, and that the latter is prevented, as has already been remarked, that the internal positions of a thick plate are to a great extent protected by the outer layers, which are, of course, the first to begin rusting. And as it must, also, be remembered, that the cost of material is far more than the cost of manufacture, that the material reserved has a market value not inconsiderable, and that the process of reducing and purifying such which plates have to be renewed is not such as to cause much inconvenience, it would appear that the age of plates, as at present manufactured has been over-estimated. Many users, for think, may be hoped for in this direction in the future—in fact, that a well-chosen, properly charged and fully treated plate will be found to last many years, and therefore it becomes distinguished. Incidentally, in the types of cells, adapted to different purposes, are also to be looked for.

Menlo Park Scrapbook, Cat. 1034

No. 21. "Carbon Telephone"

This scrapbook covers the years 1878-1885 and contains clippings about the telephone, the microphone, and other acoustic devices. There is also one article about Edison and Menlo Park. The book contains 144 numbered pages.

Blank page not filmed: 144.

1034

Carbon Telephone

21

Carbon

Un appareil Morse monté *en duplex* est un peu plus rapide qu'un appareil Hughes; il est vrai qu'il demande un nombre double d'employés, mais ils peuvent être mêlés expérimentés; le Hughes étant un appareil délicat, est d'ailleurs fatigant à manier.

D'un autre côté le Morse se monte *en duplex* très-facilement; on a imaginé au poste central un moyen commode, basé sur ce fait que les électro-aimants ont deux branches : au lieu de contrarier deux fils sur une tige, on a contrarié les tiges l'une par l'autre; aussi, pour les lignes courtes et chargées de trafic, emploie-t-on maintenant très-fréquemment ce système *en duplex*. Je dis pour les lignes courtes, car pour celles-là on peut se passer du condensateur, et comme M. Stalrus, qui en a inventé l'emploi, fait payer le plus cher qu'il peut l'usage de son brevet, ce qui est naturel en vendu à l'employer; les télégraphistes, de leur côté, préfèrent les moyens les moins coûteux, et cela est naturel aussi, c'est pourquoi avant de mettre *en duplex* sur les grandes lignes, on emploie des appareils plus rapides que nous passerons en revue dans un prochain article.

FRANK GERALDY.

RECHERCHES NOUVELLES

SUR LA THÉORIE DU MICROPHONE

3e article (Voir le nº du 15 novembre).

1 Dec 1879

Dans le précédent article on a établi que, pour que la transmission des sons articulés fût possible, il fallait que le nombre des points de contact, les différences de ce nombre pendant l'action de l'appareil et les changements de résistance qui en résultent fussent les plus grandes possibles.

C'est dans ces conditions que sont disposés le microphone du modèle principal de M. Hughes, le téléphone à charbon de M. Ralloni, le téléphone transmetteur avec deux crayons de graphite de MM. Pollard et Garnier, de M. Helleseo, etc. La forme représentée ci-dessous peut nous servir comme

type d'explication pour toutes les autres, et je la regarde aussi comme très-commode dans toutes les expériences microphoniques. Elle peut être employée pour la transmission de la parole, du chant à divers degrés d'intensité, du bruit d'une montre placée à côté, d'une mouche placée au dedans, de la musique d'un piano, etc. La membrane en de caoutchouc, bien tendue, et pourvue d'une mince bande de papier d'étain pour unir le charbon de dessous avec le bouton d'attache.

Il est facile de remarquer que pendant les vibrations de la membrane, une plus ou moins grande quantité de points de contact réunit les deux électrodes microphoniques, ce qui nécessairement produit des changements de résistance. Par le fait de l'introduction du microphone dans le circuit, cette résistance augmente considérablement, et réduit la force du courrant à 1/1ᵉ et plus de son intensité primitive. Les vibrations mécaniques de la membrane peuvent la reconnaître en partie ou la diminuer encore, et, quoique ces changements soient bien petits, ils présentent cependant, *grâce à leur rapidité*, une quantité d'inflexions qui permettent de reproduire toutes les nuances de la voix.

Si je ne me trompe, l'influence de l'énergie des ondes sonores sur l'intensité des sons perçus dans le téléphone, n'a pas été encore reconnue positivement. Au contraire on était porté à croire qu'elle ne devait pas exister (Voy. Clerk-Maxwell, *Nature*, vol. 18, p. 162) (1), et cependant il n'est impossible d'en douter. Seulement il faut prendre en considération non pas le côté sonore, mais le côté mécanique des phénomènes. Quand on parle à voix basse près du microphone, ou à voix forte mais à une distance de quelques mètres, les sons sont plus faibles que quand on parle à voix haute ou de près. Une montre à bruit fort est mieux entendue qu'une montre à bruit faible, etc. Les limites de proportionnalité sont bien restreintes, il est vrai, mais les différences de résistance le sont aussi. Augmentons celles-ci, et nous changerons celles-là.

La prétendue indépendance des sons du récepteur de ceux qui frappent le transmetteur a pris sa source dans un fait parallèle au premier, savoir, que les limites d'une articulation *distincte* sont beaucoup plus rapprochées que celles des sons non articulés. *La distinction* et la netteté *des consonnes transmis par un microphone, sont en raison inverse de leur intensité. L'intensité croît à mesure que les vibrations microphoniques tendent à interrompre complétement le courant, tandis qu'en même temps la faculté de transmettre les sons articulés disparaît.*

Et c'est là la principale difficulté qui empêche d'amplifier les sons à volonté.

L'intensité des sons acquiert son *maximum* lorsque les interruptions du courant deviennent complètes; mais alors les sons ne peuvent plus être articulés; voilà pourquoi on entend mieux quand on parle d'une voix ordinaire, que quand on parle d'une voix basse.

L'intensité des sons est aussi en rapport direct avec la force du courant, mais ce rapport est encore plus réduit que les précédents. Les manifestations microphoniques commencent dès que le courant a la force de vaincre la résistance du microphone et de le traverser. Ce sont les bruits d'interruption complète qui se manifestent les premiers; ils sont très-faibles, et leur modulation est encore impossible. Si on augmente l'intensité du courant, la modulation acquiert son premier degré, et le bruit d'une montre en perçu nettement. Il devient plus fort à mesure que l'intensité du courant fait

(1) M. Wroblewski, professeur à l'université de Strasbourg, fait mème de cette négation une loi en disant que « l'énergie des ondes sonores n'a aucun rapport avec l'intensité des sons perçus ». (*Comptes rendus*, 1876, T. 3ch. Lehnergt.

lin poussant la rédaction du téléphone encore plus loin, on peut arriver à se passer du microphone récepteur et même d'une bobine électrique, en appliquant de simples électrodes (lames ou cylindres métalliques) contre les deux tempes. Le courant intermittent passe alors par la tête, et la peau sèche joue ici le même rôle que les feuilles de papier dans le condensateur chantant de MM. Varley et Pollard. On peut aussi construire une harpe électrique avec des fils fins, rapprochés les uns des autres, et cette harpe émet des sons quand elle est traversée par un courant discontinu. C'est alors l'air qui joue le rôle du nouveau conducteur. Enfin, une spirale de fil fin engendre des sons sous l'influence des attractions électrodynamiques.

Il ne nous reste plus qu'une remarque à faire sur les propriétés thermométriques du microphone. Elles rentrent dans le même ordre d'explications que celles qui nous ont servi pour comprendre l'action du microphone agissant comme transmetteur; seulement comme il s'agit ici d'une action électromotrice et non téléphonique, les changements dans les points de conductibilité n'ont plus besoin d'être *rapides*. Une autre différence, en apparence contradictoire se fait remarquer. On sait que le *microtasimètre* de M. Edison présente des effets tout à fait opposés à ceux du *microphone thermométrique* de M. Hughes. Dans le premier, la chaleur agit par une augmentation de conductibilité; dans le second, c'est l'inverse : la chaleur augmente la résistance. Pourquoi? Parce que, dans le premier cas, s'est un corps *solide* qui se dilate sous l'influence de la chaleur, en *augmentant le nombre des contacts*, tandis que dans le second cas où il existe plusieurs petits morceaux de charbon juxtaposés, c'est *l'air*, qui les entoure et les sépare, qui se dilate avant tout, et cette dilatation doit nécessairement produire une *diminution dans le nombre des contacts*; mais le principe reste toujours le même.

En résumé, il nous est impossible de reconnaître dans le microphone une nouvelle propriété de la matière, en, tout au moins, celle de l'action directe des ondes sonores sur certains corps médiocrement conducteurs. Le microphone ne présente aucune analogie avec le *microscope*, et sa théorie n'a aucun rapport avec celle du *silénium*, ce qui cependant n'empêche pas l'invention de M. Hughes d'être une des plus grandes de notre siècle.

La seconde théorie, celle de la pression, n'est de même qu'une exposition superficielle des faits, et, à notre avis du moins, elle doit être abandonnée.

Dr Julius Ochorowicz.

RECHERCHES NOUVELLES

SUR LA THÉORIE DU MICROPHONE

Déc 15 1879

Deux hypothèses principales ont été émises pour expliquer les phénomènes que présente l'ingénieuse découverte de M. Hughes.

L'une, exclusivement moléculaire, suppose des dilatations et contractions des molécules dans certains corps médiocrement conducteurs, sous l'influence des vibrations sonores, au sein même du microphone. Les *changements de densité* deviennent correspondre à des affaiblissements de résistance ou d'un affaiblissement, et conséquemment, à une production proportionnelle des sons. Cette hypothèse présente une certaine analogie avec les phénomènes que manifeste le sélénium sous l'influence de la lumière et de la chaleur rayonnante.

L'autre, en partie moléculaire et en partie mécanique, repose sur la découverte faite il y a longtemps par M. du Moncel, et suivant laquelle les accroissements et les affaiblissements de résistance tout dus à des *changements de pression* dans les points de contact électrique. Ces changements étant produits par la pression de l'air vibrant, il en résulte une équivalence de causes et d'effets.

Si on ne tenait sur des expériences faites sur une multitude de microphones, depuis la première apparition de cette découverte, je tâcherai de prouver que, si l'une de ces hypothèses est tout à fait erronée, l'autre n'est vraie que superficiellement.

Commençons par la première :

1) Quand on humecte la baguette de charbon avec une colle quelconque, de la cire par exemple, sans lui faire subir la moindre pression, le microphone reste muet sous les plus fortes influences sonores, ce qui serait impossible s'il ne s'agissait ici que de mouvements moléculaires et non mécaniques.

2) On peut enfermer le microphone dans une tube de verre suspendu légèrement au moyen d'un fil fin, et faire le vide dans ce tube, sans paralyser les effets microphoniques. Il est évident que, dans ce cas, les molécules d'air ne peuvent avoir aucune influence sur la densité du charbon ; elles n'agissent que mécaniquement en ébranlant l'appareil tout entier.

3) Il est impossible de construire un microphone d'un seul morceau de charbon solide, présentant des contacts stables, ce qui n'empêche pas les influences moléculaires, mais ce qui rend impossible l'action des ondes sonores, des ébranlements et des ébranlements quelconques, sur le courant qui traverse le charbon.

Il me semble donc, que nous avons là des raisons suffisantes pour rejeter toute théorie exclusivement moléculaire.

Passons à la seconde :

1) La pression latérale exercée sur un conducteur électrique compact (métal, charbon, etc.), placé dans un téléphone, n'engendre aucune action microphonique.

2) Une pression longitudinale exercée sur la baguette d'un microphone au moyen d'une vis de réglage, peut être modifiée entre certaines limites, sans altérer le fonctionnement de l'appareil. Ce n'est que le timbre qui change alors d'intensation. Mais le même effet peut être obtenu sans changement de pression, par le seul fait du déplacement des points de contact. Si l'on continue d'augmenter la pression, l'appareil perd de sa sensibilité, en même temps qu'il perd de sa faculté de vibrer mécaniquement ; mais le fait seul d'une augmentation de pression ne se rapporte à aucun phénomène microphonique. (Cette expérience est à faire avec un microphone à membrane.) »

1) On peut construire des appareils dans lesquels la pression reste la même, et qui cependant agissent comme microphones, (Voir plus loin.)

Il est donc rationnel de ne pas considérer la pression comme cause essentielle des phénomènes microphoniques.

Elle en est cependant une cause accidentelle, car quand les ondes sonores frappent la partie mobile de l'appareil, la pression qu'elle exerce sur son support change; mais ce n'est pas du fait de la pression que résultent les différences de résistance ; c'est un autre fait, souvent parallèle au premier, mais qui n'en est pas moins différent.

Pour le mieux apprécier, considérons l'appareil dans sa forme la plus simple qui est celle de la figure 1.

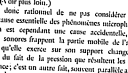

Fig. 1.

Deux bouts de fil métallique réunissant dans leur circuit la pile et le téléphone, sont tendus en croix l'un sur l'autre : le courant passe au point de croisement. C'est *à ce point seul* que se concentre l'action microphonique. Quand on fait vibrer l'un des fils par une cause quelconque, un bruit ou un son musical très-intense se fait entendre dans la salle où est placé le téléphone. Si les fils sont bons conducteurs, l'action de l'appareil n'a que deux phases : le courant passe quand un fil touche l'autre, il ne passe pas dans le cas contraire. Il n'y a donc là qu'une *simple et complète interruption du courant*; et, en conséquence, ce microphone, comme le transmetteur du téléphone de Reiss, comme celui du chanteur de M. Pollard, etc., ne peut transmettre que des sons simplet. Cette première catégorie embrasse tous les microphones dans lesquels le contact s'effectue par un seul point. J'ai obtenu les meilleurs résultats de ce genre avec une membrane de vessie tendue et une pointe d'acier. La communication électrique était assurée par une petite bande de papier d'étain collée sur la membrane. Avec un petit élément à bichromate de potasse, le chant a pu être entendu dans toute une chambre.

Sinconsistent parlant, il y a, dans ces simples appareils, quelques nuances d'action entre les limites d'intensité complète et de rupture complète du courant, et on peut considérer qu'il existe deux ou trois réglages pour lesquels *l'interruption n'est que partielle*.

C'est donc le changement des points de contact qui joue ici le rôle principal. Du nombre plus ou moins grand de ces points, dépend *l'intensité* des sons; le nombre des interruptions successives des mêmes contacts détermine leur *hauteur*, et les changements successives leur *timbre*; enfin des diverses combinaisons successives et simultanées, périodiques ou non périodiques, *devient ces différents* résulte leur *articulation*. Il suffit de comparer les traces de la parole dans le phonautographe, le logographe et le phonographe, pour se convaincre qu'il n'y a en réalité, dans ces appareils, qu'une *réduction de la qualité en quantité*. Je suis même porté à croire que cette réduction est bien simple, et qu'une série de combinaisons en temps et en espaces *de trois points matériels de contact*, suffit pour servir d'équivalent à tous nos sons articulés. Il me serait difficile de rapporter ici toutes les expériences et réflexions qui m'ont conduit à cette supposition. Je attendant, je me la donne qu'à titre de probabilité, et je passe à la troisième catégorie.

Le principe du changement dans le nombre des points de contact provoqués par la pression, nous permet de considérer les différences résistances du circuit microphonique, comme si le fil qui le compose devenait tantôt plus gros, tantôt plus fin, et explique l'action de la plupart des microphones, mais il en est qui explique pas tous.

On peut construire, en effet, des microphones dans lesquels il ne peut se produire aucun changement de pression ni, même, aucune variation dans le nombre des points de contact, et qui cependant fonctionnent bien.

Fig. 2.

Supposons un petit cylindre de charbon *a* (fig. 2) collé perpendiculairement à une membrane MM et glissant sur un autre petit cylindre de charbon *b* mobile autour de son axe. Si la forme cylindrique de ces deux morceaux est parfaite, la pression et le nombre des points de contact restent les mêmes. S'il en est autrement, comme cela a lieu dans la pratique, ce n'est plus cet effet qui joue le rôle principal : c'est la *longueur de la route traversée par le courant dans le nouveau conducteur*. Pendant que la membrane vibre, son éloignement du charbon *b* diminue ou augmente, en effet, et il y a donc un changement dans le nombre des points de résistance traversés.

C'est à cette classe d'appareils qu'appartiennent aussi les téléphones transmetteurs à liquides de MM. Gray, Bell et Salet, où le changement de résistance dans le circuit résulte d'une couche de liquide plus ou moins épaisse, qui doit être traversée par le courant.

Il est bien difficile de séparer les deux principes l'un de l'autre, mais il est possible de déterminer la prépondérance de l'un ou de l'autre, ou bien encore leur parallélisme. Supposons, par exemple, que les deux cylindres de charbon *a* et *b* soient remplacés par deux lames de la même matière, et que *b* reste immobile : les deux actions seraient égales et

charge s'écoule en dehors. D'après Faraday, l'effet ne produirait exactement comme si un fil métallique avait été substitué à la chaîne de particules attirbuées doublant la charge électrique. (*Voir ses Recherches expérimentales*, série XII, p. 1406.) Toutefois, la plupart de ces essais ne furent pas satisfaisants.

« On fit alors de nouvelles expériences avec des plaques dites *paraffinées*. L'un des premiers systèmes de ce genre était constitué par une plaque de cuivre mise en communication avec la terre, et par une autre plaque reliée à la ligne; ces deux plaques étant isolées l'une de l'autre, au moyen d'une feuille de papier ou de mica mince imbibée, la feuille, chauffée pour le fil, percé alors la papier, et s'écoule directement en terre au lieu de passer à travers les fils des appareils télégraphiques.

« Une importante modification fut apportée à ce système par M. W. Siemens, en conseillant ou en rayant les faces des deux plaques opposées l'une à l'autre, et en les plaçant l'une sur l'autre, de manière que les rayures se croisassent à angle droit. De cette manière, les plaques régulièrent comme si elles avaient été pourvues d'une infinité de petites pointes métalliques, et ces pointes devaient naturellement faciliter la décharge. Cette action est, de reste, bien connue, et son application aux parafoudres est indiquée dans les *Annales de télégraphie* de M. C. Walker, F. R. S.

« Le système Siemens, très-ingénieux en théorie, ne réalisa pas, toutefois, les effets avantageux qu'on attendait son auteur, et il ne présenta pas d'avantages marqués sur les autres systèmes. Cela tenait à ce que les pointes qui devaient résulter mathématiquement du croisement des rainures n'étaient pas formées physiquement et microscopiquement, et c'était de leur action que les effets protecteurs devaient résulter.

« Le Dr Warren De la Rue ayant mis simultanément à ma disposition sa batterie composée de 10000 éléments, je voulus éclaircir cette question, et j'y préparai deux systèmes de doubles plaques identiques comme dimensions, et la seule différence qui pouvait exister entre les deux systèmes, consistait en ce que, dans l'un, les plaques étaient cannelées, et que, dans l'autre, elles ne l'étaient pas; elles étaient d'ailleurs séparées par des bandes circulaires d'ébonite ayant 0,01 de pouce d'épaisseur. Les plaques de chaque système étaient reliées en communication avec le pôle positif de la pile, les autres plaques avec le pôle négatif, et le nombre des éléments de la pile était augmenté successivement jusqu'à que l'on pût obtenir un courant non interrompu; j'obtins alors les résultats suivants :

1° *Avec les plaques unies:*

Pour 1000 éléments	petites étincelles.
Pour 1080	étincelles visibles.
Pour 1700	étincelles fréquentes et nombreuses.
Pour 1800	arc continu.

2° *Avec les plaques cannelées:*

Pour 1000 éléments	étincelles n'apparaissant qu'au moment de la fermeture du circuit.
Pour 1080	étincelles visibles.
Pour 1300	étincelles fréquentes.
Pour 1800	arc continu, mais capricieux.

Avec 2000 éléments, on obtenait un courant continu dans les deux cas; mais avec 1300 éléments, l'effet produit était certainement plus marqué avec les plaques unies qu'avec les plaques cannelées, et nous prîmes considérer les résultats obtenus comme décisifs.

« On peut donc conclure de ces expériences que les rayures, ou cannelures, des plaques des parafoudres de cette nature, sont nonseulement inutiles, mais plutôt nuisibles aux effets préservateurs qu'elles sont appelées à produire.

« Les expériences précédentes ont, du reste, parfaitement confirmé l'exactitude des chiffres donnés par M. Warren De la Rue et par M. Stallet, dans leur communication à la Société Royale (1), sur la distance explosive des étincelles entre deux disques, — distance qu'ils fixent à 0,013 pouce avec 1300 éléments en tension et à 0,02 avec 1000 éléments.

(1) (Voir les *Proceedings* de la Société Royale, v. p. 169-172.)

« On emploie dans la pratique, au *Post-office* notamment, pour maintenir l'isolation des plaques, du papier paraffiné ayant seulement 0,002 pouces d'épaisseur. Dans ces conditions, la différence des potentiels sur les deux plaques est seulement de 280 volts.

« MM. De la Rue et Muller ont démontré que des différentes sortes de surfaces à opposer les unes aux autres, y compris même les pointes, c'étaient les surfaces planes qui exerçait le plus grand effet, du moins pour un potentiel ne dépassant pas 1300 volts, et que les pointes ne sont efficaces que quand ce potentiel est considérable; et, comme il est douteux que l'électricité atmosphérique ait un potentiel supérieur à celui qui serait développé sur un fil télégraphique par une source électrique de 1000 volts, on peut en conclure que les surfaces planes et unies, séparées par une couche isolante de 0,002 d'épaisseur, donneront les meilleurs résultats pour les parafoudres. »

W. H. Preece.

EXPÉRIENCES DE M. R. COULON

SUR LE CONDENSATEUR CHANTANT

—Telephone—

Le téléphone n'est pas, comme certains appareils, sorti d'un hasard heureux ou du tâtonnement d'un esprit simplement ingénieux. Il est, au contraire, le fruit de longues et persévérantes recherches, en même temps que le couronnement logique d'un système précongu.

Néanmoins, lorsque l'instrument a été livré à l'expérimentation et à l'étude générale, il a bien fallu reconnaître que les idées qui avaient conduit à sa réalisation ne pouvaient expliquer son fonctionnement. Ce fait n'est pas rare; beaucoup d'inventeurs illustres ont ainsi puisé leurs découvertes dans des hypothèses, sinon fausses, au moins inexactes ou insuffisantes et l'étude faite par d'autres de leur œuvre a révélé souvent bien des côtés inaperçus. Ainsi pour le téléphone, l'idée des attractions exercées par l'aimant sur le diaphragme et le mettant en vibration dut être bientôt écartée, l'explication était à trouver.

Dès l'origine, notre maître et collaborateur M. Du Moncel reconnut dans ces faits un phénomène d'ordre nouveau, un genre de vibrations différent des mouvements jusqu'alors considérés comme sonores ou magnétiques, une nouvelle manifestation de ces modifications internes, moléculaires, que les variations électriques font naître dans les corps.

Nous ne reviendrons point sur l'ensemble de ces recherches, le lecteur en trouvera les points saillants exposés dans ce Journal, numéro du 15 mai, par M. Du Moncel. Nous rappelons seulement ici la question, afin de donner l'importance qu'elles méritent aux études nouvelles faites sur ce point par M. R. Coulon, études qu'il a publiées dans le journal *l'Électricité*.

Dans le cours de ces recherches, les divers expérimentateurs ont naturellement employé différentes méthodes. Les uns, comme M. l'abbé Laborde, prenant le téléphone lui-même, ont fait varier la position et la nature de ses organes; d'autres, comme M. Hughes, M. Ader et M. Du Moncel, ont cherché parmi ces organes ceux qui étaient essentiels et ont réduit le téléphone aux formes les plus incroyablement simples.

M. Coulon voulut obtenir l'appareil non le plus simple,

point le condensateur, mais la distance entre sa surface et celle de ce dernier est variable et peut être mesurée.

La nature de la plaque peut changer sans modifier les principales conditions du phénomène.

L'appareil étant ainsi disposé, le condensateur est mis en jeu et, à l'aide d'un dispositif électrique ou d'un interrupteur bien réglé, on fait rendre un son constant. On peut alors découvrir les deux faits suivants :

1° Si l'on présente une plaque dont la distance au condensateur soit graduellement diminuée, à un certain moment cette plaque entre en vibration et rend un son *autre que celui du condensateur*, ce son augmente d'intensité et change d'acuité d'une façon régulière; à mesure qu'on s'approche, l'acuité s'élève continuellement, l'intensité, après avoir passé par un maximum, diminue de façon à ce que le contact le son, que M. Coulon nomme son secondaire, s'éteint.

2° La distance au condensateur étant constante, si l'on fait varier l'épaisseur de la plaque, le son varie en même temps. M. Coulon le démontre de l'élégante façon que voici : l'ensemble étant disposé horizontalement, il pose sur la plaque en expérience une cuvette carrée à photographie et produit la vibration il y verse de l'eau; à mesure que le niveau s'élève, le son se modifie.

Il résulte immédiatement de cette expérience, que c'est la plaque elle-même dont la vibration produit le son et non l'air interposé en tout autre corps. Cette conséquence très-importante se vérifie d'une autre façon. "

M. Coulon mesure les distances de la plaque au condensateur qui correspondent aux sons successifs d'une gamme. Il en forme une courbe et la compare avec la courbe connue des longueurs des cordes vibrantes produisant les mêmes sons. Ces deux courbes ne sont pas identiques, la différence est d'autant plus grande que la plaque est plus rapprochée du condensateur.

Il reste à déterminer par une série assez nombreuse d'expériences quelle est l'influence réciproque de la nature, de l'épaisseur des plaques; ce que M. Coulon se propose de faire.

Il nous restera à parler d'autres expériences dans lesquelles M. Coulon a étudié les sons en leur faisant produire des manifestations lumineuses. Cette série n'apporte pas beaucoup d'éléments nouveaux, elle est surtout très-brillamment démonstrative. Nous y reviendrons prochainement, mais l'ensemble des remarquables expériences qui viennent d'être décrites porte avec lui sa conclusion sans qu'il soit besoin d'attendre. Il en était que nous avons lu une confirmation nouvelle, méthodique, des théories émises par M. Du Moncel; nous retrouvons sous des formes très-diverses — très-brillantes et très-pittoresques — la démonstration de la transformation des vibrations électriques en vibrations moléculaires devenant sonores dans certaines circonstances. Essayer de dire dans lesquelles serait certainement prématuré, et pourtant nous ne sommes point sans lumières même sur ce point. On se souvient des expériences de MM. Govi et Duter, où il fut établi que dans certaines conditions de charge électrique les corps subissaient des changements de volume et pouvaient éprouver ainsi des dilatations et des contractions très-sensibles. M. Righi, en étudiant ces phénomènes, les relie au condensateur chantant par l'expérience suivante : « *Je fais observer, dit-il, que le curieux phénomène de Varley, du condensateur chantant*, peut s'expliquer par des dilatations instantanées à chaque charge et décharge; du moins cette dilatation est une des causes du phénomène, car, ayant mis en communication un de mes tubes à armature de mercure avec le fil induit d'une bobine dont le circuit inducteur était périodiquement interrompu par un diapason, le tube a reproduit le son par des vibrations longitudinales ». (Comptes rendus de l'Académie des sciences, 16 juin 1879.) Nous saisissons là sur le fait la transformation de la vibration électrique en vibration extérieure et sonore. Le fait peut n'être pas visible dans le condensateur, il y est presque prouvé. Comment cela se relie-t-il au téléphone, de quelle façon les condensations s'y produisent-elles? on ne saurait formuler l'hypothèse mieux que ne fait M. Coulon lui-même, dont les paroles seront notre conclusion.

« Je remarquai que si on réduisait un condensateur à sa plus simple expression, c'est-à-dire à deux surfaces conductrices infiniment petites séparées par une lame isolante, le chant était reproduit.

Mais deux surfaces infiniment petites ne sont autre chose que les extrémités de deux pointes, la lame isolante peut être une lame d'air : or, j'ai démontré expérimentalement que deux pointes placées en regard l'une de l'autre suffisaient à reproduire le son.

Mais nous savons aussi que l'épaisseur des lames est sans influence. Supposons les extrémités des pointes sans aucune épaisseur, elles se réduisent à un point : donc, une série de points séparés par des lames d'air reproduisent le son.

Le point réduit à l'infini, c'est l'atome; la lame d'air réduite à l'infini, c'est l'intervalle moléculaire. Or, les corps ne sont composés que d'atomes et d'intervalles moléculaires.

D'où je conclus qu'un corps n'est en réalité qu'un condensateur réduit aux dimensions atomiques. »

FRANK GUALTIER.

(*A suivre.*)

Electrician May 25, 1881

THE TELEPHONE AND THE FAIR SEX.—The introduction of the telephone by the Viceroy of Egypt into his palaces and harems has struck terror to the hearts of the fair occupants. They imagine that this is a dodge of his sovereity to keep himself acquainted with all their tittle-tattle and doings.

LONG-DISTANCE TELEPHONING.—From America it is reported that the telephone has been worked between Bangor, Me., and St. John's, New Brunswick, a distance of 214 miles. Every word is said to have been heard distinctly. We also hear that Vicksburg is connected with New Orleans, a distance of 230 miles, and that conversation is carried on with much distinctness.

Electrician 28 May 1881

Téléphone à résonateur de M. Edison.

On sait que, dès l'année 1865, M. Cecse, en pressant plus ou moins de la pinchbeck dans un tube par l'intermédiaire d'une tige à piston, était parvenu à faire varier entre des limites assez étendues la résistance d'un circuit dans lequel le tube était interposé. M. Edison a perfectionné ce système en disposant la poudre de graphite par couches, ce qui lui a permis d'accroître des variations plus grandes de conductibilité. Dans son appareil, le disque d'ivoire de notre Num exhibits de graphite et, enfin, d'un second disque d'ivoire. Cet ensemble est fermé par une plaque métallique commandée par une vis tangentielle dont l'index, en se déplaçant sur un cadran, indique le degré de la pression exercée sur le pile de disques semi-conducteurs. Dans ces conditions l'on peut faire varier la résistance du circuit de 500 à 4,000 ohms.

(*Chicago (Illinois).*)

A MESSIEURS LE COMTE DU MONCEL

Mon cher monsieur

Dans un des derniers numéros de la *Lumière électrique*, un article sur la mesure de l'intensité lumineuse m'a particulièrement intéressé. Le fait est qu'il n'existe point d'unité de mesure universelle, et c'est un défaut qui semble être resté inaperçu au milieu des utiles inventions de notre siècle.

Voulez-vous me permettre de proposer une unité par l'intermédiaire de votre estimable journal.

Puisqu'il est possible de mesurer avec une précision absolue la quantité d'un courant électrique, on pourrait-on pas utiliser ce courant pour produire une unité d'intensité lumineuse à l'aide de l'incandescence d'un fil de platine ayant un diamètre et une longueur déterminés, et traversé par une quantité connue d'électricité, étendons qui sont à la disposition de tout le monde scientifique. De cette manière nous pourrions obtenir un étalon, un véritable type permettant de déterminer l'intensité d'une lumière à l'aide de l'excellent et simple photomètre de M. Dove.

Je demeure, monsieur, cordialement à vous.

Hiram.

Eng. Mechanic & Wld Science
July 1. 1881.

[11101].—Telephone Transmitter and the Induction Coil in Telephone Circuit.—"*J. H.*" will refer to the following pages, 92, 136, and 186 of the current vol. of the *M. E.*, he will find the information he asks for. His 30s. 24 and and 36 cotton-covered wire will answer for the induction-coil. Should he find any difficulty in making the vibrating break for working the coil, he will find a description of one, and the following simple device will be found to work well and quiet:—File a number of nicks along the edge of the brass staple S (see page 92), which supports the pendant piece P, so that it may somewhat resemble a fine saw (this roughing may be dispensed with, though I prefer it). Then take one of the ordinary watch-springs, better still, insert one end of an additional wire in one of the binding-posts on the stand B, and with a small piece of platinum file saw-like back. This will cause a rapid interruption in the battery current, and will produce almost as much effect on the telephone as the automatic interrupter; besides, it will sound the "call" when the battery is too weak to work the latter. Care, however, must be taken that the platinum-tipped spring does not touch the primary wire of the coil. This can be easily effected by inserting the additional wire first in one binding-post and then in the other, if the "call" cannot be got the first time. The carbons should be apart when the "call" is made; otherwise it will be weak. I was a good deal surprised at the reply to "J. H." sent by Mr. Lancaster, on the induction coil in the Gower-Bell circuit. My experience is just the reverse of that gentleman's, as the following will show experiments. If there be no alternatives, as he asserts, from using the induction coil with a carbon transmitter, why, may I ask, do Edison, Blake, Berliner, Crossley, Gower, and others make use of it in their carbon transmitters? Simply because they find it a real advantage; for one coil with an ordinary cell will do the work of ten or twenty without it on a long or badly-insulated line.—JOHN C. FRASER.

MT. LAN, OHIO, SATURDAY, JULY 9, 1881

Editorial Sentiments of the Telephone.

Mr. W. H. Ash, writing from Pensacola, in a recent note to the editor of the *Electrician*, says: "There are two cables landing here, one from Vigo and the other from Lisbon, both of which were, unfortunately for us, broken at the same time, the former in Vigo Bay, the other about 720 miles from here. Generally one or the other is always occupied, so that any experiments of this description are not possible, but being both idle, as well as our land line, I joined the two cables together here through a telephone. The other two ends being so far away I was curious to know what I should hear, and was very much surprised to hear Morse signals. After listening some time I found it was on the direct cable of the new French Atlantic Company, their line running from Pensacola to Brest (the cable lands about three-quarters of a mile from here), and their land line going to Pensacola by a different route from this company's. So that with no earth connection here, and none on the line except at Pensacola and Brest, I could read the signals distinctly. No doubt it was by the induced current, but that it can be perceived at such a distance may suggest to some ardent inventor uses for this very delicate instrument."

ELECTRICIAN, MAY 28, 1881.

3325. IMPROVEMENTS IN TELEPHONIC APPARATUS AND IN THE METHOD OF AND THE APPARATUS FOR TELEGRAPHING ARTICULATE AND OTHER SOUNDS, *W. Mc-cann-Brown.—Dated* 25th *September*, 1880.—6 *Communication from A. Graham Bell* (1 *to* 4*d.*

Fig. 1 shows the inventor's transmitting and receiving phelgmonic apparatus for the production of a musical sound. A rep four arm steel rod C is on a plane mirror, A, into a less, B, which brings it to a state of rest. The prongs of the rep-d at a certain point, is indicated by a perforated disc, C (see Fig. 2). As C is rotated the reps pass intermittingly through the holes in B, after which they are projected on to the less B', where they are again brought parallel, and thrown pass to the receiver E, a

thin disc of india rubber, F, in case G. This disc will be affected by the intermittent beams falling on it so as to produce sound-waves, which are transmitted to the ear of the listener by a flexible tube, I. The receiving instrument, shown at a less, I, is similarly used to concentrate the rays on F. By varying the speed of C the rapidity of interruption of the beams is equally varied, and consequently the pitch of the sound. In this form the motion which causes the interruptions is continuously in the same direction.

3° Quatrième différente des points de résistance de la couche liquide;

4° Quantité différente des points de rapprochement d'un pôle vers l'autre.

Mais il est évident que ce ne sont que quatre côtés du même fait, et ce fait est le *mouvement d'une des électrodes microphoniques*.

Il ne nous reste plus à examiner que la dernière catégorie

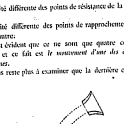

Fig. 1.

des microphones. Dans tous ceux qui sont connus jusqu'ici, la direction du courant pendant l'action de l'appareil reste la même; mais il est possible de la faire changer et d'introduire de cette manière une différence de plus dans les phases de sa fonction. Les fig. 2 et 3 représentent les deux positions extrêmes exagérées pour mieux montrer le changement; on voit la direction du courant qui arrive de la pile par deux

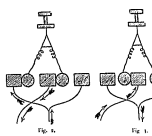

Fig. 2. Fig. 3.

fils très-fins, pour ne pas gêner les vibrations simultanées de deux morceaux réunis (sans contact électrique). En réalité, les deux boules vibrantes ne sont jamais isolées complétement d'aucun des charbons; mais il y a toujours une prépondérance d'un côté ou de l'autre. Ce microphone donne d'excellents résultats, mais sa construction est un peu difficile. Du reste, je le rends plus sensible à l'influence des mots prononcés, en ajoutant les deux morceaux sur une membrane d'une façon un peu plus compliquée.

Dans cette dernière catégorie, c'est donc aussi les points de contact qui changent et non pas seulement leur nombre.

En résumé, nous reconnaissons dans toutes les formes des microphones possibles :

1° Un mouvement mécanique des parties;

2° *Un changement dans les points de conductibilité*;

3° Un changement de résistance.

Et ces trois phénomènes essentiels, résultent l'un de l'autre. Je dis : « points de conductibilité » et non « de contact » parce que cette première expression embrasse à la fois les points de contact et la route traversée par le courant dans l'une ou dans l'autre direction. Nous voilà donc parvenus à une formule générale. Abordons maintenant les questions spéciales, et, avant tout, celle de la prétendue *amplification des sons* par le microphone.

Il est facile de se convaincre qu'elle n'existe point. *Tous les sons, consonnes ou voyelles sont toujours affaiblis par le microphone.*

Mais le microphone n'est pas seulement un appareil qui transmet électriquement les *sons*, il est aussi, et d'une manière plus particulière encore, l'appareil qui *transforme les ébranlements mécaniques en sons*, et ceux-ci peuvent être *amplifiés* dans cette transformation.

Exemples : Le tic-tac d'une montre de poche, posée sur la même planche que le microphone, quoique à une distance de 6 à 7 mètres, peut être entendu distinctement. Si cette montre est posée sur la planchette même du microphone, le son peut être entendu dans toute une chambre, parce qu'il agit, non comme *bruit*, mais comme *ébranlement mécanique*. Or cette même montre devient incapable d'influencer le microphone lorsqu'on la tient en l'air à une distance de quelques millimètres de celui-ci, parce qu'alors elle n'agit que par son *bruit*. En revanche, un faible souffle d'air, qui n'occasionne presque aucun bruit, fait l'effet d'un courant d'air, etc.

L'affaiblissement des sons articulés est d'autant plus marqué qu'ils sont plus intenses; de sorte que les sons les plus faibles éprouvent le moindre affaiblissement. Les sons musicaux simples, accompagnés d'un ébranlement mécanique relativement fort (par exemple d'un courant d'air sortant de la bouche quand on chante ou que l'on sifflé), *peuvent être un peu amplifiés* par un microphone à interruptions complètes, mais cette amplification n'a lieu que quand il s'agit de sons *faibles*.

Les ébranlements mécaniques, quoique non accompagnés de sons, *sont toujours transformés en sons*, et ceux-ci *augmentent en intensité à mesure que leur amplitude tend à interrompre le courant*. Cette interruption accomplie, l'augmentation cesse de se manifester. Un courant d'air n'agira pas plus fortement qu'un faible souffle, dès que celui-ci est assez fort pour provoquer une rupture momentanée mais complète du courant. Il y a deux limites entre lesquelles sont comprises toutes les lois des phénomènes microphoniques : la limite inférieure, où il y a naissance d'ébranlement mécanique et où le changement de contact est à peine réalisé, et la limite supérieure, où l'ébranlement interrompt le courant, indépendamment de l'énergie de cet ébranlement. Au-delà, il n'y a plus d'amplification, ni même d'articulation; mais entre ces limites, *l'intensité des sons est directement proportionnelle à l'énergie des ébranlements mécaniques qui accompagnent les ondes sonores*. Et comme les vibrations d'une ou de plusieurs parties du microphone déterminent une augmentation ou une diminution dans le nombre des points de bonne ou de mauvaise conductibilité, on en conclut que :

L'intensité des sons est directement proportionnelle à la grandeur des changements différentiels dans la résistance du microphone.

Pour que la transmission des sons articulés soit possible, il faut nécessairement que *le nombre des points de contact, les différences dans ce nombre, pendant l'action de l'appareil, et les changements de résistance qui en résultent, soient plus grandes*, C'est ce qu'on obtient dans la seconde catégorie de microphones, en réunissant de petites surfaces ne présentant qu'un seul point de contact, ou en employant des corps médiocrement conducteurs. Alors l'interruption du courant n'est que particielle, il devient modulateur, suivant l'expression de M. Hell, et plus il y a de marge dans cette interruption ou cette reconstitution partielle, plus le microphone est parfait.

Dr Julius Ochorowicz.

(*A mettre.*)

Untitled.

Sequential Telegraphicon

With a single telephone-hole, as in the right ear, the transmitted voice appears to come from a distance to the right; while with a telephone held to the left ear, it seems to arrive from the left of the listener.

With a telephone to each ear, if one ear be less sensitive than the other, or if the telephone be held further from that ear, the voice apparently shifts to the side of the other ear; and if both ears hear alike and both instruments are equally near their respective ears, the voice apparently proceeds from in front of the observer.

Nature 9 June 15. 1871.

Telephones for Long Circuits.—It has been found that wires, when employed for a telephonic circuit, are much more susceptible to disturbing causes than when employed for transmitting telegraphic signals. It has been observed that the slightest friction, such as will inevitably occur from the ordinary mode of joining telegraph wires, the closing of a pressure screw anywhere in the circuit, the slightest blow upon the wire, vibration from wind, the ordinary modes of supporting the wire, which produce no perceptible effect on the transmission of telegraph signals, are great hindrances to the transmission of voice vibrations, and thus confine the telephone to comparatively short circuits. It is thought if these hindrances could be avoided, the telephone circuit might be continued to as great a length as the telegraph—even across the ocean. Experiments are now in progress to determine all the facts connected with this matter. These experiments will involve the character, in quality and size, of the wire to be used, the best form of support, and a substitution of soldering the ends together, instead of the usual mode of joining. There is much reason for the belief that the telephone may ultimately as fully supersede the telegraph for long, as it already has for short distances.

ELECTRICITY & TELEGRAPHY

June 9 1876

Trial of Telephone.—Edison's telephone (so it is said) been successfully used over a line of 2000 miles in length. A meeting party in Delaware were thus enabled to converse with perfect distinctness with their friends in Pennsylvania, via Chicago and the Western Union Telegraph Company's line.

A Novel Use of the Telephone.—Inventor and Captain Green, of the United States Ordnance Department, the accurate determination of the time of flight of small-arm projectiles has been practically impossible at long ranges, owing to our inability to see them strike, even when firing over water. The discovery of the telephone has opened up to us a simple as well as a novel means of obtaining the time desired, and has also afforded us the means of verifying the formulæ by which three times were formerly obtained. In these experiments, two telephones precisely alike were connected (a form of Edison's carbon telephone) with a watch. One was placed within a few feet of the gun, and left open, so as to transmit the sound of the discharge. The other was in the shelter-proof, which was about 30 feet in front of the gun, and the target. A stop watch, beating fourths of a second, was used in connection with it. The telephone being at the gun, the instant the sound of the discharge was received at the target the watch was stopped. A mean of a large number of observations, which rarely differed more than a quarter to half of a second from each other, gave the time of flight. Of course there is a slight delay in starting the watch, but this is neutralized by a similar one in stopping it. The time given may, therefore, be accepted as strictly correct. It is worthy of notice that the time varies on different days, being shortened by a rear and lengthened by a head wind. The velocity of sound may be readily obtained with the telephone in the same manner. The time for the sound of the discharge passing through the air was always shown by the watch, but as it was not desirable for my purpose to stop the watch until the bullet reached the target, these times were not taken.

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HUNNING'S MICRO-TELEPHONE TRANSMITTER.*

In its crude form the Hunning's Patent Micro-telephone Transmitter was in existence about three years ago, and has subsequently passed through a long series of modifications. Its present and most approved form was designed for the patentee by Mr. Cox-Walker, of York, to embody the various improvements suggested by experience. Its outward appearance is similar to that of the ordinary Bell telephone, but the resemblance stops there. The usual mouthpiece is covered on the under side of the opening by a piece of nickel-plated brass wire gauze, which forms a protection to a thin sheet of platinum foil. This foil acts the part of a vibrating diaphragm, and is in immediate contact with a very thin layer of granulated coke, which fills a small cavity provided with a brass plate at the bottom. The platinum foil is connected to one terminal through the brass ring, and the brass plate is connected to the other terminal. The terminal wires are then passed through the hole down the centre of the handle; the latter is screwed on to the central part, and the instrument is complete. In connecting it up for use, a receiving telephone (which may be Bell's or other similar instrument) is required at each end of the line in addition to the micro-telephone transmitter, and also a battery of Leclanché or other cells. The function of the transmitter is, by the aid of the battery current, so to increase the sound given out by the receiving telephone as to make these instruments a practical success, and also to overcome by its power the effects of induction from neighbouring wires, this latter having hitherto prevented the use of telephones on wires in the neighbourhood of others along which strong voltaic currents may be passing. The success of Hunning's Micro-telephone in this respect has been undoubted, and its clear articulation and power surprise all who hear it. The loose granulated coke between the two metallic plates is the secret of this success. When the platinum foil is spoken through at the mouthpiece, the aerial waves cause more or less of its under surface to come into contact with the grains of coke, at the same time causing those particles to press more closely upon each other, thus decreasing the amount of the resistance they offer to the passage of the voltaic current through them by bringing more points into contact with each other, this action taking place in a greater or less degree in accordance with the amplitude of the vibrations of the platinum foil acting under the influence of the sonorous waves. The control which this movement of foil and coke grains exercises over the passing current is most perfect and wonderful, and it renders the use of an induction coil, which is found to be so great a necessity with all other forms of telephone transmitters—Edison's, Crossley's, and Blake's, to wit—quite unnecessary; and by the use of a special form of receiver, which is now engaging the attention of Messrs. Hunning and Cox-Walker, the effects of induction are hoped to be entirely eliminated, the experiments hitherto made by them in this direction giving promise of ultimate success. An automatic switch board, with call bell and ringing key, completes the outfit for each end of a line for telephonic purposes. The instruments were successfully tried a few weeks ago between York and Darlington, a distance of about 45 miles, the wire used for the purpose of this test trial being one of about 20 of the ordinary telegraph wires which stretch from pole to pole along the side of the railway. The effects of induction were at times most powerful, but they did not prevent the easy and successful carrying on of conversation or the transmission of ordinary railway cypher messages between the two stations.

* Abstract of Proceedings of the Cleveland Institution of Engineers.

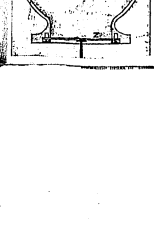
11

After all the wranglings and litigation between Bell and Gray as to the priority of the invention of the magneto-telephone it now transpires, on the authority of the United States Government, that neither Bell nor Gray were the inventors of the first magneto-telephone on record. According to the wording of the Patent Office the first claim filed for a patent on a magneto-telephone was by T. A. Edison. Why this fact, involving $1,000,000, has not before been brought to light is an interesting bit of history, and may serve as an index to the meanderings of genius and a fair illustration of the workings of the Patent Office system of Uncle Sam. The original specification was in a locked receptacle, in like fashion Edison, Bell and Gray were experimenting with telephones at the same time, and the latter three inventors, however, gave a public exhibition of their investigations until August, 1876, when Bell patented and exhibited his first telephone.

In December of the same year Edison established in Newark, N. J., an instrument for the manufacture of needles daily, and on the 18th of January, 1877, he filed a caveat in Washington his claim for a patent under the name of an acoustic telegraph, which was subsequently changed to that of telephone, reading as follows: Gray, Gray and Bell, by a singular coincidence, both on the 14th of February, the same day for patents on telephones which their last inventors, and three were the only telephones on record up to that time.

Mr. Edison at that time was in the service of the Western Union Telegraph Company, and as soon his claim to Messrs. Porter, Lowrey and Storrs, attorneys in the Western Union Building, New York, a reply was received from that the papers, as already stated, had neglected to return to Mr. Edison the official acknowledgment of the receipt of the papers from the Patent Office.

The inventions at that time, like the phonograph of Edison, had no commercial value, because it was available for sending messages only to short distances, and therefore of no quality for transmitting telegraphic currents, was at the best, imperfect. The commercial value, when discovered, as it subsequently was, by the lack of having filed his claim for his original magneto-telephone, and the neglect of Edison to look after his mind entirely, and did not examine into again until about three weeks ago, when Mr. Edison, the regular attorney for Edison in Washington, returned from a month's vacation of sojourn with his former partners, Messrs. Lowrey's lawyer by Messrs. Porter, Lowrey and Storrs. Among those papers was the discovery of the original claim filed by Edison for a magneto-telephone, the original telephone. The simplicity of its construction may be seen from the following cut:



R, receiver; T, diaphragm; C, coil; M, magnet; A, line wire.

The specification referred to in the above cut (filed and which for unknown reasons did not reach the plaintiff in the suit) is in part as follows: "The object of my invention is to transmit telegraphic messages and other sounds to a distance by means of electricity, and consists in the employment of a diaphragm, preferably of thin sheet iron, which is caused to vibrate before the pole of a magnet, around which is a coil of fine wire, in such manner that the vibrations of the diaphragm cause undulations in the current of electricity passing through the coil, which undulations are transmitted to a similar instrument at the receiving station, and cause the diaphragm of the latter to vibrate in unison with that at the transmitting station, and thereby reproduce the sounds which are uttered before the transmitting diaphragm. I am aware that it is not new to transmit telegraphic messages and other sounds by means of electricity, and do not claim such, broadly; but I am not aware that any one has previously succeeded in transmitting such sounds by means of undulations of the current produced by the vibrations of a diaphragm in the manner above described, and I therefore claim the same."

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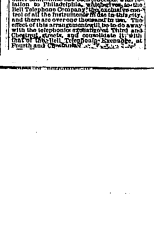

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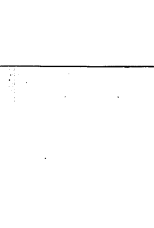


THE ATTORNEY-GENERAL *v.* THE TELEPHONE COMPANY (LIMITED).

(Before the Lord Chief Baron and Justice Lopes.)

On February 8th, in this case, Mr. Macrory, on behalf of the defendants, asked their lordships for liberty, on or before Wednesday, February 11th, to file affidavits in answer to those filed by the Attorney-General. There was an undertaking given that the affidavits should be filed by February 3rd. Certain negotiations were entered into which only terminated a few days ago, and pending these negotiations the defendants did not proceed with the affidavits. The negotiations had now been broken off, and the defendants asked their lordships for further time in consequence.

The Lord Chief Baron: I would merely suggest, Mr. Attorney, that, if it does not interfere with your other engagements, a case of such importance, affecting public and private rights, should be heard before us once and for all.

The Attorney-General: I am quite ready that such a course should be adopted, but I am anxious to protect myself against any accusation that I had been guilty of delay in the matter.

The Lord Chief Baron: I am sure no such accusation will be made against you, Mr. Attorney-General. You have the power to call upon us at any time to hear the case, and we will then appoint a day for it to be heard before three judges.

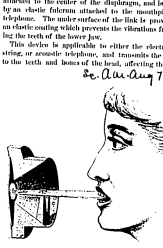
The Attorney-General: These remarks will also, I apprehend, apply to the case of the Edison Telephone Company, which will stand over until all affidavits have been filed and the evidence is completed.

DENTAL ATTACHMENT FOR TELEPHONES.

The engraving shows a device to be attached to an ordinary receiving telephone for transmitting the vibrations of the diaphragm to the teeth, to enable deaf persons to hear conversation, music, etc.

The device may be readily detached so that the telephone may be used in the usual way. A link of rigid sound conducting substance, such as wood or hard rubber, is connected with the center of the diaphragm, or with a disk attached to the center of the diaphragm, and is supported by an elastic fulcrum attached to the mouthpiece of the telephone. The under surface of the link is provided with an elastic coating which prevents the vibrations from affecting the teeth of the lower jaw.

This device is applicable to either the electric, or the string, or acoustic telephone, and transmits the vibrations to the teeth and bones of the head, affecting the auditory



DENTAL ATTACHMENT FOR TELEPHONES.

nerves, and enabling persons having defective ears to hear. This device was lately patented by Mr. H. G. Pinke, of Springfield, Mass.

Canned Salmon by the Cargo.

The first cargo of canned salmon of this year's catch, from the Columbia River, was lately cleared from Portland, Oregon, for Liverpool, England. It comprised 50,556 cases, each containing four dozen one pound cans, or their equivalent. The gross weight was over 1,400 tons. Two other ships were soon to follow, both taking nearly full cargoes. Large consignments have also been received at San Francisco, for reshipment to England, Australia, and New York. The steamer Oregon, from Portland, June 25, brought 22,556 cases, the largest invoice of the season, if not the largest single shipment ever made to San Francisco from the Columbia River.

AMERICAN MACHINES

Telegraph and Telephone Charges.

Alliance—

To any unprejudiced person who will closely this question, it must appear plain that the telegraph and telephone monopolies are standing, not only in their own light, but in that of the public. The telegraph companies started out with the notion years ago, that high charges and a small consistency were all that telegraphy had to expect, either then or in the future, and every absorption by them of a weaker rival has apparently fixed this idea more and more firmly in their minds. Acting upon this view, they have whittled out elaborate tables of rates, adding a few cents for every few miles of distance, here, there, and everywhere, as industriously as if transmitting a message 175 miles by wire really cost them a few cents more than sending one 50 miles. As a result, their tables of rates are as complicated as a war map of Afghanistan, and nobody thinks of taking the trouble to go to a telegraph counter, or of inquiring the rate (always considered a high-priced luxury) and sending a dispatch, unless under the spur of absolute necessity. The idea that telegraph blanks could be sold at a uniform price like ferry tickets, and that messages could be received and transmitted profitably to any part of the United States (east of the Missouri River) at the cost of the blank, say, 25 cents each, seems never to have entered the minds of the telegraph owners. If everybody knew exactly what a telegraph message would cost to any point, and nobody considered the rate exorbitant, every other man in the country would carry blanks around in his pocket ready for use, loan or sale, as men now carry postage stamps.

Let such a plan be adopted, and it is not too much to say, that where now one person uses telegraph facilities once a year, ten would use them daily and habitually. But the managers of this great modern invention are, strangely enough, fogyish, and afraid to try any broad gauge experiments in the way of either enriching themselves or benefiting the world at large.

The public should not lose sight of the fact, nor allow the telegraph monopolists to lose sight of it, that recent improvements in methods, actual or possible, have so cheapened telegraphy (notably the introduction of the quadruplex system, and the substitution of dynamo-machines in all the larger offices for the old plan of generating electricity by battery), that what a few years ago might have been considered an uncertain experiment, is now easily possible. The companies themselves are in no danger of forgetting that nearly all of the thousands of small offices at railroad stations throughout the country are run with little or no expense to themselves, as the operators are paid and the wires largely maintained by the railroad companies.

And so with the telephone. Its managers started out with too much capital than would suffice to run a wholesale grocery business, and think themselves rich because this capital has appreciated ten times in value. In New York they charge $90 per annum for the use of an improvement which could readily be afforded at $2 per month. As a result, one firm in fifty, and about one family in five hundred use it. The privilege of talking through the telephone should be as cheap and as universal as the use of coal gas or Croton water. And so it is elsewhere—like city, like country. From present appearances, the telephone companies bid fair in be decades of years in introducing an invention, which but for the exorbitant rates at which it is offered, would be eagerly adopted by the whole people within a few months, on account of its convenience and intrinsic merit.

Long Distance Telephoning.

To the Editor of the Scientific American:

Noticing an article in your issue of January 17, 1880, entitled "Long Distance Telephoning," I would like to say that nearly six months ago, in connection with the Western Union Managers at Marlor, Fort Wayne, Ind., and Defiance, Ohio, I talked with . much ease and clearness as ordinary conversation is now carried on in this city and suburbs by the instruments mentioned in your article, the distance being 160 miles; after which Toledo, Ohio, was put in the circuit, making in all over 300 es. The lines used were those of the Western Union Telegraph Company, and as such subject to many conditions as are likely to be met with in nearly any part of the country. The instruments were the Edison carbon transmitter and the Phelps pony crown telephone as receiver, the same as now provided by the Gold and Stock Telegraph Company, of this city, no special adjustment or preparation being made. The future of long distance telephoning is now resting at our doors.

LONG-LINES.

New York, January 16, 1880.

A Novel Extension of the Use of the Telephone

is reported from London. It consists in making the loud-speaking telephone of Mr. Edison—which embodies the principles of the electro-motograph—automatic by employing his small electric motor to turn the chalk cylinder. *Times* newspaper offices, and that a large number more are in preparation for the same establishment. The utility of this arrangement consists in the fact that the reporters of the paper, instead of dictating their short-hand notes to copyists, and transcribing the long-hand copy to the printer, simply read them directly to the telephone, thus saving the time of copying and carrying the report. The operator sitting at a type-setting machine in the printing-office, sets the type as one would play on the piano, as the words are transmitted to the automatic telephone. The saving of time on the compositor's account, as he has no copy to decipher, and other noteworthy utterances in the course of recent date makes the text of an enthusiastic sermon on the future of electricity, in which by the use of automatic and autographic telegraphy. "The indications are, that [illegible] with stenographic type-writing operating in conjunction you-must be almost instantly transmitted through long distances and at a fraction of the expense which such work now involves. Such inventions open up lines of progress too far-reaching for the boldest imagination to follow."

CONVENIENCE IN TELEPHONY.—A correspon[illegible] of the Manchester papers calls attention to a feature in telephonic [illegible] which has hitherto escaped public notice, but which, if [illegible] against, may give its way. The greatest advantage in this case [illegible] of the case of letter carrying, will probably prove to be [illegible] the adoption of a very enlightened monopoly. One firm, say, under the competitive system adopts one system, a second adopts a second system, a third a third, and so on. No. 1 wishes to converse with No. 2 or No. 3, but is unable to do so. Will the Gower give way to the Edison, or either to the Bell Telephone Company? Not so; they will get who have the power, and they will keep who can. The extract below is a portion of the letter we have referred to:—"It has been asserted several times that the 'induction' difficulty has been overcome; but if it is so, why don't we see the result of the discovery by all the wires being hung in some kind of order. As to the danger of falling wires, there is a light description of copper wire now being extensively used by Mr. Warburton, telegraphic engineer to the Lancashire and Yorkshire Railway Company, which is most suitable for street purposes, because if it falls it will not hurt anyone, besides, being so light it causes no strain on chimney stacks, and does not damage roofs when falling or being dragged along same, like the present heavy coarse iron wire. This is a very important matter to owners of property who allow wires to be attached to their places; but if the 'induction' difficulty has been overcome, the time has arrived for a wealthy corporation like Manchester to provide an iron pipe easily opened from the top, along the footways of all the chief streets, to contain all the telegraph and telephone wires. It might be made something like the water channels in Paris, and each company or owner of a 'set' of wires, if deemed necessary for extra protection, could cover them with metal, similar to a submarine cable, then all the unsightly overhead wires could be swept away. There is another matter of very great importance that should be taken up at once by the Chamber of Commerce, and that is the 'muddle' that will ensue owing to having two Telephonic 'Exchanges.' For instance, Mr. Smith, at his Ardwick Works, decides to have a connection with the 'Edison' Exchange, because on the other side of the town he has half-a-dozen firms he would frequently like to talk with; but when his wire is finished he finds half his friends have used the 'Lancashire' Exchange, a different building, and using a different instrument, so that Mr. Smith only gets half the value out of his venture. The companies should either amalgamate or choose separate towns, though the latter mode would only prove a temporary relief, as the time is not far distant when the merchants of one town will chat with those of another, notwithstanding the Government telegraphic monopoly of the present day."

THE TELEPHONE.

A Description of This Interesting Invention of Pittsburg Electricians.

Much interest has been excited in the recent invention of Messrs. Connolly Bros. & McTighe, the Pittsburg electricians and electricians, which was briefly mentioned in a Dispatch special yesterday. The claim made is the ability to transmit the physical wave force of light, electricity, similar to the transmission of sound by the telephone. It having been demonstrated that electricity is a creation of solar light, the principle bearing this invention is the transmission of electricity back again into light and, in the case of underground, the reproduction at the point of destination of the object submitted to the action of the solar or powerful electric rays at the point of transmission. It is claimed by Mr. McTighe, with whom our reporter conversed, that the principle involved in the new invention is sufficiently perfected for practical use it will be possible for one of the most interesting, or telephone to perform electric miracles, such as those the tongue of the person with the telephone to his ear, the practical utility of the invention will, however, be more thoroughly appreciated when it is known that by its means it will be possible to be able to transmit instantaneously from point to point, any written or printed document, picture, miniature, one entire city or a newspaper.

The reproduction of the image is the result of chemical changes which are now utilized in the science of photography and are perfectly familiar to every student of chemistry or of science and art. The inventors began their investigation of the subject several months ago, and have since been working with a firm attempts made at the development of the telephone. In order to be able to work undisturbed, they removed to the top of the Oakland, the Washington block of the above firm, took up the subject of photography as employed in connection with the telephone, and have made new plates and discoveries during the past few months which have electrified away at Washington, with proof of same, so that they are fully prepared to turn over the invention to the public, and will not be efforts be made to disturb the secret.

The comparative impracticability of the telephone for long distances at present lies in the fact that it requires a powerful battery to transmit the image. The telephone, like the telephone, requires but a single wire, is well transmitted, the image of any object however small, and the reproduction at the point where is magnified at the receiving point, before the reproduction in the required size.

The inventors have, in their experiments so far been able to reproduce, clearly and faithfully to a dark room at his residence, the image of persons at the other end of the line or in a room in another part of the house, and that with the telephone is yet in its infancy, of its ultimate perfection and utility there can be no doubt whatever.

SCOTTISH TELEPHONIC EXCHANGE.—The prospectus of this company contains the information that telephone exchanges are in general use in eighty-five of the principal towns of the United States. In Chicago, as has been previously stated in *The Electrician*, there are over three thousand members in communication. The first telephonic exchange in this country was started in July, 1879, at Manchester. It is also stated that the time required to put two members in communication does not exceed half a minute. It may be useful here to make a statement, and ask our readers if they can supply any corroboration to the story. A gentleman assures us that the string telephone was in use in Ceylon quite twenty-five years ago, and that it was to be seen in business houses.

THE GOVERNMENT AND THE TELEPHONE.—A correspondent has written to *The Times*, pointing out that in America the telephone exchanges help the telegraph companies by connecting up villages to their systems which would not be able to support a regular telegraph office.

—A patent has been applied for, by Mr. J. D. Husbands, as agent of Edison, for certain improvements in the telephone. It is proposed to connect friends' houses by wires. What a nice thing for the ladies!

—The telephone [illegible] between the American Union Telegraph Company [illegible]

LONG-DISTANCE TELEPHONING.—A recent trial of Bell's telephone between Dayton, Ohio, and Indianapolis, Indiana, proved that it is quite suitable for talking distances under 100 miles in the United States.

THE TELEPHONE IN WHEATSTONE'S BALANCE.—Herr Niemiller employs a telephone instead of a galvanometer in the bridge wire when measuring the resistance of liquids, with a gain in delicacy. An induction current is used, and it is found that when the galvanometer gives no deflection the telephone gives a distinct sound.

THE GOWER TELEPHONE.—As we mentioned in our last issue, the Gower Telephone Company are to use a microphonic transmitter for working their apparatus. The arrangement of this transmitter is shown by the fig.; it consists of 6 microphones formed of 6 carbon rods, the outer ends of the latter are set in carbon blocks fixed to metal plates, to which the connecting wires are attached, as shown; the 6 inner ends rest in a single carbon block on the centre of the arrangement. The whole is secured on a wooden board against which the sound waves impinge. The system in fact differs

but very slightly from Crossley's microphonic transmitter which was described in the number of the Journal for May 1st, 1879.

Hiram Abiff 17
Ohio. No. 19. Vol. 12
June. 1881.

Danger of Lightning From Telephone Connections.

The Cantonal Government of Zurich, having been applied to by a telephone company for permission to fix the supports of insulators on the tops of certain public buildings, applied to Prof. Kleiner for an opinion. The following is a summary of the chief points in his report.

1. The danger of lightning in houses over which telephone wires are stretched is not increased, but lessened, if the total conductivity of a wire is approximately equal to that of a lightning conductor. This condition is not always fulfilled under existing arrangements. It may be lessened by very simple arrangements, such as the introduction of a special wire for the conduction of lightning wherever the number of wires of two millimeters in thickness running in the same direction is less than sixty. This should be insisted upon in all cases. Single connections running along the houses should be stronger than at present—at least as strong as telegraph wires.

2. As the properties of a telephone adapt for attracting and conducting lightning extend over far wider tracts than those of a lightning rod, a strict regulation of their make and condition is necessary.

The use of telephones should be suspended during thunderstorms.—*Neue Zurich Zeitung.*

Extreme Sensitiveness of the Telephone.

Mr. W. H. Ash, writing from Penzance, in a recent note to the editor of *The Electrician*, says: "There are two cables landing here, one from Vigo and the other from Lisbon, both of which were, unfortunately for us, broken at the same time, the former in Vigo Bay, the other about 750 miles from here. Generally one or the other is always occupied, as that any experiments of this description are not possible, but being both idle, as well as our land line, I joined the two cables together here through a telephone. The other two ends being so far away I was curious to know what I should hear, and was very much surprised to hear Morse signals. After listening some time I found it was on the direct cable of the new French Atlantic Company, their line running from Penzance to Brest (the cable lands about three-quarters of a mile from here), and their land line going to Penzance by a different route from this company's. So that with no earth connection here, and none on the other line except at Penzance and Brest, I could read the signals distinctly. No doubt it was by the induced current, but that it can be perceived at such a distance may suggest to some still further uses for this very delicate instrument."

JUVENILE LECTURES AT THE ROYAL INSTITUTION OF ARTS.

The first of two lectures, by Mr. W. H. Preece, M.A.C.E., adapted to a juvenile audience, was delivered by that gentleman on last Thursday evening at the Society of Arts, Johnstreet, Adelphi. The lecture was strongly crowded, the audience being composed for the most part of children and friends of members of the society, who listened very attentively to the interesting remarks of the lecturer, and frequently testified their pleasure by vociferous applause during lengthy pauses. The lecture was on "Recent Wonders of Sound," and, as promised, it was fully illustrated, explanatory diagrams being suspended from the wall of Hoyer's, Bell's, and Edison's telephones, Edison's phonograph, Mr. Hounsfield's phonoscope, and Crossley's telephonic transmitter, which, by the kindness of various firms, were made by the lecturer to demonstrate his remarks in a practical manner. In the various experiments carried out Mr. Preece was assisted by Messrs. Sivewright, Mr. Stroud, Mr. Leish, and Mr. Wilson. At the outset of the proceedings, Mr. Preece said he had nothing of a very novel character to bring before them, his object being, in fact, to introduce the mind of young people into that old fact that the advances in science had been chiefly attributable to the application of facts, which had become new facts to light. Doubtless they had all at one time or other made simple experiments in connection with the phenomena of sound, and he had done any practical reference or learn any lesson from it and now it was to exercise their memories as well as their hands and eyes, and to show them not only how to set their cases. Sound was recognised by the vibration of matter, air consisted of molecules, of which there were millions and millions in the room in which they were then assembled. He then showed how the molecules were set in motion, and how sound was produced, by sending a beat which he had previously filled with smoke, by forcing on a whistle, and by acting in similar manner on a jar of a few inches away from the leftmost. Every time he threw these molecules into vibration by speaking or making any noise the sensation called sound was produced. Referring to the speed at which sound travelled, he remarked that that was the reason why there were such things as echo, in which sound travelled at the rate of 1,100 feet per second in wood. The velocity of those molecules through the air was very interesting. It was very complicated to explain on account of the various ways by which they set in motion. Sometimes made by the compression of a column of air, by which they were affected by the motion of the molecules, a note or the noise from a pistol, separate qualities. First, the pitch of a note, or the noise from a pistol, was produced by the number of vibrations per second, by forcing on a whistle, and by acting in similar manner on a jar of a few inches away from the leftmost. Every time he threw these molecules into vibration by speaking or making any noise the sensation called sound was produced. Referring to the speed at which sound travelled, he remarked that that was the reason why there were such things as echo, in which sound travelled at the rate of 1,100 feet per second in wood. The velocity of those molecules through the air was very interesting. It was very complicated to explain on account of the various ways by which they set in motion. Sometimes made by the compression of a column of air, by which they were affected by the motion of the molecules, a note, or the noise from a pistol, separate qualities. 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TELEPHONY.

The Postmaster-General has at length decided to grant licenses to different companies to establish and operate telephonic exchanges throughout the Kingdom. This license confers no special power to erect poles and wires on or under any public highway or private property. Licensees will have to make their own arrangements with the local authorities, and any persons whose property may be affected. Nor does the license confer authority to carry on telephonic business with any instrument which is an infringement of existing patent rights. This result will cause general public satisfaction, as there has been a growing feeling of late that the changes of the company now possessing exchanges are higher than is desirable. Competition will have the effect of reducing those rates. Already we hear of at least one opposition company about to appear, and doubtless others will in time follow. In connexion with this subject we notice that the disclaimer of the phonograph from the Edison telephone patent has been allowed by the Attorney-General.

LONG DISTANCE TELEPHONING.

In a recent Note we gave an account of the plan employed by M. Van Rysselberghe for suppressing induction on long telephone lines. The method has, we understand, been recently tried in England between Peterhead and Victoria Station on a mail-line wire, and found to give satisfactory results. The experiments were carried out by the engineer of the United Telephone Company, Mr. T. Fletcher. The arrangement consisted in putting electromagnets between the signalling key and the line on those telegraph wires running alongside the telephone wire. The ordinary Morse signals were thus "softened" in such a way as to prevent their induction on the telephone wire making a disturbing sound in the telephones. The telephones could also be connected to the wire carrying the Morse signals, so that a Morse and a telephonic message traversed it together. This was done by employing the electro-magnet as before, and inserting condensers between the telephones and the wire. The obvious drawback to this system of Mr. Van Rysselberghe is that the telegraphic and not the telephonic lines have to be manipulated. As in this country the telegraph lines are in the hands of the Government and the telephone lines in those of a private corporation, it necessitates a combined action which is unlikely to take place, more especially as the insertion of electro-magnets into the telegraph circuits is calculated to retard the speed of working of the lines. A better solution of the difficulty would be an arrangement which abolished the telephone itself from the effects of induction from without. While upon this subject we may advert to the recent report that the bombardment of Alexandria had been heard through the Abyssinian mountains, a distance of 1000 miles. This is obviously not correct, for the inductive retardation on so long a cable would undoubtedly obliterate the simultaneous currents necessary to produce the sound of the bombardment. The fact that speech was not transmitted is itself a proof of this. What was probably heard, if anything was heard at all from Alexandria, was the effect of the mechanical shock to the transmitter at Alexandria produced by the concussion of the guns. The recent telephonic trials of Mr. Van Rysselberghe over a cable many miles long, though attended with success do not prove much either, for 60 miles is but a short cable, and is comparable with a long land line. Though the telephone is heard through 60 miles of cable, 100 miles would probably absorb the sound, since the inductive retardation increases as the square of the length. Some time ago the telephone was tried successfully on a longer cable, namely, one of 75 miles, at Bongnes, but we have not heard of artificials speeds traversing 100 miles of cable.

une chambre frigorifique à la Vougre de Paris. Les hommes comptents ont eu effet le droit d'être employés concurremment aux machines actuellement connues, la production du froid par l'évaporation des liquides volatils est beaucoup plus économique que cette obtenue à l'aide de la compression de l'air qui nécessite une installation mécanique considérable. La Commission assistera par le poids de la Seine contient le centième. M. Th. Tellier démontre qu'elle a été obtenu en retenu, ce qui, assurément, est bel et bien réel.

Un refroidissement progressif du phylloxera en France jusqu'à son anéantissement, par A.-L. Rivoil. 1 broch. in-8°, Poitiers, 1879.

La création évolutive, par le comte Branda. 1 broch. in-8°, Toulouse, 1879.

Hiberat et le camp romain sur la frontière romaine, par Camille Bellot. 1 broch. in-8°, Versailles, 1879.

Carnet de l'officier de service. Agenda valet mémoire du service et renseignements à l'usage des officiers de la marine militaire et de la marine du commerce, 2e année 1880. 1 vol. in-32, Paris, Berger-Levrault et Cie.

Les oscillations polaires et les températures géologiques. Nouvelles considérations, par Jules Plocque. 1 broch. in-8°, Paris, Germer-Baillière et Cie, 1880.

Le tunnier sous-marin étudié d'après les observations faites de 1875 à 1879, à l'observatoire de Zi-ka-Wei (Chine), par le P. Marc Becherens. 1 broch. in-4° avec planches. Zi-ka-Wei, 1879.

La Nature 1880

LES COMMUNICATIONS TÉLÉPHONIQUES

AUX ÉTATS-UNIS

Si l'Amérique est le pays des réclames invraisemblables, elle est aussi par excellence le pays des applications pratiques. Alors qu'une se donne à peine en France de ce que peut être un service de communications téléphoniques, on compte actuellement dans le Nouveau Monde, 85 villes qui se servent journellement de ces installations. A Chicago il y a 2000 abonnés, 600 à Philadelphie, autant à Cincinnati, un nombre sans cesse croissant à New-York, et le chiffre de personnes abonnées aux Compagnies téléphoniques dans l'Amérique dépasse 70 000. A Paris, il ne s'est pas fondé moins de trois compagnies dans le but d'établir de communications téléphoniques à l'instar de l'Amérique; la première avec le téléphone Edison, la seconde avec le téléphone Bell et le transmetteur Blake, la troisième avec le téléphone Gower. Cette multiplicité de compagnies a rendu les futurs abonnés hésitants, et par suite fort réservés; il y a eu tentative de fondation d'une association nouvelle. Les installations téléphoniques ne sont encore qu'en voie d'organisation, et nous n'avons pas à en parler, du moins pour le moment. Chose à noter, car elle est rare : dans l'espèce, la concurrence fait l'application, et il en sera ainsi jusqu'à ce que, par des moyens que nous n'avons pas à examiner ici, on arrive à une entente que nous souhaitons bien vivement pour notre part, car la question présente un intérêt et un avenir immenses à tous les points de vue.

Transportons-nous à New-York par la pensée et voyons comment fonctionne le service du téléphone.

Si nous pénétrons au milieu de la grande salle du bureau central du *Merchant's Téléphone Exchange*, établi 198, Broadway, fig. 1, nous verrons une série de rectangles emplissés, occupés à établir les communications entre les abonnés. Là c'est un switchman correspondant avec un des abonnés qui a appelé (fig. 2); plus loin c'est un autre employé occupé à relever le signal d'avertissement (fig. 3). Dans la ville, chez l'abonné, est le *téléphone de bureau*, tel qu'on l'installe dans un grand nombre de maisons (fig. 4); ce modèle est très commode pour les affaires, car il permet de parler dans l'embouchure d'une plaque à gauche, d'écouter avec le téléphone, placé à droite pour l'appliquer à son oreille, et en même temps de prendre des notes sur le papier que la main restée libre.

Avant de suivre la série des opérations qui constituent un appel complet, examinons rapidement le système de téléphones employés dans le bureau de Broadway.

Ce système appartient à la classe des *téléphones à pile*, ce qui permet d'utiliser ces piles pour faire les appels chez les abonnés, à l'aide de sonneries ordinaires, sonneries représentées sur le poignet de la figure 4.

Transmetteur. — Le transmetteur est le téléphone à charbon d'Edison[1], fondé sur les variations de résistance électrique produites par les variations de pression qu'exerce la plaque frappée en parlant devant l'embouchure. Le circuit est fermé par la pile, — 2 éléments Leclanché — le transmetteur et une petite bobine de induction d'environ cinq pieds. Il constitue le circuit primaire de la bobine. La ligne et le récepteur de l'autre poste, sont reliés au fil secondaire de la bobine. Il doit donc être terminé est relié au récepteur du poste et à la terre. Il en résulte que les courants de ligne sont les courants *induits* par les variations d'intensité du courant qui traverse le fil primaire de la bobine. Cette disposition a pour effet de transformer en courants de tension les courants ondulatoires des trans-metteur, de les rendre moins sensibles aux variations de résistance de la ligne, de faciliter la transmission et de supprimer partie des communications, dont le maintenant pourrait causer des erreurs.

Récepteur. — Le récepteur est un téléphone Phelps, analogue au téléphone Bell, mais dont l'aimant est retourné en forme d'anneau, ce qui rend son maniement assez facile (fig. 4).

Dans la position de repos ou d'*attente*, le téléphone est pendu à son crochet, et par ce fait seul,

[1] Voy. *la Nature*, table des matières des années précédentes.

dans le sifflet A, *fixé à demeure fixe* sur le corps du téléphone, il transmet ses vibrations dans la chambre qui se trouve en dessous de la membrane vibrante. De la sorte on évite toute fausse manœuvre, on ne doit parler quaprès avoir reçu le coup de sifflet-avertisseur. Chacun doit agir ainsi. On écoute en portant un téléphone à chaque oreille.

La correspondance terminée, on dit sur repos, et les deux *fiches* mettent chacun la manette dans cette position, pour attendre un nouvel appel. Chaque poste, lors qu'il transmet, *peut sans en avertir*

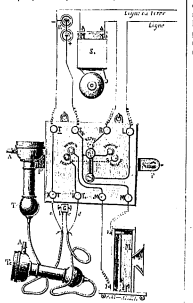


FIG. 1. — Poste téléphonique de M. Bourseul.

son correspondant, se servir du microphone transmetteur; il lui suffit de placer sa manette sur *microphone*, et, si lui-même veut entendre dans son propre téléphone, les sons qu'il transmet par son microphone, il lui suffit encore, sans aucun avis, de placer sa manette à cheval sur les deux goutfes, *téléphone microphone*

Les téléphones, au repos s'accrochent en PP. En résumé, ce poste est *simple*, sa manœuvre facile. L'*appel par sonnerie* est ainsi prolongé et aussi puissant qu'on le désire; la sonnerie d'appel peut être placée loin des téléphones dans des pièces de service; plusieurs sonneries peuvent être placées à différents endroits; toutes on isolement, à volonté, par le jeu de commutateurs bien connus, peuvent recevoir cet appel. Ce genre d'appel par sonnerie, doit donc être préféré à tout autre, à cause de sa simplicité.

Le téléphone employé dans le poste que nous venons de décrire et qui est dû à M. Bourseul, ne diffère des systèmes connus que par une complication spéciale de l'embouchure (*fig.* 2), et l'addition d'un *sifflet-signal* fixe. L'embouchure étant métallique; elle n'est plus soumise aux variations hygrométriques, qui, dans les téléphones à embouchure de bois, agissent constamment sur le serrage de la membrane M, et par suite, modifient le réglage et la sensibilité du téléphone. Ces vibrations ne se produisent plus avec l'embouchure métallique, elle reçoit la membrane M, laquelle est maintenue par une bague de laiton, par le *serrage* même de l'embouchure. Ce serrage de la membrane est ainsi très régulier sur toute sa circonférence. Un sifflet A, placé à demeure fixe sur le corps du téléphone, transmet ses vibrations dans la chambre qui se trouve en dessous de la membrane M. Chaque fois qu'on a fini de parler on avise son correspondant en sifflant en A.

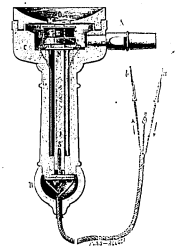


FIG. 2. — Téléphone employé dans le poste précédent.

Ce signal convient est très efficace, il s'entend bien et il évite les fausses manœuvres dans la correspondance téléphonique.

On voit que le téléphone se complète chaque jour par des dispositions ingénieuses qui en font un instrument tout à fait pratique.

PREACHING BY TELEPHONE.—*The New York Mercantile Journal* of the 24th ult. gives a report of a sermon preached by Mr. Beecher, with two transmitters under the pulpit, connected through the Central Office of the Bell Telephone Company with about fifty different places in and about the city. One of the places connected was in Elizabeth, New Jersey, some 15 miles distant, where a large party were assembled to witness the experiment. Here, it is said, the success was perfect. All the morning service, including the singing, the prayer, the reading of the Scriptures, and every part of the sermon, was heard as distinctly as at all the other places, worshipping in Plymouth Church, At Newark, and at some places in this city, the results were quite effective, but the sermon was not in every instance heard so distinctly as in Elizabeth. The trial was repeated in the evening and was just as successful as in the morning. The *Journal* describes this as the beginning of what may yet turn out a new era in church-going and concert-going.

Le téléphone vient de recevoir en Angleterre une application très-importante. Chacun connaît l'obligation de parler de son utilisation à la reproduction, dans le *Times*, des débats parlementaires de la Chambre des Communes et des Lords. Ces débats, comme on sait, ont lieu la nuit et se prolongent souvent jusqu'à une heure très-avancée de la nuit.

La composition, c'est-à-dire l'assemblage des caractères d'imprimerie qui forment un journal de l'importance du *Times*, n'est pas une petite affaire et l'on ne peut s'en rendre un compte à peu près exact que lorsqu'on a certaines connaissances de la matière. L'ouvrier typographe habile, posant les lettres à la main, ne peut, en général, en moyenne, dépasser 40 lignes par heure, ou un maximum de 50 lignes, pendant de courtes périodes de presse extrême.

Pour remédier à cet inconvénient, une machine a été substituée au travail manuel dans la composition du *Times* — depuis 1871, croyons-nous. Nous ne décrirons pas la machine; nous nous contenterons de dire qu'elle met elle-même les caractères en position, au moyen de touches que l'on frappe, comme les touches d'un piano. L'ouvrier suffisamment exercé peut composer en moyenne 100 lignes par heure, même quand il compose sur un manuscrit qu'il doit lire lui-même; cette rapidité peut être beaucoup plus grande et presque doublée, s'il est assisté d'un lecteur qui lui dicte la composition.

Par cette combinaison, on obtenu de remarquables facilités pour publier les manuscrits qui viennent très-tard, et, l'on donne à la composition presque jusqu'au moment où l'on met sous presse.

Mais avant tout, il faut avoir la copie, c'est-à-dire le manuscrit, et par conséquent, laisser aux personnes chargées de reproduire les débats parlementaires le temps de transcrire leurs notes sténographiées et de les envoyer au journal. Un temps précieux était perdu par ce fait. Pour y remédier, le *Times* a eu recours au téléphone, comme moyen de transmission, et a obtenu l'autorisation d'établir une communication, par un téléphone, entre la Chambre des Communes et son imprimerie.

Les notes prises par le *reporter* sont lues directement au téléphone, dans des galeries voisine du lieu des séances, et le compositeur, assis à sa machine, dans l'imprimerie, recueille les mots à l'autre extrémité de l'instrument. Des signaux très-simples indiquent qu'il est prêt à recevoir le message, qu'il l'a reçu, l'a compris, etc., ou bien que la transmission est incomplète et qu'il y a lieu de donner des explications.

Dans cet ordre d'idées, l'application téléphonique est encore à son début, et des modifications viendront bien certainement l'améliorer; cependant, les résultats obtenus sont très-appréciables et suffisent pour montrer ce que l'on doit en attendre.

Quelque avantage que présentent les moyens de publication rapide adoptés par le *Times*, il ne faut pas perdre de vue qu'ils ont l'inconvénient de ne pas permettre au reporter qui transmet un discours de vérifier l'exactitude du texte et d'y opérer les corrections même les plus nécessaires, qui ne peuvent manquer de se glisser dans une transmission aussi rapide.

THE AMPLITUDE OF TELEPHONIC VIBRATIONS.

The amplitude of the vibrations of a Bell receiving telephone have been ingeniously measured by M. G. Sabt. To the iron diaphragm of a Bell telephone he fixed a little disc of glass weighing 0.45 grammes, and in front of it placed a second, the first. The arrangement it will be seen resembles Finzee's plan for studying dilatations. When the telephone is spoken to direct, at a distance of 15.0, or 20 th., or when a current is sent through it from a good transmitter, such as Bottachio's, which requires no battery, the rings are seen to lose their distinctness, and disappear if the voice is raised a little. The rings, in fact, vibrate in correspondence with the diaphragm of the instrument, and it is easy to calculate from the displacement of the rings the amplitude of the telephonic vibrations. To estimate the displacement of the rings, a turning disc perforated with holes like a phonautograph, is placed before a receiver which is caused to emit a continuous note. For a certain speed of rotation the rings reappear with distinctness. If then, one blows through the disc so as to make it act like a syren, one demonstrates that the sound produced is in unison with that transmitted by the telephone. If it is lowered or raised slightly, the rings oscillate, at first gently, then with such rapidity that they become invisible. Whilst they oscillate their displacement can be estimated. In one experiment made by emitting in the transmitter the "A" of the diapason, or the vowel "a" with moderate intensity, the displacement was equal to the distance between two consecutive rings. This corresponds to an amplitude of the telephone plate of from two to three ten-thousandths of a millimetre. When the displacement is not equal to the distance between two rings, the brightness of the ring taking a point of the glass plate as zero, will give an estimate of the strength of current in the telephone.

RECENT ELECTRICITY.

At the suggestion of one of the proprietors of this journal

—Mr. A. E. Beach—a series of interesting experiments relating to the electrical transmission of sound has lately been commenced in this vicinity, which seems likely to lead to a variety of useful results. The introductory experiment the Scientific American editor and Mr. Beach's dwelling, in the upper part of this city, were connected by wires with the auditorium of Plymouth Church—Rev. Henry Ward Beecher's—in Brooklyn, N. Y., and three points were also telegraphically joined by the wires of the Bell Telephone Company and those of the Gold and Stock Company, the electrical circuit being thus enlarged and ramified in all directions, communicating with offices and dwellings in New York, Brooklyn, Jersey City, Newark, Orange, Elizabeth, Yonkers, and other adjacent places. One object of the experiment was to determine approximately through how many united circuits and lines the voice of a public speaker might be simultaneously transmitted.

At Plymouth Church, in Brooklyn, the wire passed under the floor to the platform or pulpit, where it connected with two of the well known Blake transmitters, arranged upon a shelf under the speaker's desk. The general arrangements for the experiments were under the charge of Mr. Frederick C. Beach, Ph.B., of the Scientific American office.

When it became known at the Bell telephone office in Brooklyn that experiments were to be tried, the interesting news soon spread to all of the other telephone offices, and the various operators not only called into the offices parties of their friends to enjoy the treat, but gave notice to numbers of private persons having communicating wires, who in turn invited friends to their dwellings. Thus at many points on the great ramification of connecting wires were groups of persons waiting, with telephones at their ears, to hear the words of the distinguished speaker. At one of the stations fifteen telephones were in this way connected, the instruments being joined by wires, just as a circle of people join hands in sharing an electrical shock.

The first experiment was made on Sunday, April 18, and was on the whole perhaps more successful than could have been expected. The telephone listeners stationed in Brooklyn, and nearest the church, were enabled to hear the service with much satisfaction; but those in New York, Yonkers, and Orange, N. J., only heard the music and portions of Mr. Beecher's sermon. It was concluded on the whole that there were too many telephones in circuit; and it was subsequently ascertained that the wire leading to the church had been surreptitiously tapped where it passed over a dwelling, a ground made on the tin roof, and a considerable number of telephones smuggled in.

On the following Sunday, April 25, another trial was had, precautions having been taken not to allow so many tapping liners or instruments in circuit. Special care was also taken by Mr. Adee, the adjuster of the Bell Telephone Company, to give the most perfect adjustment to the transmitting instruments at the church. The result was most successful and marvellous.

From the opening note of the organ prelude to the last word of the preacher's voice, at the close of the service, everything was delivered to the ears of the listening telephoners in the most perfect manner, the tones that came over the wires being so full, round, clear, and distinct, it almost seemed to the hearers in New York, Yonkers, and Elizabeth as if they were stationed within the church itself directly in front of the speaker.

The delivery of the music was equally perfect, every note of the organ and of the individuals of the choir being fully brought out. The majority of the listeners in this experiment were persons accustomed to the use of the telephone, and their unanimous verdict was that the results obtained far surpassed anything of the kind within their previous experience.

In consequence of the successful progress of these experiments, several new improvements have been suggested for trial, and there seems to be every probability that in a short time some new and very effective instruments will be in use, by which all who desire may carry the sounds of church services into their dwellings, and may also enjoy the best lectures, musical and other entertainments with the utmost satisfaction in their homes. Hereafter, in listening to the telephone, it has required effort and strain of the ear on the part of the listener. But this experiment shows that all sounds may be delivered in full and easy tones, readily heard, with all the natural characteristics, modulations, and lusciousness of the human voice.

We shall keep our readers informed of the further results accruing from this series of experiments. With the continued co-operation of the various electricians and managers of the lines it is believed that something of value to science may be adduced.

The progress and success of the experiments up to the present time have been greatly promoted by the active interest taken and assistance rendered by the gentlemen connected with the several telephone companies, to all of whom we return our sincere thanks. We are under especial obligations to Mr. C. P. Wiley, Superintendent of the Gold and Stock Company; to Mr. H. R. Butler, Secretary of the company; to Mr. T. G. Ellsworth, Electrical Manager of the company, through whom the experimental circuits were in the first instance arranged; to Mr. Henry W. Pope, Superintendent of the Bell Telephone Company; to Mr. E. T. Greenfield, Assistant Superintendent; to Mr. C. N. Chinnock, Electrician of the company; to Mr. H. M. Adee, Adjuster of the company; to Mr Robert Brown, Superintendent of Construction; Mr. Grinstead, of the Orange office; Mr. Alfred Hanford, manager of the Brooklyn office, Mr. Charles Walton, manager of the Nassau-street office, N. Y. Mr. R. W. Macgowan; to Col. Wm. H. Paine, C.E., and to C. C. Martin, C. E., Assistant Engineer of the great Suspension Bridge between New York and Brooklyn, for permission to lay a temporary experimental wire across the foot bridge.

Engineering Dec 4. 1883.

The *Electrician* (New York) for October contributes to the Bell owner Hels controversy a letter from Mr. H. C. Beck, enclosing one from Mr. H. F. Peter, a teacher of music in the village of Friedrichsdorf, which was for many years the home of Philipp Reis, and which contains the Garnier Institute, where he was interested in physics. Herr Peter states that he was present at Reis's experiments, and can testify that precisely speech was actually reproduced by the telephone. He says that many members of the "Physikalischer Verein," of Frankfort-on-the-Main, were also present.

A trial of the system of signalling by electricity was recently made on a portion of the New York elevated railway, which has been equipped with the apparatus for keeping trains 300 ft. distant from each other. Each locomotive carries a small chrome battery, wound for electromotive force, and the current is continually flowing, making a closed electric circuit as a mode of operation. Two of these were placed upon the line, one soon after one of them came within 300 ft. of the other; it started automatically a signal, which caused a bell to ring in the cab of the other locomotive; and it continued ringing until the first engine had moved on out of the 300 ft. circuit. No further details or explanations are given.

LE MICROPHONE

APPLIQUÉ A LA MÉDECINE

22 Mars 1879

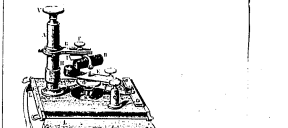
On a souvent parlé de l'importance que le microphone pourrait offrir au point de vue médical; il ne nous paraît pas nécessaire d'entrer dans des développements à ce sujet; nous nous bornerons à faire connaître un instrument récemment construit, et qui nous paraît de nature à être recommandé.

Dans une dernière séance de la *Société de biologie* M. le docteur Bondet, de Paris, a donné la description d'un microphone très sensible, monté sur un double ressort de sphygmographe, et qui lui a servi à faire des recherches intéressantes dans le service de M. Charcot à la Salpêtrière. Le petit volume de cet instrument le rend très maniable et permet de l'appliquer sur tous les points du corps.

Une petite lame de caoutchouc durci de 5 sur 2 centimètres, très légèrement concave, et percée d'un orifice à son centre, sert de base à l'appareil. A l'une de ses extrémités s'élève une tige haute de 5 centimètres environ; sur cette tige monte et descend, au moyen d'une vis de réglage, un tout petit chariot de cuivre, entre les montants duquel oscille, sur un axe transversal C, un cylindre de charbon B, long de 1 cent. 1/2 et épais de 5 millimètres. Au-dessous de ce premier charbon vient aboutir l'extrémité libre d'une mince lame de ressort H, placée horizontalement et fixée par son autre bout à l'extrémité opposée de la planchette de caoutchouc. A ce ressort est adaptée une petite lentille de charbon, qui vient toucher l'extrémité du cylindre oscillant de charbon. Enfin, sous ce premier ressort et parallèlement à lui, comme dans le sphygmographe de M. Marey, se trouve un autre ressort terminé par un bouton explorateur, logué traverse l'orifice de la planchette.

La moindre pression exercée sur ce bouton se transmet par l'intermédiaire des ressorts aux deux contacts de charbon, et fait ainsi varier l'intensité du courant qui les traverse; ces variations sont recueillies par un téléphone que l'observateur applique à son oreille. La mobilité des deux charbons en contact fait comprendre l'extrême sensibilité de ce microphone. Toutefois, il est nécessaire, dans ces expériences, d'obtenir un premier degré de pression initiale, que la vis de réglage peut déjà donner en partie, puisqu'elle permet d'appuyer plus ou moins le cylindre oscillant de charbon sur la lentille inférieure. Mais ceci n'est pas suffisant; car, si l'on explore un pouls un peu ample, les mouvements communiqués aux ressorts soulèveraient brusquement le cylindre supérieur et laboreraient des ruptures de contact.

Nous avons dit à cet inconvénient, dit M. Bondet, de Paris, en plaçant à l'intérieur du petit chariot, au-dessus de l'une des extrémités du cylindre oscillant, un petit morceau de papier couleur plié en forme de V et qui fait office de ressort. Nous n'insisterons pas ici sur l'addition de ce ressort en papier, qui nous appartient et dont les avantages ont déjà été signalés dans plusieurs journaux scientifiques. Nous rappellerons seulement que le papier est un corps très faiblement et très parfaitement élastique, ainsi que l'ont prouvé les expériences de Savart; par conséquent, il se prête beaucoup mieux que l'acier et le caoutchouc aux déplacements et aux rétablissements des contacts de charbon, ou plutôt aux variations de leur pression réciproque. Ainsi constitué, l'appareil, placé sur une artère, indique tous les bruits qui se passent à l'intérieur du vaisseau, et, avec un peu d'habitude, on arrive très aisément à distinguer les différences de rythme, les bruits de souffle, etc. La pulsation est très fortement accentuée, le diccrotisme normal devient perceptible,



Microphone du docteur Bondet, de Paris.

ou même on *entend le tracé du pouls*, tel qu'il est inscrit par le sphygmographe.

Appliqué sur un muscle, le même instrument devient un excellent myophone. Il décèle le bruit des fibres musculaires normal et, lors de la contraction, on entend parfaitement le bruit de ronflement caractéristique de ce phénomène. La tonalité des sons transmis par ce microphone est conservée dans toute sa pureté. On peut facilement s'en convaincre en faisant vibrer successivement près de lui, ou même en contact avec sa planchette, des diapasons de tonalités différentes. Le téléphone répète alors fidèlement la note émise par chacun d'eux, et, ce qui est plus curieux, on peut même distinguer les sons de deux diapasons différents vibrant ensemble, sans que la tonalité de l'un ou de l'autre soit altérée. Nous avons également construit deux autres microphones un peu différents de celui-ci, afin d'étudier la contraction musculaire sur les animaux.

A New Form of Microphone for Physiological Purposes.—Mr. Sidney H. Ravell, of the London Hospital, has devised a form of microphone which promises to effect some of the difficulties experienced in using this class of instrument for examining the pulsations of the heart, &c. Usually the two carbons are both affixed to the membrane connected with the flexible tube. Mr. Raynes' arrangement is to fix the moveable carbon on a rigid stand, whilst the fixed carbon only is attached to the membrane, which is consequently small and very sensitive. Thus, instead of the whole of the microphone vibrating with the pulsations, only the lower block vibrates, and a more accurate record, consequently, is said to be obtained.

A New Use for the Telephone.—Hitherto (says the *Scientific American*) it has been a matter of some difficulty to determine the time of flight of small-arm projectiles owing to the impossibility of seeing them strike. In a series of experiments made by the U.S. Ordnance Department this difficult has been overcome by the use of the telephone. The telephone was connected with two Blake transmitters, one placed near the gun, the other in front of and near the target. The time between the report of the gun and sound of the ball upon the target was measured by a stop-watch. The observations, founded on a large number of experiments, never differed more than a quarter or half of a second from each other, the slight delay in starting the watch being neutralized by the delay in stopping it. It was found that the time of transit was affected by the wind, being shortened by a rear and lengthened by a head wind.

The Battle of the Telephone Companies.—The Edison Telephone Company, fortified by the disclaimer to Edison's telephone patents, have stopped the Indianrubber, Gutta Percha, and Telegraph Works Company (Limited) from making the Blake transmitter for the Telephone Company (Bell's). The Edison Company holds that transmitter to be an infringement of their patents, and they are determined to take steps against any other company making these transmitters. There is no special merit in the Blake transmitter that its users should seriously inconvenience the Bell Company, since Crossley's or any other good microphone will answer just as well. *Electrician*, May 29

LA ENERGÍA ELÉCTRICA.

15 (illegible) (Conclusion.)

Puesto que el trabajo se manifiesta á nosotros, poniendo en libertad á estos gases, el calor desprendido por el circuito, debe hallarse disminuido del que corresponde á este mismo trabajo, lo que en efecto, se confirma por medidas precisas.

La telegrafía se ha aprovechado algunas veces de las propiedades reductrices de la corriente. El aparato de M. L. d'Arlincourt, que hago funcionar á vuestra presencia, descansa, en efecto, sobre la descomposicion eléctrica de una sal, el prusiato amarillo de potasa. Cada vez que el circuito de una pila lejana se cierra, la cinta de papel, impregnada de una solucion incolora de esta sal, sufre una alteracion en el punto preciso en que se halla unida por una punta metálica á la línea exterior. Se forma un azul de Prusia; y una série de corrientes se manifiesta, ya lo veis, por una série correspondiente de puntos azules. Con la ayuda de disposiciones particulares que no puedo exponeros aquí, M. d'Arlincourt ha llegado á reproducir, á través de las mayores distancias, un fac-símile completamente fiel, de un dibujo ó de un autógrafo.

A primera vista, los procedimientos galvanoplásticos, parecen tambien depender de las descomposiciones de las sales metálicas. Y sin embargo, hay que establecer una gran distincion entre estos dos géneros de fenómenos.

La galvanoplastia consiste comunmente en depositar cobre, plata, níkel y oro, sobre sustancias más comunes, á fin de comunicarles la apariencia y las cualidades superficiales de estos metales. No examinaremos aquí la accion pura el cobre. Un baño galvanoplástico se compone esencialmente de una disolucion de sulfato de cobre, en la cual se sumerje por una parte una plancha de cobre, y por otra las superficies que se desean cubrir, con una ligera capa de plombagina, para hacerlas buenas conductoras. Estos son los dos electrodos del baño, es decir, la entrada y la salida de la corriente que le atraviesa en un sentido determinado. Nos encontramos en presencia de dos acciones químicas, que se anulan rigurosamente. En efecto, por una parte el metal se deposita poco á poco sobre el objeto, pero el ácido sulfúrico puesto en libertad sobre á la plaza polar y dá origen á la formacion de una nueva cantidad de sulfato de cobre. El trabajo es, por tanto, nulo en definitiva, puesto que lo que se hace por un lado se destruye por otro. Todo se reduce á un simple trasporte de cobre entre los dos electrodos. Este trasporte no corresponde á ningun gasto de energía. Se podrá decir quizás que constituye el modo de propagacion, de la corriente eléctrica en las condiciones en que nos hemos colocado.

La tercera y última clase de que nos resta ocuparnos, comprende los procedimientos del alumbrado eléctrico. He repetido varias veces en el curso de esta sesion, que la corriente que atraviesa un conductor la calienta. ¿Pero la calienta por igual en todos sus puntos? No ciertamente: allí donde es mayor la resistencia al paso de la corriente, allí es donde se desarrolla la mayor cantidad de calor. La resistencia eléctrica depende de la forma y de la materia de los conductores. Cuando un hilo metálico es de pequeño diámetro, parece constituir una especie de obstáculo al paso de la corriente, obstáculo que puede, sin embargo, compensarse, por las cualidades más ó ménos conductoras de la sustancia de este hilo.

El problema de la luz eléctrica está completamente definido. Primera condicion: hacer de manera que sobre una débil extension de circuito, la resistencia adquiera un valor relativamente considerable. Segunda condicion: no emplear para el conductor destinado á ponerse incandescente sino un cuerpo infusible y que pueda emitir rayos luminosos á la temperatura más baja posible.

Os he enseñado hace poco, un hilo de platino enrojecido hasta el blanco, por el paso de una corriente. Una varilla de carbono, de grafito, nos daria una luz todavía más viva. Se puede ir más lejos. Imaginemos que el circuito presenta una solucion de continuidad de varios milímetros: la corriente eléctrica es bastante poderosa para conseguir vencer esta enorme resistencia; calentará los extremos de los conductores y franqueará el espacio arrastrando las partículas de la sustancia que las constituye. Esta cadena de partículas, será elevada toda ella á la temperatura del blanco deslumbrador. Si los conductores son de carbono, produciremos el arco voltáico.

La luz depende del calor y el calor depende de la corriente. Debemos, para completar esta exposicion rápida, examinar qué cualidades conviene exigir al orígen eléctrico. Un sabio inglés, el profesor Joule, ha determinado las leyes que rigen la elevacion de temperatura de un circuito por una corriente. Ha encontrado que el calor es proporcional á la tension de la corriente, y á su intensidad, es decir á la masa eléctrica gastada en la unidad de tiempo. Esto os hará ver que un arco voltáico de gran brillo no puede obtenerse sino por medio de muchos elementos asociados por sus polos de nombres contrarios, y representando cada uno una fuerte aglomeracion de energía eléctrica.

Hoy que este medio de alumbrado tiende cada vez mas á penetrar en la industria, ha sido preciso renunciar á las pilas y reemplazarlas por aparatos mas económicos. Las pilas consumen zinc, cuyo precio es relativamente elevado: este solo hecho, que nada tiene que ver con la teoría, ha bastado para anular casi por completo la aplicacion de la luz eléctrica. Las máquinas magneto-eléctricas han sido dotadas de esta necesidad que se hacia sentir. Estas transformam, ya en acumuladores, la energía mecánica en energía eléctrica. Estudiemos, pues, indicando proporcionarles el movimiento por medio de nuestros motores ordinarios, las máquinas de vapor. En pues, en suma, el trabajo de combustion de la hulla el que se halla de nuevo en el arco voltáico bajo formas de calor, despues de haber pasado por otras intermedias.

El estudio de las máquinas magneto-eléctricas, nos conduciria muy lejos.

Los límites que el tiempo impone á una conferencia, no me impiden entreteneros con las maravillas de ingenio que se han desplegado para la realizacion de estos aparatos próximos á la perfeccion.

La explosion casi instantánea de los focos tan numerosos que iluminan en este momento nuestra ciudad, atestiguan mas que las palabras, la importancia y la oportunidad de estos descubrimientos.

Hemos llegado al fin de nuestro trabajo. Tratamos de resumirle en breves palabras. No he intentado siquiera emprender la ingrata tarea de describiros minuciosamente algunos aparatos principales. Lo que he querido ha sido haceros ver la ciencia telegráfica bajo el punto de vista mas culminante. Os habeis colocado, conmigo, en las alturas de la mecánica general. Desde allí hemos abarcado de una ojeada el conjunto de diversos agentes naturales. Habeis comprendido que la resolucion de los unos en los otros, es incesante.

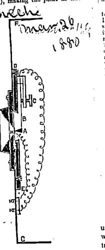
Despues de habernos así preparado y fortificado ante un horizonte tan vasto, hemos descendido al terreno particular de la energía eléctrica. Este terreno, fortilizado por el génio de los hombres, ha producido, vosotros lo sabeis, la telegrafía, la galvanoplastia y un nuevo medio de alumbrado. Y cuando se piensa que estas sorprendentes aplicaciones no cuentan mas de medio siglo ¿quién puede prever lo que el porvenir nos reserva todavía?

"Revista de comunicaciones de la Habana."

THE TELEPHONE AND MICROPHONE.

[17052].—I THINK if R. H. Harrison (letter 16971, Vol. XXX. p. 10) would try a microphone of this description, he would be as well satisfied with it as with any, and it has this advantage, that it is simple. First, I turned an ordinary mouth-piece, and screwed it on to a square piece of wood, previously inserting the diaphragm (2¼in. in diameter), on the centre of which I gummed a small piece of carbon H about ⅜in. square, and 1-16 thick, connected by fine copper wire to one binding screw; next, I ground a piece of carbon in the shape of A (Fig.), making the point as fine as

Eng. Mechanic Mar. 26th, 1880



possible, and fastening it to a fine, but rather strong, spring, B, which was connected with the other binding screw. This carbon hammer I adjusted by means of an ordinary screw. I then screwed the whole into a cigar-box, which I think increases the effect.

Whispering, singing, talking, and whistling can be heard equally well in it. It is rather loud, and, when properly adjusted, very distinct; two telephones also increase the effect. It requires two Leclanche cells to work it properly.

By two telephones I mean one for each ear, of course.

W. E. R.

English Mechanic & World of Science, July 22nd 1887.

[1161.]—Telephone Transmitters.—In my query [illegible] p. 437, for, "as they come under the action of Bell's patent," read "[illegible] under the action" ? &c.—J. H.

[1161.]—Telephone Transmitters.—In reply to "J. H.," I committed an error, which I now hasten to correct. In describing the substitute, or rather makeshift, as I ought to call it, for working the "call," I made a mistake in referring to the instrument described on p. 92. That description only applies to the one described on p. 183, which, being already fitted with the automatic interrupter, would be only required when the battery became too weak to work it. The following description applies to the instrument illustrated on p. 92. Take a piece of sheet brass, say, 1½in. long and ¾in. wide, file some fine teeth along one of its longer sides, and bore one hole at each end, then fasten it with a couple of screws to the top or side of the piece A, so that the teeth may project beyond the wood. Attach this to the wire E, which connects the carbon C to the primary wire of the coil. Now insert the additional wire in the binding post on the opposite side to O, that is the one connected to the wire F, and with this wire rub along the serrated brass piece, and the "call" will be made, as described in my former answer, provided the carbon pieces C C are asunder, as they should be at all times when the instrument is not in use.—JOHN C. FRANK.

Scientific American, 1887.

Farming by Telephone.

M. P. Dhapelincourt, of Hendebouville, France, makes use of a portable telephone apparatus, with which he directs works at a distance on his farm, thus saving the time and trouble necessary for a personal visit. His plan is simply to have a tripod carrying a movable roller, on which is wound a conducting cable composed of two insulated wires. Below this on a movable board is a small box, in which is placed a telephone and bell. The system allows the current to pass from the bell to the telephone without using a commutator. Thus, the telephone being at rest, the bell is in connection with the line, and when the telephone is in use the bell is cut out of the circuit. Another telephone and bell are fixed in the house of the farmer, with a commutator.

The Electrician July 16, 1881.

239,818. TELEPHONE, *Joseph T. McConnel, Braddock, assignor to himself and Edward A. Kitsmiller, Hawkins Station, Pa.—Filed November 15th, 1880.*

Claim.—A receiving telephone having three or more posts or points of attachment for electric circuit wires, two of which are connected by a make-and-break mechanism on such telephone, in combination with a separate battery transmitter, a main line circuit passing through the receiving telephone proper by the unconnected posts, and through the secondary coil of the transmitter, a local battery and a local circuit from such battery, through the speaking telephone and primary coil of the transmitter, to the two posts on the receiver, which are connected by the make-and-break mechanism, substantially as and for the purposes set forth.

HUNNING'S MICRO-TELEPHONE TRANSMITTER.*

Telegraphic Journal 1880

IN its crude form the Hunning's Patent Micro-telephone Transmitter was in existence about three years ago, and has subsequently passed through a long series of modifications. Its present and most approved form was designed for the patentee by Mr. Cox-Walker, of York, to embody the various improvements suggested by experience. Its outward appearance is similar to that of the ordinary Bell telephone, but the resemblance stops there. The usual mouthpiece is covered on the under side of the opening by a piece of nickel-plated brass wire gauze, which forms a protection to a thin sheet of platinum foil. This foil acts the part of a vibrating diaphragm, and is in immediate contact with a very thin layer of granulated coke, which fills a small cavity provided with a brass plate at the bottom. The platinum foil is connected to one terminal through the brass ring, and the brass plate is connected to the other terminal. The terminal wires are then passed through the hole down the centre of the handle; the latter is screwed on to the central part, and the instrument is complete. In connecting it up for use, a receiving telephone (which may be Bell's or other similar instrument) is required at each end of the line in addition to the micro-telephone transmitter, and also a battery of Leclanché or other cells. The function of the transmitter is, by the aid of the battery current, so to increase the sound given out by the receiving telephone as to make these instruments a practical success, and also to overcome by its power the effects of induction from neighbouring wires, this latter having hitherto prevented the use of telephones on wires in the neighbourhood of others along which strong voltaic currents may be passing. The success of Hunning's Micro-telephone in this respect has been undoubted, and its clear articulation and power surprise all who hear it. The loose granulated coke between the two metallic plates is the secret of this success. When the platinum foil is spoken through at the mouthpiece, the aerial waves cause more or less of its under surface to come into contact with the grains of coke, at the same time causing these particles to press more closely upon each other, thus decreasing the amount of the resistance they offer to the passage of the voltaic current through them by bringing more points into contact with each other, this action taking place in a greater or less degree in accord with the amplitude of the vibrations of the platinum foil acting under the influence of the sonorous waves. The control which this movement of foil and coke grains exercises over the passing current is most perfect and wonderful, and it renders the use of an induction coil, which is found to be so great a necessity with all other forms of telephone transmitters—Edison's, Crossley's, and Blake's, to wit—quite unnecessary; and by the use of a special form of receiver, which is now engaging the attention of Messrs. Hunning and Cox-Walker, the effects of induction are hoped to be entirely eliminated, the experiments hitherto made by them in this direction giving promise of ultimate success. An automatic switch board, with call bell and ringing key, completes the outfit for each end of a line for telephonic purposes. The instruments were successfully tried a few weeks ago between York and Darlington, a distance of about 45 miles, the wire used for the purpose of this test trial being one of about 20 of the ordinary telegraph wires which stretch from pole to pole along the side of the railway. The effects of induction were at times most powerful, but they did not prevent the easy and successful carrying on of conversation or the transmission of ordinary railway cypher messages between the two stations.

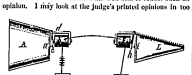
* Abstract of Proceedings of the Cleveland Institution of Engineers.

THE TELEPHONE.—JUDGE LOWELL'S OPINIONS COMMENTED UPON.—INGENIOUS TRANSFORMATIONS.

OF SOUNDS.

A few days ago I chanced to see a small pamphlet that is being sent out by the American Bell Telephone Company to their agents, and containing the decision of Judge Lowell in relation to the alleged infringement of those-called Bell telephone. Having been wrestling with the element electricity, experimentally and otherwise, for a number of years, and with scientific and other forms of telephones, I at once found the pamphlet very interesting and exceedingly amusing.

Now, basing my opinion upon Judge Lowell's decision, I cannot believe that he had very much aged telephone information laid before him by the defendants; for if he had his conscience would never have allowed him to render such an opinion. I may look at the Judge's printed opinions in too



Bell's Apparatus.

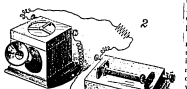
strong a light, and I may not understand them just as he would have me; but be that as it may, I do think that when he rendered this now famous decision he little thought of what valuable material he was furnishing for the future use of the defendants. Take the following for example—the italics are mine:

"There is some evidence that Bell's experiments with the instrument, described in Fig. 7 (see Fig. 1), before he took out his patent, were not entirely successful; but this is now immaterial: *for it is proved that the instrument will do the work, whether the inventor knew it or not.*"

Now, if that is rock bottom law, Bell and his followers (especially the "followers"—for Bell is out of the business, slick and clean) must feel a little squeamish; because, according to the above ruling - the father of the telephone, and the rightful claimant, would be the person who took out the first patent upon an instrument or apparatus that would transmit articulate speech, "whether the inventor knew it or not."

Who is the fortunate parent?

Bope, undoubtedly, was the first to discover and make public the fact that articulate sounds could be transmitted telegraphically. But, according to Judge Lowell, Reis can-

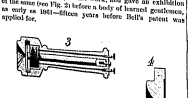


Reis's Telephone.

not be credited with it, because, before Reis's discovery there were thousands of instruments in use, and being made daily, that would transmit articulate speech, "whether the inventors knew it or not."

There is great satisfaction in knowing that Reis cannot come down on us for exorbitant rentals, because he is not protected (?) in so doing by U. S. patents.

Why did Reis neglect to patent his discovery and apparatus? Probably because he did not attach much importance to the discovery, or else that he was satisfied that he had not made an invention, and was too conscientious to try to benefit say one iota the belief that he had. It would not do to credit it to Reis anyway, because he *did know* that his apparatus (telephone) would work, and gave an exhibition of the same (see Fig. 2) before a body of learned gentlemen, as early as 1861—fifteen years before Bell's patent was applied for.

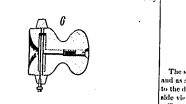


Meme, "ils inventent analogue," cannot bring in a legal claim for the telephone, because the Meme patents have expired. But then it might be credited to him, for two reasons: First, because he lectured and cannot object; second, Judge Lowell's reason, because Meme's instruments will transmit articulate speech, "whether the inventor knew it or not."

Here is another quotation: "But Bell discovered a new art, that of transmitting speech by electricity." Now why not give Judge Lowell a patent for the discovery of a new art—the art of discovering that *Bell* was the discoverer of the art of transmitting speech by electricity? Certainly no one but Judge Lowell has made this discovery, therefore he is entitled.

How, in the name of common sense, Bell can be credited with making the discovery of "a new (?) art," when, as long ago as 1861, Prof. Reis published and gave to the world full particulars of this same "new art," and not only Bell, but all other scientists throughout the globe were acquainted with the fact! Perhaps they were not aware of it at the Patent Office at the time Bell put in his application. It is not well that the examiners in my department should be thoroughly posted, because if they were it would greatly lessen the number of new patents issued upon old devices, and that would never do, for the business of the Patent Office is to issue patents—the more the merrier. Never mind whether they will hold water or not; the Office grinds them out, medical college fashion, and the people must abide by the results.

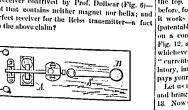
The judge is probably correct when he says: "It seems to me that the defendants use both the method and the apparatus of Bell." There is not a particle of doubt about that; but what did Bell use for his experiments, and as a model? Simply nothing but the methods and the apparatus of former experimenters. How much of the so-called Bell telephone, as now constructed (Fig. 3), was invented or contrived by



Bolleot's Receiver.

Bell? The most reliable information upon the subject credits the "permanent magnet" (as applied to an instrument constructed purely for telephonic purposes) to Prof. Dolbear, of Tufts College; the "converging mouthpiece," Fig. 4, to Prof. Pierce, of Providence, R. I.; and the general makeup of the instrument into the "butter-stamp" form, Fig. 5, to Edson S. Jones, of the same city. The butter-stamp form of telephone, Fig. 5, is the one now in general use. Compare it with Bell's apparatus, Fig. 1.

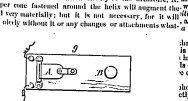
In referring to the Reis telephone, the judge says: "The rogue of all its admirers was, that articulate speech could not be sent and received by it," all of which is an exceedingly elevated mistake, for the Reis apparatus will transmit articulate speech, and as perfectly as any of the hundreds of other forms that have since been constructed—a fact that is well known by telephone investigators throughout the land. Also, that "a Bell receiver must be used to gather up the sound before the instrument (Reis's) can even now be adapted to a limited practical use." Bosh! Can it be possible that Judge Lowell *believes* such nonsense? Has he been misled up in this cow, all this time, and never heard of the simple little receiver contrived by Prof. Dolbear (Fig. 6)—an instrument that contains neither magnet nor bells; and yet it is a perfect receiver for the Reis transmitter—a fact that explodes the above claim?



I devoted considerable time last winter to the examination of the Patent Office reports for the self-satisfaction of knowing what had been patented in the electrical line, in years gone by, that bore any relation to the articulating telephone of to-day. And, without entering into details, suffice it to say that I found one instrument—a "magnetic sounder"—patented by one Wm. Henman in 1871, two years before Bell was heard of, and containing every part—armature, helix, and *permanent* magnet—of the most perfect magneto tele phone as now made; and without one particle of alteration or change in construction, it answers nicely for transmitting and receiving articulate speech.

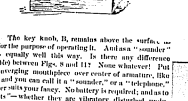
Within a few weeks I have had the pleasure of using these instruments, both double and single helix, for conversing over lines of considerable length, and the results were quite satisfactory—equally as good as I have obtained from many forms of specially constructed telephones.

Fig. 7 is a top and Fig. 8 a side view of the magnetic telegraph instrument. A is the soft iron armature; C, the coils; P M, the permanent magnet; and in this instrument it is of the horseshoe form, with both pole ends turned up at right angles, and carrying the coils. C. The spring, S, retains the magnet in its normal position. The instrument is operated by working the knob, B, in the usual way; and it is as simple in adjustment, etc., that the merest tyro cannot fail to understand. To work it as a transmitter and receiver of articulate speech, you will simply hold or fasten down the knob, B—which will bring the magnet and armature nearly together; then talk and listen closely to the armature, A. A paper ruse fastened around the helix will augment the sound very materially; but it is not necessary, for it will work nicely without it or any changes or attachments whatever.



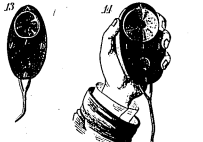
The single helix instrument is of a much cheaper form, and as a transmitter and receiver of vocal sounds is superior to the double helix instrument. Fig. 9 is a top and Fig. 10 a side view.

To save expense in finish the spring, S, and spool, C, are placed within the case; and all metal work reduced to the lighter and plainest form. In principle and operation it is identical with Fig. 8. To make it still less expensive in construction the armature can be placed within the case, as shown in Fig. 11, and the adjusting screw, H, left flush with



the top. The key knob, B, remains above the surface, as before, for the purpose of operating it. And as a "sounder," it works equally well this way. Is there any difference discernible between Figs. 8 and 11? None whatever! Put on a converging mouthpiece over center of armature, like Fig. 12, and you can call it a "sounder," or a "telephone," whichever suits your fancy. No battery is needed; and as to "currents"—whether they are vibratory, disturbed, undulatory, intermittent, or pulsatory—they are all there—" you pays your money and takes your choice."

Let us make the case in an oval form, instead of square, and bring the line wires out at the bottom, as shown in Fig. 13. Now compare it with the Phelps telephone, as illustrated



on page 61 of Prescott's book, "The Speaking Telephone, etc.," and as shown here in Fig. 14, and tell me if they wouldn't make pretty fair twins?

Franklin Mass., September 19, 1881.

In 1878, M. Desportes demonstrated in a telephone under the name magnet, enveloped by a telephone. This effect has resulting from displacements the influence of the shock. nce that time have, however, complicated, and by consequence in order to elucidate the teresting results, which have the French Academy.

recautions are taken to avoid core inside the bobbin consible, one coats the wire of ffices the pieces in shellac, ore with a non-magnetic body, to perfectly well reproduced ces. It can also be superembedded in shellac are loosely ver turns.

ll ordinary bobbin metallic we find that only the magnetic *ulses force*, provided the bob- a wire of iron or nickel gives a *wire of tempered steel*, not

hat these effects are the more is more divided in the interior have been obtained when the s of iron wire disposed end to er two millimetres long by

hone was made quite capable ctly. To effect this, all that r a telephone diaphragm (of 35 millimetres thick, and forbobbin of fine wire (No. 40) with the said fragments of iron pressure, the external piece, others, against the centre of the mouthpiece then, a series a producing a series of currents in a satisfactory manner with-

a further of proving an importhe question. It proves that *re in the heart of the bobbin does e.* It is necessary that there several shocks. This may be diaphragm of the apparatus a Under these conditions the and in presence of the terres developed currents capable of be forthcoming, and to obtain

Le Golfe de Naples

2 Octobre 1881

Le télégraphe souterrain en Allemagne

On lit dans la *Post* du 25 septembre :

« Le réseau télégraphique souterrain est maintenant achevé; il relie entre elles 221 villes et s'étend de Hanovre jusqu'à Strasbourg, de Breslau à Emden, de Thorn à Aix-la-Chapelle.

« La première section, celle de Berlin à Halle, a été commencée au mois de mars 1877, et la dernière section, celle de Cologne à Aix-la-Chapelle, a été terminée il y a trois mois.

« La longueur totale du câble actuellement construit—la réseau a donc près de 38 mois et les dépenses se sont élevées à 30,300,000 marks.

« La longueur totale du câble estale 5,913,950 kilomètres, et celle des différents fils de 37,372,284 kilomètres.

« Des 23 lignes dont se compose le réseau, 18 comptent 7 fils et 5 n'en ont que 4.

« 70 pièces du câble passent sous les rivières »

THE TELEPHONIC TRANSMISSION OF MUSIC.

TELEPHONIC communication for general business purposes has been for some years an every-day occurrence, and some 1200 different firms are now connected in London alone with the Telephone Exchange in Coleman-street. One of the striking features of the late Electrical Exhibition at Paris consisted in the rooms fitted up with telephones where the performances from the Grand Opera could be listened to at a considerable distance from the theatre and heard with great distinctness. The installation by means of which this result was obtained was illustrated and described in ENGINEERING, page 555, ante. On Tuesday evening last, the United Telephone Company, Limited, exhibited a similar effect to a small audience, a room at the Bristol Hotel, Buckingham Gate, being fitted with a number of telephones, through which the performances of the opera of "La Mascotte," at the Comedy Theatre, about half a mile distant, was most effectively transmitted. The installation appeared to be of the simplest possible character; two Hicks microphonic transmitters were placed in the Comedy Theatre, fixed to the wooden posts supporting the curtain hangings, and about 10 ft. above the stage level. From each of these transmitters one wire passed direct to the house, the current being supplied by a battery of four large Leclanché cells contained in the same case as the transmitters. At the house, connecting with every set of telephones in groups of eight in each, making a total of eight telephones, was placed a single bell wire, and a single bell at his disposal two telephones, one connected to a Gower transmitter at one side, the other to that on the other side of the stage. All these telephones were in full use throughout the evening, and the effect produced was a very remarkable one. In some the voice of the singer was distinctly recognisable, every word being plainly audible; still there was a peculiar vagueness about the transmission of which there can be no doubt that distance lends enchantment to the listener, who involuntarily presses the telephone closer to his ear in order more distinctly, or rather to avoid a peculiar hissing which somewhat mars the effect. Every wire connecting the switchboard at one of the floors of another, produced a jarring sound. Still the music or conversation transmitted from the stage could be easily heard by the whole of the company, and the applause of the audience was distinctly heard as the rising or dropping of the curtain; certain musical instruments, particularly when playing simultaneously with others, produced a jarring noise, as for example, the lower notes of a violoncello and the low notes of brass instruments. A chorus could, however, be thoroughly enjoyed, and was most effective in the transmission of a performance of this kind, necessarily is, however, that the listener does not see the actors, though he hears the words, and, therefore, frequently does not understand where the laugh comes in. The effect might be best compared to listening to a conversazione at a theatrical performance from a position behind the stage, and a theatrical form it by a light wooden partition. A little reflection at telephones of different descriptions, switches all and orders, and an Edison loud-speaking telephone, were at show in one of the rooms, and at some future date, we understand, the latter instrument will be placed in circuit, so that an audience may enjoy the performance without even so much as holding a pair of telephones up to their ears. The latter are, it should be mentioned, the ordinary well-known Bell telephones. Altogether the evening was a most enjoyable one, and the United Telephone Company deserve great credit for the liberal spirit in which they endeavour to popularise the capabilities of the telephone system.

THE SPEAKING CONDENSER.

In a former Note we announced that M. Dussaud had succeeded in making the "singing condenser" of Varley act as a telephonic receiver of speech. Since his first experiment he has brought the apparatus into a more practical form. It consists of a transmitting circuit consisting of a microphone, a battery of four Leclanché cells, and the primary of a small induction coil, having about 0.5 ohms resistance. The receiving circuit is composed of the line wire, a receiving condenser of condensers, and a battery of from six to twenty Leclanché cells, according to the number of receiving condensers employed. The microphone is of a peculiar construction. Two metal plates enclosed in a ring of wood and forming a box, are connected in the circuit. Each plate has attached to its inner centre a small button of carbon, and between these two buttons is a little spindle of carbon held there by a brass wire crossing the interior of the box between the two plates, and capable (by the degree of tension given to it) of increasing or lessening the pressure of the microphonic contact between the two ends of the spindle and the buttons. All condensers will serve as receivers provided a battery be employed in the receiving circuit to keep them charged; but M. Dussaud prefers those having a thickness not over six centimetres, and made of thirty or thirty-six sheets of tinfoil separated by sheets of ordinary or of parafined paper. A thin ring of wood or ebonite placed round each surface gives solidity to the pole. One side is fitted with a gutta-percha cup-piece, or two condensers hung from a head-piece may be fixed upon each ear of the observer. When loud speaking is required, twelve condensers are placed in an open trough about three inches apart, and by this arrangement speech may be heard over a radius of five or six yards when a battery of thirty cells is used in the receiving circuit.

CABLE FOR TELEPHONIC CIRCUIT.

AN English patent has been taken out for a type of telephonic cable designed by Messrs. J. Holmes and E. T. Greenfield, of Brooklyn, New York, to eliminate the effects of inductive electric conductors running close together. The arrangement is novel, and is worthy of reference, and worthy of some notice. It is said, however, scientifically, that the intensity of the induced current in a conductor ranged upon the parallelism between the conductors, and that such a current is generated and the primary is broken, or such a current goes feebler as the parallelism of the lines is destroyed, and becomes inappreciable when the lines cross each other at right angles. It is then proposed to utilise for a telephonic line a metallic circuit or conductor wire of which shall be made to cross and recross repeatedly the main wire of the circuit, the expansion and contraction of the line will not be disturbed by induction from a neighbouring wire through which an electric current is passing. One practical objection to this construction is that it requires double the length of wire, and is connected with a construction which uses so much connection, and also is attended with a vastly increased resistance. However, it proposes the protection of a single line from the above inversion provides a more simple and less expensive mode of utilising the general fact above noted, and is perfectly adapted to any number of lines arranged in proximity to each other, and following through a general direction; and it consists simply in causing the wires of the cable to cross and recross at so that they will repeatedly cross and recross at short intervals, each line wire in succession, and consequently no metallic return wire is used. The most convenient manner of securing this relative arrangement of the wires is to braid them together into a cable, for which purpose they must be insulated, to prevent actual contact of the conducting surfaces. By braiding the wires each one of the system will be carried alternately over every one of the others, and if the wires are fully close, as with machinery, the construction will be uniform throughout the cable, occurring at regular intervals, and the curves rising to uniform heights from the axial line of the cable, which regularity of construction will produce the most complete neutralisation of induction. Each wire is made to act as a support to its neighbours, and while the wires thus serve to support each other, the whole cable can be as readily mounted on poles, or otherwise supported or submerged, after the manner of a single wire. A cable constructed according to this plan may be composed of three conductors braided together; but, manifestly, the same principle would apply to any larger number of wires which could be conveniently braided up into a single cable. If two wires only were to be used they might be braided into a cable by means of a third strand a cord of any non-conducting material, or they might be served by serving, or in any other suitable way, to a cable of tape or any other suitable support. In this case two wires are attached to the insulating strip in such a way as to cross and recross each other at short intervals and with regular curves. According to this construction, when conductors are arranged as above described, no induced current is formed in any one of them by the passage of an electric current through any of the others, or if formed it is so far modified by the action of the others as to be practically not to interfere with the working of any of the lines in the cable, and the cable can, accordingly, would be free of them with reference to any other line now by but not included in the same cable.

APPLICATION OF THE TELEPHONE TO THE MEASUREMENT OF THE TORSION OR TRANSVERSE SHEARING STRAIN OF SHAFTS, &c.

THE Société Internationale des Électriciens, in a paper read by Le Lieutenant Electricien Sebert, has described a method of measuring the torsion or transverse shearing strain of shafts, &c., by means of the telephone. The apparatus consists of M. Carlo Ganz's system of two electro-magnetic transmitters to two stationary electro-magnets, and resting in each case opposite to the poles of the latter on the shaft revolves. The electric waves being electrified through a telephone, so that the currents in the two coils tend in opposite directions, no sound is produced by the instrument when the apparatus is properly adjusted and the shaft is not under torsion; but it will be seen, however, that the slightest effort will disturb the equilibrium by throwing the armatures into different positions, varieties of induced currents, which affect the telephone, being thereby produced. The sentences of the sound emitted by the instrument depend upon the number of armatures and the velocity of rotation; but the intensity of it is stated, depends upon the angular displacement of the armatures, or the torsion of the shaft. This may be accurately ascertained by allotting one of the sets of armatures to the end of the shaft, as in the figure, where we call L the length of the shaft between the two sets of armatures, and α the angular displacement of the latter in circular degrees the torsion x for unit length will be $x = \frac{\alpha}{360} \frac{1}{L}$. If x, be the torsion of the shaft when the machine does no work, the expression $\frac{x}{x'}$ will be the ratio between the force necessary to overcome friction, &c., and that actually transmitted to the shaft. The force necessary to produce a given torsion may be measured by a dynamometer, having a lever of length R, to which one end of the shaft is fixed. If a force of P kilos. produces the torsion x on the length of shaft L, the torsion of unit length will be $x = \frac{P}{L}$. If we know the angular velocity and the number n of revolutions of the shaft in unit time, we have all the elements necessary for calculating the work done. For, since the force P, the moment of which is P R, produces a torsion x, the force necessary to overcome friction is $P \frac{x'}{x}$, and the force corresponding to the torsion x, measured by the kilojoules by displacing the armatures will be $P \frac{x'}{x}$. The force P being applied through a lever of length H, the total work transmitted through the shaft will be $P 2 \pi H n \frac{x'}{x}$. That absorbed by friction, &c., will be expressed by $P 2 \pi H n \frac{x'}{x}$; the useful work will be $P 2 \pi H n \frac{x - x'}{x}$; and, lastly, the ratio of the effective to the total work, or the duty of the machine, will be $\frac{x - x'}{x}$.

LE PREMIER CHERCHEUR D'OR

Le *Progrès* de San Francisco rappelle l'histoire de la découverte de l'or en Californie, découverte qui a produit une si grande révolution dans le monde économique, et il l'accompagne d'un mot qui a conservé le pouvoir d'éveiller des images ardentes, chaleureuses, et actuellement, même en Europe. Après avoir parcouru d'immenses richesses, il est banal dans la gouvelle. Son nom est Jean Sutter.

Né en 1803, dans le duché de Bade, Sutter entra au service dans la garde suisse de Charles X. En 1834, il quittait la France et se rendait à New-York, pour fonder aux États-Unis une colonie de vignerons. Il passa ensuite dans le Missouri, le Nouveau-Mexique, travailla pour le compte de la Compagnie des fourrures dirigée par les Astors, parcourut les îles Sandwich et l'Alaska. Mais il ne trouva nulle part, lorsqu'il traversait San Francisco, il sollicita et obtint du gouverneur de l'État une concession gratuite de trente lieues de terrain dans la vallée du Sacramento, sur les bords de l'Amérer la Fourche, et à cheval auprès d'un Sacramento Gu, c'était en 1839. Jean Sutter se mit résolument au travail avec ses Blancs et tout Indiens; il se construisit une maison sur un monticule d'où il commandait tout le pays. En 1847, la conquête et l'achat de la Californie par les États-Unis ne le déposséderent pas, et en 1848 l'ancien garde suisse se trouvait à la tête d'une exploitation agricole empressée à la culture des céréales et à l'élevage des bestiaux. Il avait construit des moulins, des scieries, des ateliers de toutes sortes; ses chevaux et ses bestiaux se comptaient par milliers.

Enfin, au printemps de 1848, en faisant marcher pour la première fois la machine d'une scierie mécanique sur la Fourche, un de ses ouvriers découvrait dans le sable une paillette d'or. Sutter s'efforça de tenir la découverte secrète; mais en quelques semaines elle était connue à San Francisco, et bientôt des milliers de diggers ou chercheurs d'or, Indiens et Européens, accourant sur les bords de la Fourche; les soldats, les matelots désertaient pour exploiter ce nouvel Eldorado. Sutter ne devait pas profiter des richesses incroyables que les nouveaux venus allaient détecter. Après de nouvelles vicissitudes, il quitta définitivement la Californie, et s'établissait, dit le *Progrès*, âgé de près de soixante-dix-huit ans, il habite une chaumière dans le petit village, moitié de Lititz, à six lieues de Philadelphie.

LES COMMUNICATIONS TÉLÉPHONIQUES

A PARIS

SYSTÈME EDISON

Deux Compagnies se disputent à Paris le service des communications téléphoniques, dont les lecteurs de *la Nature* connaissent déjà les principes généraux par l'article que nous avons publié dans le numéro du 28 février 1880 sur l'un des systèmes actuellement employés en Amérique. Nous décrirons aujourd'hui les appareils de la Compagnie Edison, réservant pour un article ultérieur ceux de la Compagnie Gower.

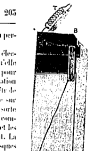
Le transmetteur est un téléphone à charbon système Edison, représenté en coupe figure 1, et en perspective, figé 2, son support, figure 2.

Il est fondé sur les variations de résistance électrique qu'éprouve une pastille de charbon lorsqu'elle subit des pressions variables. Ce charbon, pour donner de bons résultats, demande une préparation toute spéciale. Il est obtenu en brûlant du pétrole dans des lampes à longue mèche; il se dépose sur les parois de la chambre de combustion une sorte de noir de fumée qui est ensuite légèrement comprimé dans un moule qui lui donne la forme et les dimensions d'une pièce de un franc en argent. La pastille ainsi préparée est placée entre deux disques de platine dont l'un est fixé sur la boîte métallique qui soutient la plaque vibrante; l'autre disque porte un petit bouton d'ivoire qui vient s'appuyer contre cette plaque, du réglé la pression en vissant plus ou moins la plaque sur le support. Les deux disques formant donc les deux conducteurs d'une boîte ronde et aplatie dont la périphérie est formée par un anneau d'ébonite fixé sur le disque visé dans le support. Un fil de platine amène le courant sur la face antérieure du disque placé du côté de la plaque, ce courant traverse la pastille de charbon et sort par la partie métallique du support. En parlant devant l'embouchure, même à 20 centimètres de distance, les vibrations se transmettent à la pastille, se traduisent par des variations de pression et par suite par des variations de résistance électrique.

Le courant de la pile, après avoir traversé le transmetteur, n'est pas envoyé sur la ligne pour actionner le récepteur, mais il traverse le gros fil on fil *inducteur* d'une petite bobine d'induction (fig. 3) sans condensateur ni trembleur, et va à la pile. Ce circuit est donc constitué par la pile, le transmetteur et le fil inducteur de la bobine. Le fil induit de la bobine est relié à la terre par l'une de ses extrémités, son autre extrémité correspond avec la ligne. Au poste récepteur, l'un des fils de la bobine du téléphone récepteur — un téléphone magnétique système Bell, par exemple — correspond avec le fil de la ligne et l'autre extrémité de la bobine avec la terre. Tel est l'ensemble complet de la communication. On envoie donc dans la ligne, non pas le courant de la pile, mais le courant induit dans le fil fin de la bobine par les variations d'intensité du courant inducteur, lorsque la parole émise devant le transmetteur modifie les résistances de la pastille de charbon.

L'idée d'employer les courants *induits* et non pas le courant direct remonte aux recherches de M. Gray sur les téléphones musicaux, bien avant l'invention du téléphone parlant. M. Edison est le premier — en Amérique — qui ait eu l'idée de l'employer au téléphone à pile, idée qui était aussi venue à MM. Pollard et Garnier avant qu'ils n'aient eu connaissance des expériences antérieures de Gray et d'Edison.

L'emploi de la bobine d'induction présente plusieurs avantages. Le circuit formé par la pile, le fil inducteur et le transmetteur est très-court, et par suite sa résistance est très-faible. Il en résulte que le courant qui le traverse est très-intense, et que les variations d'intensité produites par les vibrations de la pastille de charbon sont très-grandes. Le courant induit, qui traverse la ligne, est donc très-énergique, et il peut actionner le récepteur à de grandes distances. Le circuit de la ligne, au contraire, est très-long, et sa résistance est très-grande; il en résulte que le courant induit qui le traverse est très-faible, et que les variations d'intensité produites par les vibrations de la pastille de charbon sont très-petites. Mais, comme le courant induit est très-intense, ces petites variations suffisent encore pour actionner le récepteur à de grandes distances.



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transmetteur et le fil inducteur de la bobine présente une faible résistance. Il en résulte que les variations de résistance de la pastille de charbon se traduisent par des variations assez grandes dans l'intensité, et par suite les courants induits dans le fil fin sont eux-mêmes fonction de ces variations d'intensité du circuit primaire. Si l'on mettait le parleur à charbon dans le circuit de la ligne et que cette ligne fût un peu longue, les variations de résistance de la pastille de charbon seraient insignifiantes par rapport à la résistance totale du circuit, et par suite le téléphone récepteur serait à peine influencé. C'est ce qui explique pourquoi on ne peut faire de la microphonie directe à de grandes distances. D'autre part, les courants induits ayant une plus grande tension que les courants directs, peuvent être transmis à de plus grandes distances sans que la résistance de la ligne affaiblisse beaucoup leur intensité. L'emploi de la bobine d'induction est donc un artifice aussi ingénieux que nécessaire lorsqu'on emploie des transmetteurs à pile sur des lignes un peu longues.

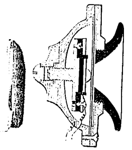


Fig. 1. Coupe du transmetteur à charbon d'Edison.

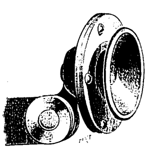


Fig. 2. Transmetteur à charbon d'Edison.

Le récepteur est un téléphone magnétique de Bell modifié d'une façon très heureuse et très pratique par M. Phelps. La figure 4 représente la disposition actuellement employée, à laquelle M. Phelps a donné le nom de *pony-crown* (petite couronne). On y retrouve l'embouchure E, la plaque P et la bobine B du téléphone Bell. Avec les courants induits, il faut rouler sur la bobine B du fil très fin et très long pour bien utiliser le courant, qui présente peu de quantité et beaucoup de tension. L'aimant est en forme d'anneau et le noyau G de la bobine est un petit cylindre de fer doux fixé à l'un des pôles de l'aimant à l'aide d'une vis. Le téléphone ainsi construit est puissant, très commode à saisir pour l'approcher de l'oreille et facile à suspendre lorsque la conversation est terminée.

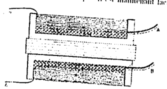


Fig. 3. Bobine d'induction.

Il n'est d'ailleurs qu'une simplification du type primitif le *crown-telephone* (fig. 5), composé d'une série d'aimants en couronne dont toutes les extrémités nord sont reliées à un noyau cylindrique central et toutes les extrémités sud placées en cercle contre le bord de la plaque. Ce modèle a une puissance remarquable, mais il est assez incommode, lourd et coûteux; on lui a, pour ces motifs, substitué le *pony-crown*, dans lequel tous ces inconvénients sont supprimés.

Il est maintenant facile de comprendre comment le poste central peut converser avec chaque abonné ou les relier entre eux; le diagramme (fig. 6) représente le montage au moment où les deux abonnés 27 et 36 sont en conversation.

La ligne L' est reliée directement à la ligne L'', en plaçant une cheville en 2; cette cheville établit une communication par l'intermédiaire des plaques métalliques C' et C''. Il y a donc trois circuits distincts :

1° Le circuit du transmetteur de l'abonné 27, formé par sa pile P', le fil inducteur de la bobine B' et le parleur T';

2° Le circuit du transmetteur de l'abonné 36, formé par sa pile P'', le fil inducteur de la bobine B'' et le parleur T''.

(Ces deux circuits sont représentés en gros traits sur le diagramme.)

3° Le circuit de ligne relié à la terre par ses deux extrémités et traversant les deux récepteurs R', R'',

"2418."" Transmitters for telephones."—R. M. LOCKWOOD and S. H. BARTLETT, of New

33

les fils induits des bobines B', B'' et les signaux avertisseurs A', A''. Ces signaux avertisseurs sont toujours dans le circuit, et en voici la raison : Lorsque la conversation entre les abonnés 27 et 36 est terminée, en accrochant les téléphones en place, un commutateur *automatique*, manœuvré par le fait même de la suspension des téléphones, place la sonnerie de chaque abonné dans le circuit, prête à recevoir un appel. Il suffit alors que l'un des deux abonnés, ou tous les deux, envoient un courant dans la ligne, en appuyant sur le bouton d'appel, pour que les signaux A' et A'' — analogues aux signaux de sonneries d'hôtel — tombent *tous les deux en même temps*, et indiquent au bureau central que la conversation entre 27 et 36 est terminée. Le bureau central enlève alors la cheville 2, relève les signaux tombés et relie les deux lignes à la terre.

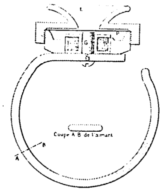


Fig. 4. Pony-crown de M. Phelps.

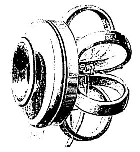


Fig. 5. Crown-telephone de M. Phelps.

Dans la position d'attente, les deux extrémités de la ligne de chaque abonné sont reliées à la terre, mais dans chaque ligne se trouve intercalée :

1° La sonnerie de l'abonné;

2° Le signal du poste central portant le numéro de l'abonné;

3° La sonnerie du poste central.

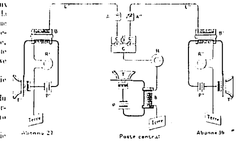
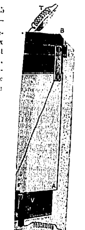


Fig. 6. Diagramme des communications téléphoniques.

Dans ces conditions, si le poste central veut appeler l'abonné, il envoie un courant dans la ligne et fait fonctionner la sonnerie; si c'est l'abonné qui appelle, la sonnerie du bureau central tinte, le signal tombe et indique à l'employé le numéro de l'abonné.

En plaçant une cheville en 1, par exemple, si c'est l'abonné 27 qui a appelé, le poste central se trouve en communication téléphonique avec l'abonné, lui demande le nom de la personne avec laquelle il demande la communication, et après un appel préalable, établit la communication en plaçant une cheville en 2. Il importe de remarquer qu'avec cette disposition, le poste central peut *toujours*, par dérivation, se mêler à la conversation entre les deux abonnés, l'écouter et l'interrompre. Il y a là un avantage et un inconvénient; l'avantage prédomine cependant, à notre avis. Il y a un inconvénient à ce que la conversation puisse être entendue par l'employé du poste central : on ne peut empêcher ces indiscrétions que par une surveillance sévère et une interdiction formelle. Il peut être utile néanmoins, lorsque M. A parle avec M. B, que le poste central puisse avertir M. B, par exemple, que M. C attend, pour parler, que la conversation entre A et B soit terminée. Suivant



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Nov. 13. 1880

Mr. T. D. Lockwood
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of Professor Hughes
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Hughes

of the carbon, *c*, with the piece, *a*, may be regulated at pleasure.

l'importance relative qu'on attache aux communications avec l'un ou l'autre des correspondants, il sera facile de *faire attendre* M. C ou, au contraire, d'interrompre la conversation avec M. A pour donner audience immédiate à M. C. Tous certains cas, au contraire, MM. A, B et C pourront s'entretenir en même temps, comme s'ils étaient réunis dans la même pièce; il suffira pour cela que le poste central établisse les communications demandées par les intéressés.

Ce montage à triple communication présente donc des avantages de même à faire oublier le petit inconvénient que présentent les indiscrétions possibles, mais peu probables, du poste central.

Les communications téléphoniques par le système Edison donnent des résultats très satisfaisants lorsque les lignes ne sont pas trop nombreuses et trop rapprochées des lignes télégraphiques, qui produisent, dans ce cas, des courants d'induction parfois assez gênants. Il demande seulement un entretien de la pile et un certain réglage du transmetteur, organe un peu délicat, à Bruxelles, on a remplacé le parleur à charbon d'Edison par le transmetteur microphonique de M. Blake, qui donne d'excellents résultats sans nécessiter des réglages aussi fréquents.

Dans un prochain article, nous examinerons le système Gower, dans lequel l'appel et la conversation se font par des organes exclusivement électromagnétiques.

E. HOSPITALIER.

CORRESPONDANCE

SUR UN SINISTRE AÉRIEN

Marseille, 17 août 1880.

Monsieur,

M. Charles Brest a fait à Marseille, le premier de ce mois, sa première ascension avec le ballon *Stanislas*, parti à cinq heures du Prado, par un temps très calme, il franchissait vers cinq heures et demie la chaîne des montagnes de l'Estaque et atteignait en peu de temps les plaines de Pesquelès, près d'Aix.

Le dimanche suivant, 8 août, malgré un vent violent du nord-ouest, M. Charles Brest s'élevait pour la deuxième fois avec le *Stanislas* et disparaissait bientôt à l'horizon, passait par le mistral vers la haute mer.

Une dépêche de Berre indique que le 9 août on a recueilli dans une anse, entre Rona et Port, près d'Ajaccio, un ballon avec une nacelle et accessoires. Dans la nuit du 8 au 9, grosse mer et vent grand frais sur cette partie de la côte.

Voici d'autre part, le récit publié par le *Petit Marseillais* et dû au capitaine du *Segonde*, qui, dans sa traversée de Marseille à Palerme, a vu, en mer, le *Stanislas* dans une situation des plus critiques.

« Dans la soirée de dimanche 8 août, dit le capitaine du *Segonde*, entre sept et huit heures du soir, notre bateau se trouvait en face du détroit de Bonifacio, vers le 42e degré de latitude et le 7e de longitude, lorsque nous aperçûmes de bas, venant vers nous, un ballon aux allures bizarres dans la nacelle. Le vent soufflait assez fort, venant du nord-ouest et poussait le ballon naturellement vers le sud-est, avec une vitesse d'au moins 25 milles à l'heure.

« Le ballon courait presque à fleur d'eau, suivant les ondulations des vagues et disparaissant à moitié dans le creux de l'une à l'autre. Il ne tarda pas de nous atteindre, mais à ce moment il s'éleva à perpendiculairement à hauteur de mât, nous dépassa et disparut derrière l'horizon avec une rapidité vertigineuse. Les passagers du *Segonde* eut eu tout le loisir d'observer la nacelle, dans laquelle on voyait un accumulateur bissant sur son échelle à coude, sans doute pour échapper aux coups de vague auxquels la nacelle était exposée et nous avons tous pensé qu'il allait atterrir en Corse. »

L'ensemble de ces renseignements vous apprendra qu'il faut ajouter à la liste déjà si longue des victimes de l'aéronation, le nom de M. Charles Brest.

Veuillez agréer, etc.

UN LECTEUR ASSIDU.

CHRONIQUE

L'éruption du volcan Furgo dans le Guatemala. — On nous apprend de Panama que le volcan Furgo, près d'Antigua (Guatemala), qui était inactif depuis plusieurs années, a fait soudain éruption le 29 juin 1880 à trois heures du matin. Les passagers du paquebot Wilmington, de la ligne du Pacifique, ont vu ce magnifique spectacle d'une distance de 50 milles à vol d'oiseau. Du plus haut pic du Furgo, des colonnes de flammes s'élancaient à 5000 pieds, illuminant une vaste étendue d'espace à l'est et au sud, tandis qu'au nord et à l'ouest leur éclat obscurcit par d'immenses nuées de poussière et de fumée. La première grande colonne de feu, dit un témoin oculaire, s'est élevée à 5000 pieds de haut pour le paraître, lancant des matériaux d'environ 5 pieds cubes; celles d'une pièce d'artillerie. Une demi-heure après, on a vu descendre brûlant deux torrents de lave. L'un au sud, vers la ville d'Antigua, et l'autre à l'ouest, vers la mer, des masses de matières en fusion consumaient tout sur leur passage, détruisant des forêts, combinant des eaux d'un et remplissant l'atmosphère de nuages de fumée et de vapeur. Une rue considérable s'est manifestée subitement dans la rivière de Guacalde, qui prend sa source sur le versant occidental de la montagne.

Tremblement de terre dans la Turquie d'Asie. — Une violente secousse de tremblement de terre s'est fait sentir à Smyrne dans la matinée du 29 juillet 1880. Les oscillations, qui se déplacèrent du nord au sud, ont duré douze secondes. Si elles avaient continué quelques secondes de plus, on aurait eu à déplorer une catastrophe aussi terrible qu'en 1776 à cette époque. Quinze personnes furent ensevelies sous les ruines de la ville. A cinq heures, tous les habitants étaient dans les rues. Un Turc a été tué dans son arabeie pendant qu'il récitait les prières du matin. Dans la rue Saint-Georges, une jeune fille et un jeune garçon ont été ensevelis sous les ruines d'une maison; on les en a retirés avec beaucoup de difficulté, mais encore vivants, quoique grièvement blessés.

Les dommages causés aux monuments publics et aux propriétés privées sont considérables et doivent s'élever à plusieurs millions de piastres.

2218. "Transmitters for telephones." R. M. Lockwood and S. H. Bartlett, of New York. Dated June 15, '64. The effectiveness of these transmitters depends not upon the mechanical vibration of a diaphragm but upon what is termed molecular movement, transmitted from molecule to molecule of a non-resonant material, which for a body remains stationary while waves and the molecules which control the volume, pitch, and vocalness of sound transmitted to and through the wires. A microphone of any suitable character is provided which transmitting-wires, and is either wholly or partly embedded in cork, light wood, or other non-resonant material.

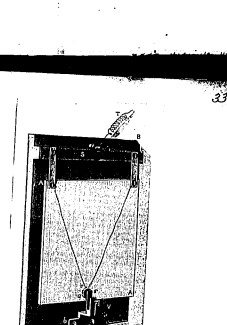
Fig. 1 represents the transmitter in section.

The microphone is represented as composed of two bars, a a, arranged in or about in the same plane, with their inner ends approaching each other but out of actual contact, as shown. These bars are preferably of carbon of the kind well known to electricians, but they may be of any suitable conducting material, such as metal, which, however, as far as experiments have extended, has been found inferior to the carbon in its results. The adjacent ends of the bars, a a, have semi-cylindrical notches cut in them opposite each other, forming a circular opening between the bars for the reception of a pin, b, on the lower face of a small button or disc, b, of carbon or other conducting material similar to that of which the bars, a a, are composed, said button resting by gravity on the inner ends of the bars.

DE LOCHT'S PANTELEPHONE.

Leon de Locht, Mining Engineer and Professor at the College of Mining, Mont-St-Martin, Liége, Belgium, after several years' experimenting, has succeeded in overcoming the defects of the best telephones at present in use. After the invention of Graham Bell, Ader, Edison, Hughes, Blake, Gower, Crossley, Preece, Varley, and others, which have been brought to perfection in various countries, has thought of a new principle which he calls the pantelephone. The pantelephone is a microphonic transmitter of a new construction, and receiver which differs at a first view from all that are in use. It is capable to transmitting without broken at forty-five feet from the apparatus of a distance of several miles through the medium of receiving telephones. The pantelephone, which is extremely simple, is composed essentially of a movable plate carrying a contact-piece, and a screw against a disc of carbon or metal—silver or platinum.

In connection with the accompanying cut, the plate is seen figured at b, b. It may be of aluminium, sheet iron, steel, or any suitable metal. In this instance, whatever that is capable of being formed into plates of large superficial area, while at the same time possessing the requisite amount of lightness. It is preferable that the form should be square or oblong, and, when made of metal, two or three inches in width, and from two to three feet in length, as inflexible as possible, and not liable to bend out of shape through the influence of heat, moisture, or humidity. It is surrounded by two small vertical bolts and springs, S S, from a support, S, which is perfectly straight and stands out from the face of plate B B, forming the framework of the apparatus. The bolts pass through the lower end of the plate b, forming or soldered a small carbon disc, c, which, when the apparatus is in use, is pressed by a screw, a, against a small piece of silver or platinum fastened to the end of a short and somewhat inflexible spring, c, the latter being fixed by means of a screw, c, to the copper support s s. By means of a thumb-screw, T, passing through the support the contact of the carbon, c, with the piece, d, may be regulated at pleasure.



The pantelephone is placed in the circuit of a voltaic pile in such a way, for example, as in the current entering at E proceeds to the support S, thence through the spring r to the contact between c and d, the carbon c, and through the plate b b to the springs S S, and leaves the apparatus at T.

The microphone and receiver are of ordinary construction, by means of which the invention is enabled to re-produce the utterances as to insure the greatest distinctness and the best possible results. Various arrangements may be employed, too, to diminish or avoid all noises which might arise from tremors of the wires, or from the shaking of the wall to which the apparatus is attached. It is claimed that the pantelephone is capable of being regulated, in all limits to get out of any sound; moreover, that the expense attending the introduction of the system is insignificant, since the apparatus under proper conditions requires for its working only the electromotive force of a single voltaic couple. The instrument transmits all sounds, articulate or inarticulate, with equal facility, through the medium of either solids or the air. It is declared in a key (which may be set to music) several octaves in depth in such a way that its reproductions to accurate vibrations is in no way impaired.—*Scientific American.*

THE TELEPHONE IN POLITICS.—The President of the French Republic has established in his study a telephone apparatus, enabling him to have instantaneous communication with the Presidents of the Senate and Chamber and all the Ministers. *Scientific American*, Sept. 13, 1880

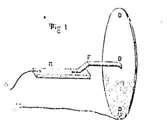
In a letter to the *Operator*, Mr. T. D. Lockwood discusses the right of Mr. Bellmer to the credit for having been the first to invent, an instrument identical in principle with the microphone of Professor Hughes. He applied on April 14th, 1877. Mr. Bellmer filed a caveat in the patent office on the 27th of April, 1877. Mr. Bellmer filed an application in the patent office for a patent on his invention on the 27th day of April, 1877. He described in his caveat of April 14th, 1877. But October, 1877, Mr. Hughes commenced his experiments; privately exhibited his microphone in January, 1878; and gave his perfected invention to the public in May, 1878.

Journal Universel D'Electricite

Le microphone Berliner.

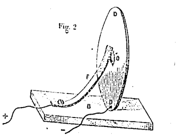
La persistance avec laquelle M. Berliner réclame la priorité de l'invention du microphone, et la complaisance de certains journaux allemands pour accueillir cette réclamation, nous forcent de revenir un peu sur ce système, et en même temps de faire connaître les appareils de ce genre essayés en 1876 et 1877 par MM. Peirce et Blake. D'après des renseignements qui ont été donnés en 1878 à M. du Moncel par M. Blake, alors à Paris, M. Peirce en faisant des expériences à La Providence avec les appareils de Bell, fut très-étonné d'entendre la parole avec un transmetteur téléphonique à pile composé d'un disque de tôle DD (fig. 1) placé verticalement et actionnant un morceau de fer rouillé B (placé horizontalement), par l'intermédiaire d'un ressort F, frottant sur ce morceau de fer, et fixé au centre O du disque. Sous l'influence des vibrations du disque, le ressort produisait de petits frottements qui suffisaient pour fournir, par instants, la reproduction de la parole. Toutefois ces résultats n'ayant pas été suffisants pour lui faire croire à des applications utiles, M. Peirce s'est contenté de les considérer comme une expérience curieuse qu'il signala à M. Blake. Or cette expérience avait *été faite en septembre 1876*. Un an plus tard, M. Blake eut l'idée de la reproduire dans d'autres conditions que nous représentons ci-dessous (fig. 2). Il employa comme M. Peirce un disque vertical en tête DD au centre duquel il pratiqua, en *repoussé*, une saillie bombée O, comme une boursouflure, et il appliqua contre cette saillie une lame de ressort F, de manière à constituer ainsi un interrupteur de courant. En parlant devant le disque, il put reproduire d'une manière, sinon

Fig. 1



parfaite du moins suffisante, la parole à travers un téléphone introduit dans un circuit voltaïque, mis en rapport avec ces deux parties de l'appareil. Sauf la lame de charbon qu

Fig. 2



se trouve représentée ici par un disque de tôle, cet appareil représente bien celui que M. Berliner réclame. M. Blake lui a donné du reste une autre disposition que nous représentons

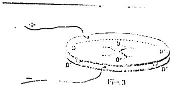


Fig. 3

fig. 3. Ce sont deux disques de tôle DD, D'D' superposés horizontalement et munis à leur centre de la saillie bombée dont nous avons parlé. Ces disques sont en contact par cette saillie. Les bords des deux disques sont d'ailleurs séparés par des cales de bois assez minces pour maintenir leur parallélisme

nous venons de parler avant de se prononcer d'une manière si catégorique. Cela dit en passant, nous allons examiner maintenant le nouveau transmetteur de M. Berliner qu'on nous donne comme une merveille, et qui n'est qu'une dérivation des transmetteurs Blake, Edison et Fernandez Janez.

Les figures 4, 5, 6 et 7 ci-contre représentent cet appareil dont la coupe, fig. 4, représente les détails principaux, *ee* est l'embouchure téléphonique; *ff* le diaphragme en fer battu soutenu sur ses bords par une enveloppe de caoutchouc élastique. Une lame flexible d'argent *k*, fortement pressée contre cette enveloppe de caoutchouc par une vis *l* porte vissée en *i*, une sorte de cartouche métallique *i*, qui renferme l'un des contacts microphoniques, constitué par un petit cylindre de graphite. Le courant arrive à ce contact par la vis *l*, qui est isolée de la masse de l'appareil par un taquet d'ébonite *m*, fixé sur le couvercle en fer de l'appareil. Une large lame d'argent *pp*, fixée en *m*, et emboitant avec isolement la cartouche *i*, permet de serrer plus ou moins fortement la cartouche contre le diaphragme, au moyen d'une vis *ss*, et porte articulée obliquement une lame *q* terminée par un petit cylindre métallique *r* qui renferme le second contact de graphite, lequel est arrondi par sa partie extérieure. Derrière ce système est disposé, une traverse de fer *ss* et une bobine d'induction *t* sur laquelle agit le courant du microphone, et dont le fil induit communique avec la ligne téléphonique. L'appareil est naturellement suspendu verticalement.

THE TELEPHONE.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—While working with a Gower-Bell telephone and a Crossley transmitter and Bell receiver in circuit it was observed that when speaking on the "Gower" the sounds always proceeded from the Bell receiver, and when speaking on the Crossley transmitter from the "Gower" with very marked improvement in distinctness.

Dec 1 1880

Moving the Bell receiver when speaking on the Gower, or the Gower when speaking on the Crossley, gradually from the ear, when a distance of three-quarters of an inch intervened the sound began to move round to the other telephone, and when the distance was increased to an inch and a half the sound passed entirely into the other telephone.

On connecting an astatic galvanometer, the best at hand, in circuit with the Gower, and blowing with sufficient force to produce a clear sound on the whistle, the needle was deflected through 40 divisions. Increasing the blowing force until a deep sound was produced, the needle returned to zero, and passed through 10 divisions in the opposite direction.

The effects obtained when the blowing was at the distant station were similar but less marked, the deflections being 15 and 5 divisions respectively.

The figures given are the averages of several trials.

I am, Sir,
Yours faithfully,
F. MACRAE KEITH.

Edinburgh.

EDISON'S TELEPHONE.—We understand that the "grinder" telephone is not giving satisfaction, and that in many instances a Bell telephone has been substituted as the receiver, in consequence of complaints from renters.

Electrician Nov 27 1880

THE GOVERNMENT AND THE EDISON TELEPHONE COMPANY.

THE important and long-anticipated struggle between the Government and the Edison Telephone Company was commenced on Monday last at the sittings in Banco in the Exchequer Division, before Baron Pollock and Justice Stephen, the Attorney-General being the appellant, and the Edison Telephone Company the defendants. The statement of the appellant was to the effect that the defendants, by the use of the telephone, had infringed the privilege conferred on the Postmaster-General by the Telegraph Act of 1869. The Attorney-General, the Solicitor-General, Mr. Kay, Q.C., Mr. C. T. Simpson, Mr. W. W. Karslake, and Mr. J. F. Moulton, appeared for the Crown; Mr. Benjamin, Q.C., Mr. Webster, Q.C., and Mr. Cozens Hardy represented the defendants. The Attorney-General, in opening the case, commenced by formally stating the prayer of the Crown and by referring to early Acts of Parliament which were followed by the Acts upon which the Crown more particularly relied. The Postmaster-General was granted power to purchase all telegraph works in the kingdom, but the Telegraph Act of 1869, which among the other statutes was passed for the protection of the public revenue, and the general advantage of the country, gave extended powers in the same direction, and gave the Postmaster-General the exclusive right of using the telegraphs in the United Kingdom. The question then arose what were telegraphs or telegrams within the meaning of the Act. In the Act of 1863 a telegram was stated to be any message or other communication transmitted or intended for transmission by a telegraph, [illegible] called a telephone [illegible] messages on behalf of the defendants had been transmitted. The Act of 1869 stated that the term telegraph should in addition to the Telegraph Act of 1863, mean and include any apparatus for the transmission of messages or other communications by means of electric signals. Nothing could be broader than those words for the purposes of the present case, and he therefore submitted that the defendants were infringing the Acts by sending telegrams, notwithstanding the purchase of those rights by the Postmaster-General at a price of 10,000,000*l*. of the public money. The result of the contention of the defendants appeared to be that whenever any improvement should be made in carrying out works of which the Government had the monopoly such improvement would remove the works out of the control of the Government. The Government had no wish whatever to stop energy for increased knowledge in telegraphy, the sole object of the Crown on the present occasion being to obtain an order for a compulsory license upon all persons who should use the telephone. Telephonic communication would be allowed to companies and to private persons, provided that the rights of the Postmaster-General were protected in the manner provided by the statutes. The next course of his argument would be to demonstrate that there was practically such a physical resemblance between the telegraph and the telephone as to bring the latter within the Act. There were for instance three features which were identical in both, and those were the employment of electricity, variation in the current, and the agency of a conductor, and beyond that it could only be said of the defendants' telephone that it was a most praiseworthy and ingenious mechanical arrangment for varying the strength of the electrical current. By Morse's patent key instrument forty-five words could be transmitted in the course of a minute, which was found sufficient for the present purposes of telegraphy. Formerly the method employed was by the sight of a needle, but by the latest improvements the method was by sound, the variation being caused by the character of the touch upon the transmitting knob. The only difference, therefore, between Morse's patent and the telephone was that in one case communication took place in a language which was not so conventional to the public as in the other case. It was possible even for the operator at one end to know which operator performed at the other end by the character of the touch and nature of the sound produced. Cowper's automatic stenograph possessed the power of transmitting, drawing, or writing at a distance, specimens of which he produced, which had been effected by a transmitter and receiver situated respectively at Waterloo and Woking. It could not for a moment be contended that Mr. Cowper could work his patent without a Government license, and there was no additional reason why the defendants should be allowed to do so. He would now proceed to deal with the defendants' patent itself. In the defendants' own definition he found the telephone was described as a means for transmitting electric currents and conveying sounds at a distance. That was precisely the definition of a telegraph, and, in fact, in subsequent claims to his earlier ones the defendant described his invention as a means for sending "telegraphic sounds" and "speaking by telegraph," and thus the defendant brought the telephone within the Act by his own description. Then again, as regarded the instrument itself, the voice of the operator did not come out at the receiving end as learned gentlemen on the other side appeared to allege, but the voice of the operator caused certain vibrations in the electric current which by means of a mechanical contrivance at the receiving end produced corresponding waves of sound to those transmitted at the operating end. There was thus therefore no practical difference betwen Morse's patent key instrument and the defendants' telephone, except that the latter was a more marvellous and ingenious display of the union of science and nature. The Attorney-General, combatted the view set out in Sir W. Thomson's affidavit that, at the time of the passing of the Telegraph Act of 1869, the telephone, both as an instrument and as a principle, was a thing utterly unknown both in practice and in the scientific world, and he quoted the Count du Moncel's book on electricity, published in 1857, to prove his assertion. He alleged Mr. Edison himself acknowledged he had borrowed the idea of the telephone from Mr. Reiss, who invented an instrument for reproducing sounds musical, but not articulate, in 1860; Mr. Edison had only altered some details of this in its mechanical contrivance, improving and protecting it no doubt. He submitted the telephone was only an ingenious advance by the application of mechanical means in varying and interrupting the electric current and expressing the results to the ear of the person to whom it was conveyed. The defendants said they had not evaded the Act, and they came within the exceptions. But a private wire, as therein specified, meant one belonging to one person, stretched to one place, the apparatus being the exclusive property of that one person, and the messages sent solely on the business of that one entity. As, for instance, that used in the different offices of Bass's brewery, which were separated, but where the owners earned no revenue as against the Crown, but merely carried on their own business. Or, again, no infringement would take place if a London bank chose to have a private wire to its branch at Southampton. But it would not be allowed for that bank to have a central station with radiating lines to neighbouring towns, and to take money from anybody whom they might allow to send messages thereby. He was bound to acknowledge the frank manner in which the defendant company had behaved throughout; their officers had afforded every opportunity for seeing and inquiring into the business. He also hoped the Crown had behaved with equal candour. He, the Attorney-General, had waived all question of penalties, and had, he believed, raised the question with perfect fairness. He then proceeded to explain the method of business, known as the "exchange system," remarking that all the wires of the defendants were open to all the subscribers of the company through the means of the central office or exchange and the switch board. But the subscribers had no property in the "trunk wire," and the whole control of the network of wires lay in the company. The defendants, no doubt, wished to have as many subscribers as they could get to their company; but suppose the whole community were to subscribe, postage would be at an end. The defendants asserted that in Glasgow a Mr. Symington had set up a system of private telegraphy in that city, and they seemed to rely on that fact as somehow favourable to their case. But the fact was the Post Office had thought the matter wrong, though their complaint had stood over till the decision of this case; but because the authorities had been lax, if they liked, or did not think it worth while to enforce their rights, that, he urged, would not induce the Court to misconstrue an Act of Parliament. Throughout the affidavits, there were a number of definitions of telegraphs, &c., by eminent writers and men of science. Those would be taken for what they were worth, as being the *bonâ fide* opinions of the eminent men who gave them, but not as governing an Act of Parliament. There were also many matters of speculative opinion in abstruse scientific matters, and he would endeavour to avoid entering into a profitless warfare on scientific subjects, but would confine himself to cross-examining as to facts. During the address of the Attorney-General the Court on several occasions intimated their impression that the case did not by any means turn upon a question of the invention of the telephone, subsequent to the acquisition of the telegraphs by the Government, and that the point at issue was the interpretation of the wording of the Acts of Parliament, a question of law and not of science. The reading of the material parts in copious affidavits on behalf of the Crown was then commenced by the Solicitor-General and the other counsel. Mr. C. B. Patey deposed to a correspondence between the litigants, in which the Post Office declared they would not allow the defendants to extend their wires more than half a mile from the centre, nor permit any two centres to be connected. Other witnesses gave their opinion that the telephone is, in fact, a telegraph, and described the various steps made in telegraphy and telephony by different inventors, and the machines made for carrying out their ideas, such machines for example as those of Mr. Morse, Mr. Cowper, Mr. Reiss, Mr. Stroh, Mr. Bell, and Mr. Edison himself, as exhibited in Court and alluded to by the Attorney-General.

Mr. Benjamin, when the appellant's affidavits were concluded, began to read those affidavits filed by the defendants.

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The defendants' witnesses denied the similarity of the telegraph and telephone, pointing out the differences. Professors Tyndall and Stokes supported this view. The former said he never on any previous occasion expressed an opinion, in any legal proceedings, on questions affecting the application of science to the uses of life, having always steadfastly declined to do so. But, as he had explained the principles and illustrated the action of the telephones of Mr. Graham Bell and Mr. Edison in the Lecture Theatre of the Royal Institution, he was desirous that his silence should not be misinterpreted, and he had, therefore, on this occasion, consented to express the opinions contained in his affidavit. The difference between the telegraph and the telephone was one of kind and not of degree. Professors Gladstone and Forster testified to the same effect. The telephone, according to them, is a totally distinct invention from visual telegraphy with a needle pointing to letters on a disc, &c., being set in motion by sound. Dr. Hemming was the next witness whose evidence was read. He pointed out the difference between the system of Bell and that adopted by Edison. The mere extension of the power of hearing the human voice could not, in his view, be called a telegraph.

Mr. Justice Stephen said some of the definitions given were more difficult to understand than the thing defined, though they had given much trouble to their authors, who were men of great eminence. But what the Court had to do was not to define the ideal telegraph and point out wherein it differed from all other things, but to construe the words of three Acts of Parliament.

Various other affidavits were then read. For the defendants those of Baron Reuter, Mr. Symington, Lord affidavits by Mr. Greave and Sir Charles Bright were put Rayleigh, and Mr. Hopkinson. For the other side further in. In the last-named it was stated that Sir W. Thomson himself, the defendants' witness, speaking at Glasgow of Graham Bell's telephone, had termed it "by far the greatest of all the marvels of the electric telegraph due to a countryman of their own—Professor Graham Bell."

During the reading of the affidavits Mr. Justice Stephen again drew the attention of counsel to the fact that although it was very interesting to hear the opinions of scientific persons upon the meaning of the word telegraph, and the distinction which undoubtedly they must hold existed between a telegraph and a telephone, yet the real question which the Court would have to decide would be what construction should be put upon the word telegraph in three Acts of Parliament.

After the reading of the various affidavits, or of such portions of them as were considered relevant to the case, the Solicitor-General proceeded to sum up the case for the Crown, premising that it would be unnecessary for him to enter into any considerable amount of detail. He maintained the definition of the word telegraphy, as employed in the Act of 1869, to be any communication, by any means, through a wire that appealed to the senses of a person at a distance. Electricity was at the passing of the Acts the only agent thought of sufficient rapidity to be a useful messenger. In the Act of 1869 the word "electric" was first introduced, and a telegraph was declared to be any apparatus for transmitting intelligence by means of electric signals, no mention of wire being made. It was said by the defendants that what passes along the telephone was not a message; but the Act spoke broadly of "other communications"—that is, any intelligence transmitted from one person to another. It was admitted if this telephone was not different in kind, but only an improvement, modification, or development of the old lines, then it came within the monopoly; and he submitted that the principle was known and adopted in the earlier machines, though progress was made by Mr. Graham Bell and Mr. Edison. By this means the thing transmitted grew more intelligible, resembling more in the one case written, in the other spoken, language. The telephone was an extremely ingenious device; he would not depreciate it in the smallest degree; but he considered it only a step taken in oral telegraphy which had been taken before in visual telegraphy; and in this sense Morse's "sounder" was a telephone. The defendants said their invention was founded on different principles from the telegraph; but their own witness, Dr. Flemming, said Edison's and Bell's telephones were based on different principles, so that if either of them had been in existence before the Act of 1869, one would have been within the Act, but the other one would not. Dr. Gladstone, called for the defendants, also spoke of the difference between Edison's and Bell's telephones, and no doubt such difference existed. As to whether the defendant's came within the exception, those telegrams were excepted in respect of which, or in the collecting, receipt, or transmission of which no charge was made; the wire and the apparatus at each end must be the sole property of the owner, and it must be used and maintained by him alone for his own private business. This was not in any sense the way the defendants carried on their business. The payments by the subscribers covered the doing of acts without which the transmission could not take place.

Mr. Benjamin in speaking for the defence said he thought it was almost time that a word should be heard on behalf of his clients. Their lordships had had for three days an exposition by very able advocates of the views of the Crown, and it was paying them no compliment to say that a great prepossession had been created against the defendants in the minds of the Court. This question was novel to all of them, and had hardly been thought out as yet except by those whose special duty it was. It was surprising with what an enormous mass of irrelevant matter the case had been overlaid. What was the monopoly claimed by the Postmaster-General? Was it a monopoly of apparatus, wires, and instruments? The only one the law gave him was in the transmission of messages, and the sole question was, had the defendants been sending messages in violation of that monopoly? He then dealt with the Post Office Acts (7 Will. IV. and 1 Vict., chap. 33), saying there was nothing to prevent a private individual sending or taking his own letters or those of other people. He was not to collect them or send the letters of other people for hire. Had Parliament granted to the Postmaster-General the monopoly of speech between any two of Her Majesty's subjects?

Mr. Benjamin proceeded to contend that in 1869 telegraph meant a contrivance for communicating between two persons at a distance by means of a preconcerted code of signals, the meaning of which was known to each person, and that the meaning of the word telegraph could not be extended to an entirely new discovery, utterly unknown or unheard of at the time of the passing of the Acts. At that time it was clearly understood that telegraphic messages meant physical material things that could be collected, transmitted, marked, stamped, and carried about, requiring an intervening person to deliver them, and it never was meant that the words should be extended to the speech between man and man. In the Act of 1869 the words "transmitting messages" were never used where private wires, used for the purposes of individuals, were spoken of; public telegraph messages were clearly distinguished.

Mr. Justice Stephen suggested that the words "apparatus for communicating by electric signals" in the Act of 1869 must mean something other than wire, and inquired whether the counsel contended that an ordinary electric telegraph did not come within the Act of 1863.

Mr. Benjamin replied that it would be difficult so to contend; but the Legislature did not at that time contemplate any other mode of communication than by electric signals. He combatted the plausible and ingenious argument of the Solicitor-General that speech was a signal, and maintained that conversation between two persons could not be called "transmitting a message," although such persons were, as suggested by Mr. Justice Stephen, 1000 miles apart.

The counsel proceeded to maintain that the Government monopoly ought to be restricted to its very narrowest limits, and stated that if the matter were before Parliament, he should not fear to discuss the question of public interest, and the protection of the revenue as compared with the public benefit to be derived from the invention, and the rewarding of such scientific benefactors as Bell and Edison. The wires of the defendants, he argued, belong to the subscribers, who do not pay one penny for the privilege of speaking at the time, but maintain the wires solely for their own private purposes. There is no charge for collecting or receiving as in letters or telegrams. Private messages may be sent if the messages are not paid for at the time, and if only the maintenance of the line is paid for by the transmitters who are not the owners. So that whether the lines are considered the property of the company or of the subscribers as a body, or as individuals, they are within this exception.

At this point, the argument for the defendants was continued temporarily by Mr. Webster, who said the question turned on the construction of the Acts of Parliament, and was one of vast importance to the persons he represented. An attempt had been made by the Attorney-General to depreciate the value of the inventions of Mr. Edison and Mr. Bell; but that attempt he was sure would not have any effect out of doors. By the genius of the former the voice was enabled to be transmitted commercially, whereas it had only been conveyed experimentally, as it were, before by Mr. Bell's invention. But he, Mr. Webster, disclaimed any scientific issues which they had not raised, being put on the defendants by the Crown. It was the fact, however, that prior to the discoveries of these two gentlemen no device had ever transmitted the human speech or anything approaching to it. This invention was as novel as it was meritorious, and he challenged the Attorney-General to produce a similar instance of such a perfectly and entirely new result produced by such entirely and perfectly new means. The words of the Act of 1869 should not be interpreted by the light of the knowledge of 1880. The defendants' method of communication was a new and highly useful one for people residing close to one another, who would not use the telegraph, which did not run between their abodes, and the voice sent was an entirely new commercial commodity. Therefore there was nothing in it that detracted from the monopoly of the Crown or could be properly made the subject of revenue?

(To be continued.)

1764.* Telephone Apparatus: R. and M. Theiler, London. [2d.]—This invention relates (1) to improvements in transmitters, in which the pressure of two contacts against one another is made to vary by the vibrations of a diaphragm or sounding board. One of the contacts, in connexion with a battery and the circuit of an induction coil, is fixed to the surface of the diaphragm, while the other contact is suspended as a pendulum, so that it leans slightly against the contact on the diaphragm. An adjustable limiting stop is so placed that the pendulum can be regulated to lean more or less against the other contact, but is prevented from leaving it entirely. (2) Electro-magnetic telephone receivers. Instead of acting upon the diaphragm by only one coil at the centre, or by two coils beside one another, three coils are placed behind, and all act on the centre of the diaphragm, so that the amplitude of the vibrations received is made greater. The iron diaphragm carries at its centre a pin formed one half of brass, the other half of soft steel or iron. A U-shaped permanent magnet carries on each pole an iron tube; one of these tubes almost touches the diaphragm, the other is brought very close to the end of the compound pin. One of the coils is put on the tube which faces the diaphragm, the second coil is fixed to the inside of the same pole of the permanent magnet, and the third coil is put on the tube which faces the end of the compound pin. By these means the action of the current is fourfold. (1) The diaphragm is acted on by the magnetised tube facing it, (2) by the elongation and contraction of the compound pin, (3) by the alteration in the magnetic polarisation of the pin and (4) by the coil attached to the other pole of the magnet, and facing the end of the pin. (April 30, 1880).

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DOLBEAR'S NEW SYSTEM OF TELEPHONY.

A NEW system of telephony has been devised by Prof. A. E. Dolbear, of Tufts College, Mass., which dispenses with the magnet and the fundamental features of the Bell telephone. The system has been set up in the office of the *Scientific American*, where it is stated to have given the "utmost satisfaction." We extract the following notes from the descriptive article written for our contemporary by Prof. Dolbear himself:—

The Receiver

consists, in its simplest form, of two metallic discs about 2in. in diameter, so mounted as not to be in metallic contact, and this is effected by turning a flange in a hard rubber case so that they may be kept apart by it. A cap is screwed down upon each plate, one of them having a small hole in the middle of it to listen at; the other is a larger one, having a knob turned upon it for conveniently holding it in the hand. Through the middle of the knob a screw is sunk which touches the back plate and serves to adjust it to the best position relative to the front or vibrating plate. The back plate is thus fastened at both edge and middle, which prevents it from vibrating, while the front plate is only fast at its edge, leaving the middle free to vibrate. Each of these plates is in metallic connection with the induction coil so as to be its terminals. When thus connected and one makes and breaks connection in the primary circuit a click may be heard by one holding the receiver near to the ear. If a Helmholtz interrupter be employed to make and break the primary circuit the pitch of the fork can easily be heard, and with a *Reiss transmitter* or other suitable one in the same place any kind of a sound will be reproduced. The explanation of this is easily understood. The electromotive force generated by induction in the coil changes the two terminals in the receiver, one positively, the other negatively; they therefore attract each other. One of them is free to move, while the other is rigid. The middle of the freer plate consequently moves slightly toward the other whenever they are electrified, and *in so doing spends the energy of the electricity*, while its elasticity brings it back to its place. It is not essential, however, that both of these terminal plates should be connected to the induction coil, for if only one is connected the recurring charges will cause the free plate to vibrate, for a charged body will attract any other body, so if the connection be to the back plate it will attract the front one and make it move, and if the connection be to the front plate it will attract the back plate and approach it. The effect will be increased by putting the finger upon the terminal that is free; not because it *makes a ground*, as it is termed in electrical science, or completes an electrical circuit, for if the individual listening be as perfectly insulated as glass or hard rubber can make him, the sound is as loud as if he stood on the ground; but the individual becomes electrified by induction—it is the same as enlarging the terminal would be. Consequently, receivers are made having only one wire terminal, the other plate being connected by a conductor to a metallic ring upon the knob, and this receiver is as efficient as the other.

left in the best vacuum yet produced, it is not a matter of much surprise.

When a non-conductor, such as air, or vulcanite, or mica, separates the two plates, there is a complete transformation of the electricity at the limiting surfaces, and with small condensers the efficiency depends upon the electromotive force employed. For low electromotive forces, such as common batteries of a few cells can give, the effect is almost inappreciable, and for this reason such a receiver as this is quite free from the disturbance known as induction, which is so troublesome in the magneto-telephone, such induced currents being generally of low electromotive force.

Among the earliest of my experiments, made while developing this method, was to attach one terminal wire from an induction coil to the outer coating of a Leyden jar, taking the other wire from the coil in one hand, and applying one ear to the knob of the jar. Every word spoken at the transmitter was distinctly heard, but the prickly sensation due to the electricity was too disagreeable. Another receiver, not less curious than the Leyden jar, was found in the pair of insulating handles made for the medical application of electricity. When these were connected to the coil wires, and one held in each hand by the wooden part, while the metallic ends were placed at the ears, any kind of a sound at the transmitter was heard without any difficulty, but of course the same sensation was felt as with the jar. Many forms of condensers have been employed with capacities too small to measure up to two microfarads, and these in all sorts of relations, charging the plates from batteries, from Holtz machines, charging the line as in cable works, &c., all of which give results that differ only in degree.

The Transmitter.

As with other systems in common use, there is a transmitter as well as a receiver. One form is attached to the door of a box containing battery and coil. This transmitter is substantially the same as the one invented by Reiss in 1861. His consisted of a cubical box about 5in. on a side, having an opening on one side to talk into, and another one on top, across which the diaphragm was fastened. A pin of platinum was glued to the middle of the membrane, and connected by a wire to a binding screw. A V-shaped wire with platinum point touched upon the platinum of the membrane, and with its binding screw served to complete a galvanic circuit. The present one differs from that of Reiss only in making the chamber smaller, making the connecting wire on top I-shaped, and substituting carbon or other suitable substance for the platinum; but the platinum does very well. It is a matter of some surprise that the old transmitter is still spoken of as a "make and break" circuit, and that it can only transmit pitch, whereas, whether it breaks or not when a sound is made in it depends solely upon the intensity of that sound, just as with the Blake transmitter. If one talks gently to the original Reiss transmitter, it not only does not break, but it transmits speech with all its qualities.

Accompanying the transmitter is an induction coil, and as the working of the receiver depends upon electromotive force and not upon current, it is necessary, if a coil be used to raise the electromotive force, to have one with many more turns than is needed with the magneto receiver, and the best results have been obtained with a coil having a resistance of four or five thousand ohms, but it is probable that this will be reduced.

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On account of the high electromotive force a better insulation is needed than ordinary telegraph lines give when the induction coil is at the further end of the line, but if it is at the receiving end, and a low electromotive force is employed in the primary, then ordinary insulation will answer. Again, the electromotive force being high, inserted resistances do not so markedly decrease the efficiency of the instrument, as in the case with the magneto-telephone. For instance, the articulation is perfect and loud enough with a resistance of fifty thousand ohms, a resistance equal to five thousand miles of common telegraph wire, and it may be heard through a resistance of a million ohms, practically an infinite resistance.

If one of the terminals of a receiver be charged in any way, the reaction between the two plates will be stronger than it will be without. Let, then, one terminal be attached to a knob of a Holtz machine that is kept charged by rotation. The sounds will be heard much louder, and any other source of electricity with high potential will answer the same purpose. Hence a battery of a large number of cells may be substituted for the Holtz machine, and one of the terminals of the battery may go to the ground, though this is not essential. This arrangement will keep the terminal-plate charged to the potential due to the chemical relations and number of cells in the battery. If the battery be placed in the line wire it will keep both ends of the line charged. A Volta's pile may be substituted for the battery in either place, and so may a charged condenser of any capacity, the electrically charged terminals in this system acting in a way analogous to the permanent magnets in the magnetic system. There are various other ways of employing condensers, and as one would infer from the preceding descriptions of the phenomena, these condensers will talk, that is, they will reproduce in sound the varying electrical conditions to which they may be subjected, as will also either a battery or a Volta's pile. I have often heard them talk, and have made many experiments with such receivers.

A complete exhibit of this new system has been prepared and will be on view in the International Electrical Exhibition at Paris next August.

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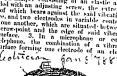
230746. Microphone.—(Emile Berliner, Boston, Mass.)—(Filed March 31, 1880.)—(No model.)—Patented in England, May 5, 1880; in Belgium Jan. 9, 1880; and in Italy Feb. 15, 1880.

Claim.—1. A microphone or contact-telephone in which one electrode is left free to move in position by being suspended from or attached to a permanent magnet for the purpose set forth. 2. In a microphone or contact-telephone, the combination of a stationary electrode, a diaphragm consisting of an elastic metal provided with an adjusting screw, the extreme point of which is opposite the said vibrating surface, and two electrodes in variable contact with one another, which are supported between the said screw-point and the edge of said vibrating surface. 3. In a microphone or contact-telephone, the combination of a vibrating surface forming one electrode of an electric



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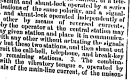
tric current, a pendulous weight forming the other electrode, and a device for changing the inclination of said pendulous weight, substantially as and for the purposes set forth. 4. In a microphone or contact-telephone, the combination of the diaphragm B, the block P, adjustable weight G, plate H, forming an armature-magnet, E, electric plate I, and adjusting-screw J, substantially as and for the purposes set forth. 5. In a telephonic apparatus, a magnet forming an electrical circuit, and electrodes on its face in contact, substantially as and for the purposes set forth.

234772. Switch for Telephone Lines.—(Charles B. Hoadley, New York, N.Y.)—Filed March 15, 1880.—(No model.)

Claim.—1. In a series of telephones upon the same main circuit, connected with a central station, the combination, with each of the telephones, of a shunt or cut-off, substantially as set forth over the main circuit, and a talking device for each of said shunts or cut-outs, substantially as set forth, consisting of a talking by a current in one direction over said main circuit, and for unlocking by a reversed current, whereby any given number of telephones may be placed in communication, and all the other telephones left in or cut out of the circuit by an operator at the central station, except those at stations where the shunt or circuit is locked. 2. The combination, with the



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telephone and signal at each station, of a telephonic shunt and shunt-lock operated by a series of pulsations of the same polarity, and a signal-shunt and shunt-lock operated by a pulsation of the opposite polarity, substantially as and for the purpose set forth, whereby the operator at the central station may call any telephone and place it in communication with any other without actuating the signals of any but those to which the shunt and then shunt and of the remaining stations, and break-key thus, with the vibratory tongue. 3. The combination of the main-line current, as operated by reversals of the current, with the telephone-shunt and its cut-off shunt, operated also by said tongues and controlled by a current over the main line, substantially as described. 4. The combination, with the vibratory tongue as operated by reversals of the current, of the telephonic apparatus controlled by said tongue, and the telephone-shunt and its operating devices controlled by a current over the main line, substantially as described. 5. The combination, with a single polarized magnet and its vibratory tongue, armature, the unison device, and cut-off shunt controlled by said armature, of a local telephone-shunt and the devices operated by said magnet for actuating said cut-off and telephone-shunt, substantially as described. 6. The combination, with the telephone switch-lever I, carrying the spring arm g, having a contact-point, and the spring f, in electrical contact therewith, of the metal segment m, having its ends insulated from each other when the switch-lever is in the position one of said ends will be in contact with one spring and the telephone switched out of the main circuit, and when the said lever is swung outward the other end of said segment will be in contact with another spring, and the telephone switched into the main circuit, substantially as described.

The Lilly Mechanical News 1881.

WHY THE TELEPHONE OPERATES.

A correspondent of the Cleveland Trade Review, signing himself "An Experimenter," writes as follows:

"Millions of people use the telephone without inquiring as to its principle, and none of the inventors of this mode of communication (for according to evidence there were several) or any of the adepts, have done anything to enlighten the public on the question. We have the fact that the speaking telephones than the Bell are coming into operation which do not depend on electric induction, but on the communicative properties of the air itself. This circumstance confirms my theory.

"Most people are aware that the sound from scratching with a pin upon a piece of dry timber at one end can be heard distinctly at the other end. This results, I take it, from the fibrous character of the wood—a distinance of contact between particles. I conclude that it is the fibrous character of the atmosphere to which we are indebted for telephonic communication. The atmosphere, when pure, is composed of two gases, with the admixture of a small proportion of aqueous vapor and carbonic acid.

"Now, as the atmosphere is admitted to be a body, may we not suppose that it is constituted like other elastic bodies, though it cannot, like these that are solid, be brought within the sphere of microscopical investigation, and that this aqueous vapor is distributed throughout the atmosphere in the form of an infinitely minute and symmetrically reticulated fibrous tissue, susceptible of tension and attenuation, like that known to exist in animal and vegetable substances?

"By such a supposed distribution of the aqueous vapor, an independent vehicle of sound is at once supplied, and the gaseous elements of the atmosphere are left to perform their wonderful and important duties in the economy of the creation undisturbed. The supposition which I have hazarded, will also satisfactorily account for the greater facility with which sound is transmitted in the lower regions of the atmosphere, where the relative proportion of the aqueous vapor to that of the gaseous elements is greater than in its higher regions."

Mechanical News, Dec. 25, 1880.

ELECTRICIAN, DECEMBER 25, 1880.

3971

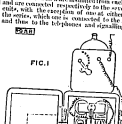
Engineer Mechanic
World of Science
Nov 6th 1880

J. T. GENT AND CO.'S MICROPHONE TRANSMITTER.

THE patentees inclose an instrument in a d. mast walnut case, to the lever of which they attach, leaving a slight space between, a

diaphragm of wood; to this diaphragm they affix thin plates of metallically-prepared material, the plates nearing but not touching each other.

These attach to lever brackets, having spindles on which are loosely-hung metal arms, each arm carrying a plug or pencil of prepared material, these again resting on plates affixed to diaphragms. They prefer to use from 12 to 16 of these suspended arms, arranged in series of 2 or 4, so that the current of electricity to traverse the whole must pass over successive sets. Each arm is adjustable, and may be placed horizontally or vertically. The object of using a row of plates is that the whole of the vibrations of diaphragm may be utilised, and the redundancy current be correspondingly more powerful. The



plates at one end are connected to battery, and at the other end to a coil in the case.

Any form of telephonic receiver may be used with this transmitter, and they use flexible tubes to protect wires from injury, thus obviating one objection to the use of wire conductors between transmitter and receiver. The usual automatic switches and call-bell form part of the apparatus. The transmitter and use of tubes for purpose or use are patented.

each circuit any number of stations, each station being provided with an apparatus, which, when an audible signal is given at any station, will give visual station there, substantially as described. The receiving one circuit with signal bell, each of which is fully described. The switch board receiving each of the external circuits, for use, telephones, keys, and signalling apparatus, with one of the ends of the coils of the electro-magnets of the system from external sources together. It consists of a suitable frame-work containing a series of spindles and are connected respectively with the external circuits, with the exception of two at the extreme end of the series, which are connected together, and thus form the telephones and signalling appa-

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1. 1880. Improvements in Telephonic Apparatus and Systems. *By John Henry Johnson,*—(A communication by *George Lee Anthony, of Boston, and Thomas Augustus Watson, of Everett, in the State of Massachusetts, United States of America.*)

In the system there are a series of telephonic signalling apparatus, one at central station, and one at

tuses at the central station. Immediately behind the upright bars and at right angles to them are a series of parallel horizontal metallic rods, also insulated from each other, which serve to electrically connect two or more of the upright bars together by means of metallic connectors, which connectors can be slid on the upright bars, and when released spring into contact with the horizontal rods. Each of the horizontal rods connects with a spindle, and each spindle has which is connected to the electro-magnet of a suitable vibrator, which lies full a number plate when the electro magnet of the annunciator is excited or otherwise. Connection and from said electric magnet connection is made with the battery. Each spindle is in addition in exchange system is also provided with a switch-lever, pressure of one two stations can communicate with one another telephonically a person at any other station is prevented from overhearing the conversation without notifying the stations talking with one another. This result is accomplished by means of a rocking switch, which in this system is placed at each station. When a telephonic signal is given at any station, and successfully passes through the signal bell of each station to the next station, and the telephone when not in use is not in circuit; but when it is desired to communicate by telephone with a station on either side, by the intervention the station

surveillant de la surface, le mécanisme du ventilateur et les portions des divers postes. Il conviendrait que ces derniers fussent astreints à noter, avant leur descente, la pression barométrique, et à la comparer avec les observations du poste précédent. Le mécanicien, ou le chef de place, devrait également, à certains moments de la journée, observer le baromètre, et, dans le cas où il constaterait une baisse rapide, en prévenir les surveillants du fond, qui auraient à prendre des mesures en conséquence. En même temps, la marche du ventilateur serait activée. Ces mesures ont d'ailleurs déjà été introduites dans la pratique par les directions de plusieurs mines à grisou. La température devrait aussi être observée : dans ce but, il serait utile d'établir à la surface des thermomètres à maxima et à minima. »

Je me tiens compte des recommandations qui précèdent n'eût entraîné une lourde responsabilité, dont les conséquences pourraient, dans certains cas, à notre avis, provoquer les rigueurs de la loi.

Chaque fois qu'une chute barométrique aussi prononcée que celle du 17 de ce mois serait constatée[1], toutes les fosses à grisou devraient être évacuées pendant au moins quelques heures. Le travail ne reprendrait qu'avec la hausse du baromètre; la ventilation serait en outre rendue beaucoup plus active et des recommandations spéciales seraient faites aux mineurs. On nous répondra peut-être que ce système offrirait certains inconvénients dans la pratique; mais nous ferons observer que ces inconvénients sont peu de chose lorsque la vie d'un grand nombre d'hommes se trouve en jeu.

Les mesures de précaution que nous prenons ici pour les mines sont, dans un autre ordre d'idées, les mêmes que celles dont tous les capitaines de navires sont moralement obligés de leur conseiller. Leur existence en dépend souvent, du reste. Le vaisseau qui attend le signal du départ et est parti retenu au port par l'annonce d'une tempête prochaine. Ce retard à se mettre en route lui est toujours préjudiciable, mais il vaut mieux souffrir ce contre-temps que de s'exposer à périr corps et biens, pour avoir fait il dès avis météorologiques précis de leur exigence, ou même du navire tout entier.

Les responsabilités sont les mêmes pour le commandant d'un navire et le directeur d'une mine. L'existence des hommes placés sous leurs ordres est intimement liée à leur prévoyance, à leur sang-froid et à l'observation des règles qui se rapportent à l'exercice de leurs fonctions.

Il est à espérer que la météorologie, à laquelle la navigation est déjà redevable de beaucoup de bienfaits, pourra, dans un avenir prochain, rendre des services non moins importants à l'industrie houillère. Elle ne sera certainement pas une panacée à tous les malheurs qui arrivent dans les mines, mais on peut affirmer qu'elle servira à en diminuer notablement le nombre. Elle acquerrait par là un nouveau titre à la reconnaissance de l'humanité.

A. LAMASTRE.

[1] Depuis plus d'un an, l'Observatoire royal de Bruxelles a pris à tâche de signaler aux mines, par voie télégraphique, les baisses barométriques anormales. Malheureusement ces avis restent d'ordinaire sans effet, et il est important de pousser le tube de 15 centimètres.

APPAREIL AVERTISSEUR DES GELÉES

Les cultivateurs prennent constamment un appareil capable de les prévenir en faisant marcher automatiquement une sonnerie électrique dès que la gelée se ferait sentir pendant la nuit. Il suffit de tendre près de terre un fil de fer isolé de dix à quinze mètres de longueur; de telle façon qu'une de ses extrémités soit fixe et que l'autre soit libre. Si la température s'abaisse, le fil se contracte et diminue de longueur; le fil peut être disposé de telle façon que les deux contacts correspondant à la température de 0 degré, ou extrêmité libre termine en crochet établisse un contact et ferme le circuit d'une pile, de manière à faire fonctionner une sonnerie. Il va sans dire que nous n'indiquons ici que le principe d'un système qui peut être établi de plusieurs manières différentes. Un ingénieur physicien a même proposé de compléter cet appareil, en faisant communiquer l'extrémité libre du fil de fer avec un bras de levier qu'il arriverait à boucher ou ouvrir avec la température de 0 degré. Le contact ferait basculer un poids sur une mauvaise qui mettrait le feu à des matières combustibles. Les matières en brûlant produiraient un nuage de fumée destiné à prévenir les cultivateurs des effets du refroidissement nocturne. Il y a dans ces idées très originale qu'il serait intéressant de mettre en pratique.

LES TÉLÉPHONES SPÉCIAUX.

La plupart des téléphones connus se composent toujours d'un transmetteur, tantôt magnétique, tantôt microphonique, d'une ligne et d'un récepteur dans lequel on retrouve toujours comme parties essentielles :

1° Une plaque vibrante;
2° Un moyen aimanté ou un électro-aimant;
3° Une hélice traversée par les courants ondulatoires émis par le transmetteur.

Aucun de ces organes *essentiels* d'un téléphone n'existe dans l'*indispensable* à son fonctionnement, mais il y a plus, on a pu entendre et la parole *sans récepteur*, ou du moins sans récepteur apparent, et entendre le photophone de B-ll nous a montré qu'on pourrait transmettre la parole à distance *sans fil conducteur*.

Ce sont les singuliers appareils qui réalisent ces conditions que nous avons cru pouvoir grouper sous le titre de *téléphones spéciaux*, à défaut

dinaux; les matériaux solides consistent en débris volcaniques (pyroxène et feldspaths triclinique) et en pyrite.

Champignons parasites des vignes. — M. Maxime Cornu, dans une note analysée par M. Dumas, montre comment la théorie des germes s'applique à l'histoire des champignons épiphytes. Il s'occupe spécialement des parasites de la vigne. L'auteur remarque que l'oïdium et l'anthracnose tuent souvent des grappes qui, mêlées ensuite dans le fumier, ne sauraient se conserver. Mais il ajoute qu'il est loin d'en être de même pour le péronospore, et il tire de ce fait la conclusion que tout traitement de vigne contaminée par ce dernier, loin d'être introduit dans un compost, devra être détruit par le feu avec le plus grand soin.

Électricité. — Le décès de M. Lévêque avait laissé vacante une place de correspondant dans la section de physique; l'Académie y pourvoit aujourd'hui. La liste de présentation portait : en première ligne, M. Abria, à Bordeaux; en deuxième ligne *ex æquo* et par ordre alphabétique : MM. Cossa, à Montpellier, Violle, à Lyon, et Terquem, à Lille. Les votants étant au nombre de 49, M. Abria est élu par 45 suffrages; trois se portent sur M. Violle, 2 sur M. Terquem et 1 sur M. Cossa.

Le vénéré a été réellement trompé par un comité secret dans lequel ont été élus les sept experts de Commissions de paix. Cependant, nous devons enregistrer, outre deux très longues communications de M. Chevreul et de M. Tresca; une note de M. Raudot sur une pile *imputrescible* qui extrairait de l'eau plus d'hydrogène que celle-ci n'en contient! (16 volumes pour 1 volume d'oxygène); — une réclamation de priorité formulée par M. Buzer contre M. de Rondelet, relativement à la loi d'extinction des liquides; — les offres de service de M. Lefèvre, capitaine de frégate, qui se met à la disposition de l'Académie pour observer le prochain passage de Vénus; — la description d'un avertisseur pour les incendies, par M. Barbier-Dreuil; — un mémoire de M. Bitte sur l'action mutuelle de l'acide chlorhydrique et des chlorures métalliques; — des expériences de M. Chapuis sur le spectre d'absorption de l'ozone; — enfin des recherches médicales et statistiques sur la ville de Cette par M. Louis Amat.

STANISLAS MEUNIER.

NOUVEAU MICROPHONE

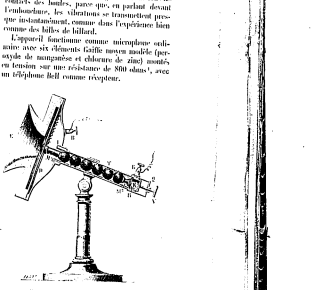
DE M. ROTHEY, DE PARIS

Ce microphone, à contacts multiples, représenté dans la figure ci-contre, se compose d'une rondelle charbon R, fixée à l'extrémité d'un tube de verre T d'un centimètre de diamètre, fixé lui-même sur un pied à genou, ce qui permet de faire prendre à l'ensemble de l'appareil toutes les inclinaisons.

L'embouchure porte une plaque d'ébonite de 1 millimètre d'épaisseur, sur laquelle est fixée une masse de cuivre M qui pénètre un peu dans le tube du verre. Dans ce tube, se trouvent six boules de charbon du comme d'un diamètre un peu plus petit, de façon à pouvoir s'y mouvoir très librement.

Le microphone est complété par une seconde masse de cuivre M' s'appuyant sur le haut d'une cuisse ronne K, par l'intermédiaire d'un petit ressort en spirale non représenté sur la figure. La vis V fixée sur l'écrou O sert à régler la pression de la masse M contre les boules. Les variations de résistance du microphone se produisent également sur tous les contacts des boules, parce que, en parlant devant l'embouchure, les vibrations se transmettent presque instantanément, comme dans l'expérience bien connue des billes de billard.

L'appareil fonctionne comme microphone ordinaire avec six éléments Gaiffe mouvé modèle (peroxyde de manganèse et chlorure de zinc) montés en tension sur une résistance de 800 ohms[1], avec un téléphone Bell comme récepteur.



Microphone de M. le docteur Raudot.

En employant des courants *induits* et un téléphone récepteur à 11 fil fin, condition nécessaire avec les courants induits, la distance peut être considérablement augmentée et atteindre, avec des résistances artificielles, jusqu'à 250 000 ohms.

Nous avons constaté à des expériences faites avec ce microphone, et nous avons constaté qu'il transmet très nettement la voix, sans altérer son timbre et sans craquements.

[1] Comme valeur *pratique*, une résistance de 1 ohm repréente celle d'un fil de cuivre pur de 1 millimètre de diamètre et de 19,5 de longueur, ou environ 10 mètres de fil de cuivre de cinquième d'un égal diamètre, ou bien encore 97 m. très de fil de fer de 4 millimètres de diamètre (fil télégraphique ordinaire).

Le Propriétaire-Gérant : G. TISSANDIER.

Imprimerie A. Lahure, rue de Fleurus, 9, à Paris.

THE TELEPHONE.—Mr. Rolls, of the South-Western Railway Telegraphs, has lately been carrying out some experiments with the Gower-Bell loud-speaking telephone which have proved remarkably successful, as the first plans the instrument was tried over sections of varying lengths as a means of verbal communication between signal cabins, a noteworthy point in the experiments being that the block wire itself was the only connection between the distant points, Mr. Rolls placing the telephones in multiple circuit with the block instruments at each end, between line and earth, in such a manner as in no wise to affect the block working; in fact, while listening at the telephone a train passing the distant cabin could be heard simultaneously with the receipt at the sending-signals upon the block instrument indicating the train's departure, the movement of the levers placing signals on behind the train five miles away could also be distinctly heard. Conversation was carried on with the utmost ease by inexperienced persons, and all sounds were remarkably clear, although several through postal wires would be powerful currents are on the same set of posts. This form of telephone having proved so successful, was subsequently tried as a long circuit speaking instrument between Yeovil and Exeter, a distance of forty-nine miles, upon the same set of poles as before; and despite the usual effects of induction, the voice was as remarkably predominant and as clearly and distinctly heard as in the previous experiment over a short section. Further trials indicated that the distances mentioned might be at least doubled.

THE TELEPHONE FOR DIVING OPERATIONS.—*L'Electricité* states that M. Dubois has introduced the use of the telephone in connection with the operations of the bed of the bay of Naples. By this means the lieutenant overheard are able to communicate with each other as quickly and intelligibly as could be desired.

A novel microphone, made by M. Bondet in Paris (*La Nature*, No. 394), has the general shape of a telephone as a support. It comprises a mouthpiece, in which is an ebonite plate in which, with a short piece of copper connecting from its middle a short way into a glass tube in which are six little balls of retort carbon in a row; a second piece of copper following the tube, ending in a small cup-shaped piece of carbon, which is in contact by means of a screw with the carbon balls. This cup can be raised or lowered by means of a milled head, with an Gimbal in tension, by a fulcrum and chain, is also mounted voice very distinctly without altering its timbre and without the disturbing sounds being rendered.

Electrician March 19 1881

LONG DISTANCE TELEPHONE SYSTEM OF DR. HERZ.

A new system of telephony, invented by Dr. Herz, is attracting a great deal of attention among electricians in Europe, on account of the surprising distances through which telephonic communication has been maintained by it. The first announcement of the invention in the papers of September stated that conversation had been carried on through the cable connecting Brest and Penzance, a thing generally considered impossible, on account of the comparatively sluggish action of the electric current in submerged cables. The experiment proved sufficiently successful to encourage Dr. Herz to push forward his investigations, and, according to foreign advices, he has been rewarded by being enabled to carry on conversation through an actual distance of over six hundred miles over circuits having no special adaptation to telephonic communication.

Dr. Herz has apparently solved two difficult problems: that of increasing the amplitude of electrical vibrations, and that of neutralizing currents foreign to the telephonic circuit. The first he accomplishes by a microphonic transmitter with multiple contacts, and a system of derived currents; the second by interrupting the line and intercepting conductors or diffusers. We have received an extended illustrated description of this interesting invention, written by Th. Du Moncel, which will be published in full in SUPPLEMENT 274.

A SPEAKING CONDENSER.

IT is well known that the capacity or condenser of tinfoil sheets when connected to the terminals of the coils of the secondary circuit of an induction coil will produce musical notes when the primary circuit is excited by a battery and a Bell's electric vibrating telephone with intermittent contacts. The note to be heard is determined by the number of the pauses, whose vibrating telephone makes and breaks the primary circuit, in accordance with the vibrations of the coils, and the corresponding induced currents acting upon the condenser. The transmitter set into this vibrating telephone, which is audible as a humming sound, when, as Professor Hughes has called it, the "singing condenser" is introduced, was likewise, by Mr. C. F. Varley, used carefully investigated by Mr. C. F. Varley, and other French experiments, in connection with the application to telephony by Mr. Edison, who has succeeded in making it reproduce articulate speech after the manner of the Bell telephone receiver. M. Dussaud found that when a carbon microphone was placed in the primary circuit of an induction coil, instead of a free interrupting clicking of a vibrating and the striking of a bell could be imperfectly heard, but speech appeared quite inaudible. Following up this promising step, however, by including in the circuit of the secondary coil, with the condenser M. Dussaud found that speech was then delivered with great distinctness. For articulation the sensibility is simply inverted between one end of the secondary circuit and one pole of the condenser. Upon the terminals of Ruhmkorff coil, under the simple influence of the induced currents of the secondary circuit, articulate speech sounds, were found to reproduce with visibility the most delicate articulations when the condenser was made with sufficient capacity. With a condenser of 2 microfarads the best results were obtained from a condenser of this capacity. With a ten-centimetre induction coil, one metre of wire, and thirty-six layers of tinfoil. Leclanché cell in the primary circuit, gives pure progress now being made in Glasgow. It is also worthy of remark that Messrs. Graham have just secured the right to the exclusive use of the Gower-Bell telephone over an area extending to thirty miles round Glasgow, an area which embraces many towns and districts of commercial and manufacturing importance. But perhaps the most important fact in connection with the enterprise in which Messrs. Graham are engaged is that the firm has been granted a license from the Postmaster-General, in response to an application which they made to the Post Office authorities prior to (not after) the decision given by the Judges of the Court of Exchequer in the Telephone case. We have not learned what the exact terms of the license are, nor are we certain that the formal document has yet been handed over to Messrs. Graham; but at the very fact that they have been granted a license is quite sufficient to show how the legal proceedings initiated by Mr. Martin's-le-Grand regard the immediate future of telephonic telegraphy. We may now confidently expect that licensed telephonic exchanges will be established in other parts of the kingdom, unless the Post Office people think that they can overwhelm all the work that may arise until the new system of speech-communication between persons at a distance shall have attained much more formidable proportions than at present confronts us in some quarters. It is scarcely expected that in the meantime any more licensed exchanges will be allowed in Glasgow, and it is an step in advance to know that, by securing a legal position for themselves, Messrs. Graham have inspired much confidence in the minds of their exchange-subscribers, both actual and prospective.

BELGIUM.—In September last an International Congress of Commerce and Industry was held in Brussels, and in the Scientific Section papers were read on electrical subjects, such as "Telephonic Communication," "Electric Light," &c. A brief report of the Congress is given in Mr. Kennedy's report to Earl Granville. He says:—"M. Bede read an interesting report on telegraphic communication, explaining the battery telephones for which the Reiss and Gray apparatus are used, and the telephone without battery, of which Bell's system is the prototype. Two apparatus with batteries have, he said, been taken up—viz., Edison's and Blake's. M. Bede, without speaking more in favour of the one than the other, simply affirmed that numerous systems are in existence, and capable of meeting all the wants of the public. He went on to examine the question of telephonic communications in cities, and from one town to another. He considered it important that the connection between the central offices and telephonic lines should be perfected and examined, the advantages and disadvantages of above and under ground telephonic wires. He thought that the State should not monopolise telephonic communication, but should leave its working to private enterprise, and not fear its competing with the telegraph or Post Office. M. de Locht Labye, an engineer, explained to the meeting a pantelephone of his own invention. In his opinion local telephones are, and must be, undertakings of public interest, or, in other words, each person, subscriber or not, should be able to use it. On this condition only could the State allow the highways to be used. He was strongly in favour of a concession being given to one company in each district, as the best means of promoting the interests of a service incapable of division. He quoted the examples of London and Paris, where, after numerous and cumbersome trials of competition, companies amalgamated; and, in conclusion, he suggested that each concession should be put up to auction. M. Bede expressed a contrary opinion to that of M. de Locht Labye as to each concession being put up to auction; he thought it should be left entirely to private enterprise; he added that the Department of Public Works was antagonistic to the proposal, and, with every respect for the Telegraph Department, he still thought that his new system would best succeed under private companies. M. Hubert considered that there should be but one company per district, so as to avoid disputes; but that a monopoly could not belong to Government. In answer to M. Bede, he would say that telephonic connections exist already, and that there had been no complaints made against any of the offices so connected; he thought that the Government would manage matters better than a private company. M. Bonguie remarked that in France the State alone has the right of laying wires; and that this circumstance is a great drawback to telephone development. M. Bede thought that no comparison could be drawn between telegraphic and telephonic apparatus; therefore the staff of the State would not serve for the last-named undertaking. M. Desguin considered that only one branch should exist in each town unless the companies were amalgamated; otherwise the subscribers to one would be isolated from others, and the public would consequently be deprived of advantages. As regards the stimulus of competition, it would be replaced by the interest of companies to increase the number of their subscribers and to perfect their apparatus. He thought that the intervention of Government would be more desirable than in postal and telegraphic matters, as the telephone requires no intermediaries are of general interest, desires that a law may be speedily voted on the granting of concessions."

A SPEAKING CONDENSER.

IT is well known, that the capacity or condenser of tinfoil sheets when connected to the terminals of the coils of the secondary circuit of an induction coil will produce musical notes when the primary circuit is excited by a battery and a Bell's electric vibrating telephone with intermittent contacts. The note to be heard is determined by the number of the pauses, whose vibrating telephone makes and breaks the primary circuit, in accordance with the vibrations of the coils, and the corresponding induced currents acting upon the condenser. The transmitter set into this vibrating telephone, which is audible as a humming sound, when, as Professor Hughes has called it, the "singing condenser" is introduced, was likewise, by Mr. C. F. Varley, used carefully investigated by Mr. C. F. Varley, and other French experiments, in connection with the application to telephony by Mr. Edison, who has succeeded in making it reproduce articulate speech after the manner of the Bell telephone receiver. M. Dussaud found that when a carbon microphone was placed in the primary circuit of an induction coil, instead of a free interrupting clicking of a vibrating and the striking of a bell could be imperfectly heard, but speech appeared quite inaudible. Following up this promising step, however, by including in the circuit of the secondary circuit and one pole of the condenser M. Dussaud found that speech was then delivered with great distinctness. For articulation the sensibility is simply inverted between one end of the secondary circuit and one pole of the condenser. Upon the terminals of Ruhmkorff coil, under the simple influence of the induced currents of the secondary circuit, articulate speech sounds, were found to reproduce with visibility the most delicate articulations when the condenser was made with sufficient capacity. With a condenser of 2 microfarads the best results were obtained from a condenser of this capacity. With a ten-centimetre induction coil, one metre of wire, and thirty-six layers of tinfoil. Leclanché cell in the primary circuit, gives pure musical sells can be amplified by one-litmus-cadmia cell, for articulation the sensibility battery in the secondary circuit should be of battery in the primary circuit, as has been told, but that the voice is feeble, but when ten cells in the secondary, a voice continuous cell, and two cells in the primary, the voice is as loud as that of a good Bell telephone; and with fifteen Bunsen cells in the secondary, the sounds were brightened and speech could be heard with the ear held a yard from the receiving instrument. This is a practical result of some importance. M. Dussaud has yet further improved in response to an application which they made to the Post Office authorities prior to (not after) the decision given by the Judges of the Court of Exchequer in the Telephone case. We have not learned what the exact terms of the license are, nor are we certain that the formal document has yet been handed over to Messrs. Graham; but at the very fact that they have been granted a license is quite sufficient to show how the legal proceedings initiated by Mr. Martin's-le-Grand regard the immediate future of telephonic telegraphy. We may now confidently expect that licensed telephonic exchanges will be established in other parts of the kingdom, unless the Post Office people think that they can overwhelm all the work that may arise until the new system of speech-communication between persons at a distance shall have attained much more formidable proportions than at present confronts us in some quarters. It is scarcely expected that in the meantime any more licensed exchanges will be allowed in Glasgow, and it is an step in advance to know that, by securing a legal position for themselves, Messrs. Graham have inspired much confidence in the minds of their exchange-subscribers, both actual and prospective.

Electrician March 19 1881

SOMETHING FOR THE AMERICANS.—The celerity in switching, for which praise is given to the Glasgow Telephonic Exchange, is said to be in a measure due to the plan of the mirrors in the panelling of the switch-boards, a device which effectually prevents the eyes of the young lady operators from wandering off the boards for more than two seconds together all the time they are on duty. Falling discs are consequently instantly seen and attended to.

Tel. Journal June 1, 1881

Tel. Journal June 1, 1881

Engineering June 24 1882

Engineering June 24 1882

Engineering June 24 1882

441 Scientific American, Feb. 26, 1881

LONG DISTANCE TELEPHONE SYSTEM OF DR. HERZ.

A new system of telephony, invented by Dr. Herz, is attracting a great deal of attention among electricians in Europe, on account of the surprising distances through which telephonic communication has been maintained by it. The first announcement of the invention in the papers of September last stated that conversation had been carried on through the cable connecting Brest and Pontanezen, a thing generally considered impossible, on account of the comparatively sluggish action of the electric current in submerged cables. The experiment proved sufficiently successful to encourage Dr. Herz to push forward his investigations, and, according to foreign advices, he has been rewarded by being enabled to carry on conversation through an actual distance of over six hundred miles over circuits having no special adaptation to telephonic communication.

Dr. Herz has apparently solved two difficult problems: that of increasing the amplitude of electrical vibrations, and of neutralizing currents foreign to the telephonic circuit. The first he accomplishes by a microphonic transmitter with multiple contacts, and a system of derived currents; the second by interrupting the line and interposing condensers or diffusers. We have received an extended illustrated description of this interesting invention, written by Th. Du Moncel, which will be published in full in SUPPLEMENT 274.

Deutsche Illustr. Ztg. 16. 1881.

THE DEVELOPMENT OF THE ELECTRIC TELEPHONE.

The telephone was introduced as a practical business medium in May, 1878. There are now 300 companies, or districts, in the United States. This increase has not been more rapid than the improvements in the telephone apparatus and appliances. Instead of the original box, which, if attached to a wire connected with numerous other boxes, made all receivers of each and every message audible, there are now central exchanges in the cities and at the terminal points of railroads. Each box is now only known to those engaged in it. By latly improved devices at the exchange offices, delays or blunders in giving communication seem to be only the result of stupidity or carelessness on the part of one of the employé's whose duty is to connect the wires. One is expected to do this duty within fifteen seconds after the call. By neat systems of checks, dereliction may be traced to the offender. A very late invention is an elevated tube for telegraph and telephone wires, designed to do away with the unsightly poles on the streets and the awkward features on the house-top, and to prevent the interruption of service by the breaking and crossing of lines. Electric street lights and clocks, fire alarms, ambulance and police calls, letter boxes and drinking fountains, can be attached to this contrivance and the pillars that support it. Experiments in laying telephone wires underground have so far proven successful for only a distance of between five and six miles.

Opening an account with a telegraph office, may from his office telegraph by telephone to any part of the world, besides effecting, if a branch telegraph office has to be used instead, a saving in receiving the message of at least thirty minutes.

Naturally, the minds of inventors and operators were turned to the local fields of telephone development, although occasional experiments have been undertaken and made in long distances. Through literality, or from circumstances beyond control, the fifteen-mile limit has been extended by the Western Union, and an eastern telephone company has opened speaking communication between Boston and the cities of Lynn, Worcester and Springfield, the latter city being about one hundred distant. Among the experiments conducted under the patronage of the French government on the telegraphic lines of the state, one of the most extraordinary was the transmission of a speech on a single wire from Tours to Brest, passing through Paris, the length of which exceeded 800 miles. A prominent inventor and the manager of a telephone exchange in New York cities that, from knowledge gained from experiments, long distance communication can be satisfactorily made from New York to Albany by the use of a single wire. It may be here observed that telephone wires are exceedingly sensitive to induction, and the crossing of two wires renders sound unintelligible in transmission through them. In this connection it is announced that in England trials have demonstrated the practicability of the submarine telephone.

Mining & Scientific Press, April 16, 1881.

DANGER OF LIGHTNING FROM TELEPHONE CONNECTIONS.—The Cantonal government of Zurich, having been applied to by a telephone company for permission to fix the supports of insulators on the tops of certain public buildings, applied to Prof. Kleiner for an opinion. The following is a summary of the chief points in his report:

1. The danger of lightning in houses over which telephone wires are stretched is not increased, but lessened, if the total conductivity of a wire is approximately equal to that of a lightning conductor. This condition is not always fulfilled under existing arrangements. It may be insured by very simple arrangements, such as the introduction of a special wire for the conduction of lightning wherever the number of wires of two millimeters in thickness running in the same direction is less than 60. This should be insisted upon in all cases. Single connections running along the houses should be stronger than at present—at least as strong as telegraph wires.

2. As the properties of a telephonic plexus for attracting and conducting lightning extend over far wider tracts than those of a lightning rod, a strict regulation of their make and condition is necessary.

The use of telephones should be suspended during thunderstorms.—*New Zurich Zeitung.*

Journ. Soc. Tel. Eng. 11. 1881.

Speech by Telephone.
From the London Times.

PARIS, AUG. 27.—I have several times had opportunities of exhibiting the telephone to the military inmates of the exhibition, but one which will be the chief attraction to a large class of visitors will be that which gives some account of the microphone and microphones which are to be seen there.

I must describe the very interesting auxiliary of these instruments. It is none other than the well-known Edison phonograph, which, during the pleasant of the day light after night noting extended companies in the Gallery and at the Telephone Exchange, has been busily at work. In the latter office there are a number of pairs of telephones. The phonograph is placed in the office and ran to the telephones. The format is the more interesting for the fact that the voices and words of the performers are of the first importance. You enter the room in groups or, perhaps, ten at a time, and the phonograph is set in motion and a pair of telephones, which is in connection with it, are worn over. Each of these is connected with another placed in the room of the Duke, one to the right and the other to the left of the presenter, and the Duke's ears are applied to the receivers. Attention of the phonograph is connected with the telephones at our right and, one to his left. Then while the singer turns our right or left, the sounds increase or diminish, being equal or not, even when they advance or recede. The same increase or diminish in both, and the effect is one which it is impossible more accurately to describe. It is difficult to believe that the performance is not taken place in the room, and that the singer is not before the audience. Perfect silence reigns (two words should be used, for there is no silence in Paris), while the glorious voices of the finest singers of the day are heard as if unaccompanied in the middle of a large room by the silence, across which have rushed the sounds of the orchestra of a mile. The orchestral accompaniment is somewhat weak, owing to the arrangements of the instruments, but the voices are perfect and more clear, falling entirely into the music by movement and action; and in no part of the room is the slightest sense lost with greater [illegible] silence and with the most charming and perfect ease in this splendid room in the Palais d'Industrie.

The successful exercise to which the different talents have been put during the past week is astonishing. Perfect silence reigns (two words stand round, with their hands holding to their ears, listening to the voices, and when they express expression of satisfaction, of coldness, or rapture, on their faces; they look at each other and express themselves with their eyes; but when the performance has been received and they hear the clapping of the hands of the unseen audience they let down their telephones and irregularly join their applause uttered to that which has reached them in the room, unable to contain themselves from the expression of their delight.

Scientific American, July 16th 1881.

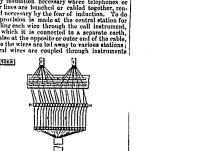
There are few defects, but these are of serious importance. The arrangement is a little too much complicated; a rocking motion is sometimes heard in the receivers, which comes from the microphones, and the whole apparatus is too delicate to be performed by the instruments and is to be heard with undue loudness. These defects are, however, of secondary importance, and as the general lines and the highest aim are correct, the invention is said hereof through all their most delicate changes as they occur and almost with all [illegible] as at the theatre itself.

As [illegible] to the arrangements of the circuits in some detail, I need only say that likewise that at the Théâtre Français is extremely simple, consisting of a single wire, carried overhead, and the double arrangement of microphones [illegible] and receivers attached to them. If and to see, the [illegible] to notice.

The Electrician, July 16th 1881.

5068. IMPROVEMENTS RELATING TO TELEPHONIC AND OTHER SYSTEMS OF ELECTRICAL COMMUNICATION. *J. P. Culverhouse and J. C. Swain.—9th December, 1880.* 6d.

The object of this invention is to avoid the battery connection necessary where telephones or other instruments are used in a circuit, and is declared necessary by the four of induction. To do this provision is made at the central station for coupling each wire through the call instrument, with which it is connected to a separate earth; and also at the receiving or outer end of the cable, where the wires are led away to various stations; several wires are coupled through instruments



to separate and independent earth plates having no metallic connection with one another. The instruments at the central station is also arranged that the bells may be rung through the earth, and that they may also be coupled to an independent earth plate, preferably through a resistance coil. In the figure F F are cables of wires from different stations; G are lightning protectors; H are electro-magnet call instrument receivers; I, wires from each apparatus to one or other of the bars A of the commutator; C C are the separate earth connections; K K are the separate and independent earth plates.

4402. IMPROVEMENTS IN TELEPHONES. *S. Pitt.—Dated 23rd November, 1880.—[A communication from C. de Sollieck.]* 2d.

The inventor claims the mouthpiece of the transmitting telephone by pasting or connecting over it a diaphragm of paper. The vibrations are thus developed, and the entrance of dust, and rusting of the plate by moisture of the breath, is avoided.

The National Scientific Journal, Aug. 1st 1881.

MOLECULAR SOUNDS.—The passage of an intermittent current through iron or other wire gives rise to sounds of a very peculiar and characteristic nature. Page, in 1837, first noticed these sounds on the magnetization of wires in a coil. De la Rive published a chapter in his "Treatise on Electricity" (1853) on this subject, and he proved that not only were sounds produced by the magnetization of an iron wire in an inducing coil, but that sounds were equally obtained by the passage direct of the current through the wire. Gaugid, 1841, and Du Moncel, 1878-81, all have maintained the molecular character of these sounds. Reis made use of them in his, the first electric telephone ihvented, and these sounds have been, since the apparition of Bell's telephone, often brought forward as embodying a new form of telephone. These sounds, however, for a flexible source of electricity, are far too weak for any applied purposes, but they are most useful and interesting where we wish to observe the molecular action which takes place in a conducting wire. I have thus made use of these sounds as an independent method of research.

The apparatus was the same as in the last chapter, except no telephone was used. The intermittent electric current was connected by means of a switch key, either with the coil inducing longitudinal magnetism in the wire, or could be thrown instantly through the wire itself, thus rapid observations could be made of any difference of tone or force by these two methods; a reversing key also allowed when the wire stood, a constant current of either polarity to pass through the wire under observation.

Iron, of all metals that I have yet tried, gave by far the loudest tones, though by means of the microphone I have been able to hear them in all metals; but iron requires the microphone to make its sounds audible, for I demonstrated at the reading of my paper, March 23rd, that these sounds with two kilobmonts rolls were clearly audible at a distance. A fine soft iron wire (No. 28) is best for loud sounds to be obtained by the direct passage of the current, but large wires (1 millim.) are required for equally loud tones from the inducing coil. By threading any suitable wire between these sizes, we can obtain equal sounds from the longitudinal magnetism or direct current. The wire requires to be well annealed; in fact, as in all preceding experiments, the sounds are fully doubled by heating the wire to nearly red heat. There are many interesting questions that these molecular sounds can aid in resolving, but as I wish to confine the experiments to the subject of the two preceding chapters, I will relate only a few which I believe bear on the subject.

On sending an intermittent electric current through a fine soft iron wire, we hear a peculiar musical ring, the cadence of which is due to that of the rheotome, but whose musical note or pitch is independent both of the diameter of the wire and the note which would be given by a mechanical vibration of the wire itself. I have not yet found what relation the note bears to the diameter of the wire; in fact, I believe it has none, as the greatest variation in different sizes and different conditions has never exceeded one octave, all these tones being in our ordinary treble clef, or near 870 single vibrations per second, whilst the mechanical vibration due to its length, diameter and strain vary many octaves.

I believe the pitch of the tone depends entirely upon molecular strain, and I found a remarkable difference between the molecular strain caused by longitudinal magnetism and the transversal or ring magnetism produced by the passage of a current, for if we pass the current through the coil, inducing magnetism in the wire, and then gradually increase the longitudinal mechanical strain by tightening the wire, the pitch of the note is raised some three or four tones (the note of the mechanical transversal vibrations being raised perhaps several octaves); but if we tighten the wire during the passage of an electric current through it, its pitch falls some two or three notes, and its highest notes are those obtained when the wire is quite loose. A similar but reverse action takes place as regards torsion; for if the wire is magnetized by the coil, we obtain an almost complete zero of sound by simply moving the torsion index 45° on either side, and as this was the degree which gave silence in the previous experiments for the same wire, it was no doubt due to the same rotation of its polarized molecules; if we now pass a constant current through the wire whilst the intermittent one is upon the coil, we hear augmented sounds not in pitch, but loudness, and if we give torsion of 45° to one side we have silence, or nearly so, whilst the other side it gives increased tones which become silence by reversing the battery. If, whilst the wire by torsion has been brought to zero, we decrease or increase the mechanical longitudinal strain, then at once the polarized molecules are rotated, giving loud sounds; and we further remark that when the wire is loosened, and we again tighten it, we gradually approach a zero, and on increasing the strain the sounds return; thus we can rotate the molecules by a compound strain of torsion and longitudinal strain.

If we wish to notice the influence of a constant current passing through the wire under the influence of the intermittent current in the coil, we find if the wire is free from torsion that on passing the current the tones are diminished or increased according to the direction of the current; the tones thus have an entirely distinctive character, for whilst preserving the same musical pitch as before, the tones are peculiar, metallic, and clear, similar to when a glass is struck, whilst the tones due to longitudinal magnetism are dull and wanting in metallic timbre. If we now turn the index of torsion upon one side, we have a zero of sound with or without the current; but the opposite direction gives increased tones whilst current is passing through the wire, but zero when not. Here again a peculiarity of timbre can be noticed, as although we have loud tones only to the action of the current through the wire, the timbre is no longer metallic, but similar to that previously given out by the influence of the coil; evidently then the metallic ring could only be due to the angular polarization of the molecules, and when these were rotated by torsion the tones were equally changed in its action upon the wire.

I have already shown that a permanent magnet brought near the wire could rotate its polarization, and it equally can produce sound or silence in these molecular sounds showing that the wire is of a zero of torsion, and a constant current sent through the wire as in the last experiment). We find that either pole of the natural magnet has equal effect in slightly diminishing the sound by an equal but opposite rotation from the line of its maximum effects; but if the wire is brought nearly to zero by torsion, then on approaching one pole of the natural magnet we produce a complete silence, but the opposite pole at once rotates the molecule to its maximum loudness, and on taking away the magnet we have comparative silence as before.

Bending the wire to nearly red heat by a spirit lamp increases the tones of longitudinal magnetism induced by the coil some 25 per cent., but it has a much more marked increase on the tones produced by the direct passage of the current where they have more than 100 per cent. increase; and if we pass the intermittent current through the coil, and constant through the wire, we find no direct rotation of the molecules by heat, although an apparent rotation takes place if we, by the required torsion, first place the wire at its zero. Then on the application of heat faint sounds are heard, which become again almost silent on cooling; are these obtained when the wire is quite loose. A similar

Tempered steel gave exceedingly faint tones, requiring the use of the microphone; but on magnetizing with a constant current, inducing spiral magnetism, the sounds became audible, some 15° micrometre, against 73° for iron; thus the molecular rigidity of steel as observed by previous methods was fully verified.

I have, I believe, demonstrated by retinal experiments which are easy to repeat, that—

1. An electric current polarizes its conductor, and that its molecular magnetism can be reconverted into an electric current by simple torsion of its wire.

2. That it is by the rotation of its molecular polarity alone that an electric current is generated by torsion.

3. That the path of an electric current through an iron or steel wire is that of a spiral.

4. That the direction of this spiral depends on the polarity of the current, or that of its magnetism.

5. That a natural magnet can be produced, having its molecular arrangement of a spiral form, and consequently reversed electric currents would both have a similar spiral in passing through it.

6. That we can rotate the polarized molecules by torsion or a compound strain of longitudinal and transversal.

7. That the rotation or movements of the molecules give out clear, audible sounds.

8. That these sounds can be increased or decreased to zero by means that alone have produced rotation.

9. That by three independent methods the same effects are produced, and that they are not due to a simple change or weakening of polarity, as when rotation has been incomplete a more mechanical vibration line at once reduced the maximum effect.

10. That heat, magnetism, constant electric currents, mechanical strains and vibrations have all some effect on the result.—*Prof. D. E. Hughes.*

England, Northumberland, Shipley, 4th of January, 1881.

[FIELD.]—Telephone Transmitters.—Imply to "J. H. G." It is not a question in doctrine the modulate, or rather control, the I ought to call it, for working the "call," but in practice it is referring to the instrument described on p. 92, first description only applies to the one described on p. 93, which, being all steel with the automatic interrupter, would be only required for short distances because to work to work it. The following description applies to the instrument illustrated on p. 92. Take a piece of soft iron tube, say, 10in. long, 2in. wide, file out the teeth along one of its longer sides, and bore one hole in each end, then fasten it with a couple of screws to the top or side of the piece A, so that the teeth will project beyond the wood. Attach this to the wire B which connects the carbon C to the primary wire of the coil; then to the two additional wire D, the binding post on the opposite side to that is fix one connected to the spring E, and to this wire rub along the serrated lower piece, and the "call" will be made, as described in my former letter, provided the carbon pieces C C are sensitive, as they should be at all times when the instrument is not in use.—JOHN C. FIELD.

Correspondence.

The Bell Telephone.—The Decision of Judge Lowell.

To the Editor of the Scientific American:

In a number of your late issues you have had some interesting articles on Judge Lowell's late decision in the Bell telephone suit against certain parties for alleged infringement. I have read the opinion of the court in the above case (published in SCIENTIFIC AMERICAN of August 27,) with much care, and decline to say a few words upon the same, as I view said opinion as not justified before an intelligent host of American inventors, thinkers, and writers. To be granted two suits by such decisions brings our patent system into disrepute, as affording monopolies the power to control entire fields of useful invention. By careful examination of the field in dispute I realize that the device of the Bell monopoly is to gain, by decisions of courts, the only right to use electricity to convey intelligence by vocal sounds. There is no right over apparatus, no right over the means employed to vary the current; the monopoly simply asks to have the current set aside for their use, whether said current is *undulated, vibrated, intermitted, pulsated, or disturbed.*

Now let us quote the most astounding part of said decision: "But Bell discovered a new art, that of transmitting speech by electricity, and has a right to hold the *broadest claims* for it which can be permitted in my case." It is a fact well known that many others in the same line of experiment, before Bell's patent of 1876, were in sight and in the *hearing* of the desired result. They were all using a current, and were trying different plans of using said current, and had succeeded in a partial manner by *disturbing* a current of electricity. Mr. Bell found a more effective way of using the same current. Just as well give McCormick the only *right* to cut grass and grain because he did it better than any who worked before him.

By all means give Mr. Bell his every due—give him credit for being a persistent worker, and give him all he has invented; but it seems very incorrect to confer on him the only right to use a vibrated or undulated current. Look at the facts—Reiss, Gray, Edison, and others, *prior* to Bell's patent of 1876, were working hard and strenuously with this old, *disturbed, varied, and vibrated* current, getting groans, music, and words out of it, and now all the hosts of electricians of our country are to see another step in and take away their old current.

What I desire is that each inventor shall fully be entitled to use what he invents and brings forward, and no more.

As the Bell telephone stands to-day it looks as if it is next to impossible to obtain the permanent magnet, the induction coil, and current, but if some inventor can find a means of using electricity and its e-stablished powers in the transmission of vocal sounds, *in a manner and by apparatus not pretended by any one else*, that an established public sentiment and a high and honorable court of last resort should protect all alike. How will Mr. Reiss over in the old country, and in our own land of right and liberty how will Elisha Gray feel when that little current, so subtle, so unmanageable, had finally been taken from him? How will my old friend Dolbear feel, too, after *merging* the current, away back yonder, years ago? In fact, what will be the wonder and surprise of the hundreds of intelligent professors who have in years and years been using intermittent currents and getting sounds and songs, when they learn that they are forbidden to undulate a current in any endeavors to make a machine which will talk at the other end of the line?

I hope to hear others speak out and give their views on this subject.

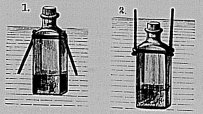
Yours OVER GRAVITY.

Do axis Mes vats for Invention of the Telephone by "Carlos Gilbert"

A Life Saving Lesson in Physics.

It is a well-known fact that any person of average structure and lung capacity will float securely in water if care is taken to keep the hands and arms submerged and the lungs full of air. Yet in most cases people who are not swimmers immediately raise their hands above their head and scream the moment they find themselves in deep water. The folly of such action can be impressively illustrated by means of a half empty bottle and a couple of nails; and the experiment should be repeated in every household until all the members —particularly the women and children—realize that the only chance for safety in deep water lies in keeping the hands under and the mouth shut.

Any short-necked, square-shouldered bottle will answer, and the nails can be easily kept in place by a rubber band



or a string. First, ballast the bottle with sand, so that it will just float with the nails pointing downward, as shown in Fig. 1; then by turning the arms upward, as shown in Fig. 2, the bottle will be either forced under water at once or will be tipped over so that the water will pour into the open mouth, and down it will go. To children the experiment is a very impressive one and the moral of it is easily understood.

The vital value of this precaution was strikingly illustrated near Accomac C. H., Virginia, a few days ago. A niece of the Hon. John Neely, while bathing, was swept off into the ocean by a strong current and soon disappeared in the high breakers. As she could not swim her companions gave her up for lost. Two young fishermen who were employed some distance away thought they set out with a small boat in search of her, and soon, when a mile or more from shore, found her floating on the water. She had been drifting nearly an hour and was greatly exhausted, but soon recovered. Unable to swim she had pluckily floated, thereby making her rescue possible.

A NEW USE FOR THE INDUCTION BALANCE.

BY GEO. M. HOPKINS.

The form of induction balance devised by Professor Hughes, of London, already has several interesting and useful applications, and a new use for it is now suggested by the recent tragedy at Washington. It seems essential to locate the bullet in the body of the President.

The induction balance is a most delicate electrical instrument for detecting the presence of metals, and a modified form of it could be easily applied to this purpose with a reasonable expectation of success. This instrument consists of two short glass cylinders, around each of which are wound two parallel coils of fine insulated copper wire. One coil of each pair is included in a battery circuit in which there is

Fig. 1.—THE INDUCTION BALANCE USED AS A BULLET FINDER.

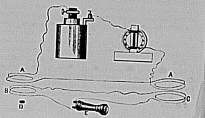


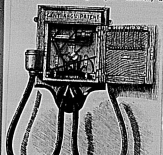
Fig. 2.—Diagram showing circuits of the induction balance.

The form of induction balance devised by Professor Hughes, of London, already has several interesting and use-

Scientific American Supplement No. 287

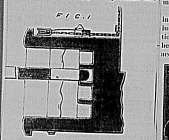
J. T. GENT AND CO.'S MICROPHONE TRANSMITTER.

THE patentees inclose an instrument in a neat walnut case, to the lever of which they attach, leaving a slight space between, a



diaphragm of wood; to this diaphragm they affix thin plates of specially-prepared material, the plates resting but not touching each other.

These attach to lever brackets, having spindles on which are loosely-hung metal arms, each arm carrying a plug or pencil of prepared coal, and these again resting on plates affixed to diaphragm. They can be set to vibrate from 12 to 16 of these prepared arms, arranged in series of 2 or 4, so that a current of electricity is traverse the whole of these arms at once or successive sets. Each arm is adjustable, and may be placed horizontally or vertically. The object of using a row of plates is that the vibrations of the vibrations of diaphragm may be multiplied, and the undulatory current be correspondingly more powerful. The



plates at one end are connected to battery, and at the other end to a coil in the case.

Any form of telephonic receiver may be used with this transmitter, and they use flexible tubes to protect wires from injury, thus obviating one objection to the use of wire conductors between transmitter and receiver. The usual automatic switches and call-bell form part of the apparatus. The transmitter and use of tubes for purpose named are patented.

The National Telephone Exchange Association.

The third semi-annual convention of this association was held in Saratoga, the second week in September. There were present, at the first session 230 delegates, of whom 100 represented telephone companies. Among the prominent delegates were:

G. L. Wiley, assistant general superintendent of the Metropolitan Telephone and Telegraph Company; W. A. Childs and Francis Shaw, of the Law Telegraph Company; Henry W. Pope, of the Staten Island Telephone Company; Henry Metzger, general manager of the Pittsburg Telephone Company; William Sargent, the general superintendent and electrician of the Bell Telephone Company, of Philadelphia; Mr. Goodyear, representing L. Tillgthson. C. H. Hotchkiss, John A. Hocking, Walsburn & Moen, and other firms were represented. Among the subjects for discussion were these: The latest improvements in all the instruments used; underground wires; wire construction and kinds of wires; also a report on electrical disturbances interfering with the telephone service.

IMPROVEMENT IN TELEPHONES.

The engraving shows an improved telephone transmitter and receiver recently patented by Mr. J. A. Lakin, of Westfield, Mass. This instrument is especially for use in railroad offices, and other places wherein much local noise disturbs the successful operation of the common telephone now in general use. This instrument consists of a square box, in which are placed both a transmitting and a receiving diaphragm. From the receiving diaphragm chamber two sound tubes extend to be received one in each ear. They are kept in place by a small spiral spring, tending to draw the tubes together, and thus keep the small rubber caps on the ends of the sound tubes in place in the ear. These cups shut out all extraneous sounds and confine the sounds of the receiving telephone, so that their full effect is felt on the ear.

The lower part of the box, as seen in the drawing, contains the transmitter, which is made very sensitive. It is claimed that this instrument will talk two hundred miles or more.

Pressing the button, as shown in the cut, brings the battery into circuit with the transmitter. The inventor of this instrument has given much time and study to the construction of telephones, beginning as early as 1869, although, as he informs us, most of his attention has been given to acoustics.

LAKIN'S TRANSMITTING AND RECEIVING ELECTRIC TELEPHONE.

For further information address J. A. Lakin, Westfield,

Home Department.

The Induction Balance as a Bullet-Finder.

Considerable interest has been felt in the proposal made by several gentlemen well known in the scientific world to locate the position of the bullet that struck down the President, by delicate electrical apparatus. The form of induction balance devised by Prof. Hughes, as exceedingly delicate electrical instrument for detecting the presence of metallic substances, has been suggested for this purpose, and it appears probable that it could be used in many cases with success.

This instrument consists of two short glass cylinders, around each of which are wound two parallel coils of fine insulated copper wire. One coil of each pair is included in a battery circuit, in which there is a clock microphone. The other pair is placed in a closed circuit with a receiving telephone. The two glass cylinders, with their enclosing coils, may be widely separated. The induction set up in the secondary or telephone circuit is balanced by the reversal of one of the secondary coils, and so adjusted that the induction in one of the secondary coils exactly balances or neutralizes the induction in the other, so that when the ear is applied to the receiving telephone no sound is heard. If, however, a fragment of metal, no matter how minute, is placed in one of the glass cylinders, its presence destroys the electrical balance, and the fact is indicated by the loud ticking of the clock on the microphone. The same result will be observed if the coil is placed in the neighborhood of a piece of metal.

Mr. George M. Hopkins, to whom the idea occurred of using this instrument as a bullet-finder, in some trial the experiment of testing the effect of a leaden ball in the instrument, placing the bullet at different distances, and repeating it from the coil by installing substances. The experiment, however, failed at first to give satisfactory results, and for the reason that the metal head produces the least effect on the instrument, and requires a very strong current to obtain suitable results. As a strong current burned the carbon of the microphone, it was found necessary to use a current interrupter operated by a clock which interrupted the current at regular intervals. With this current breaking, Mr. Hopkins announces that he has obtained results that surpassed his expectations, as he was able, with a set of coils that were by no means sensitive, to locate the leaden ball with the coils raised a vertical distance of nearly two inches.

Encouraged by these results, Mr. Hopkins states, as stated, Mr. Hopkins wrote to the President's private secretary, suggesting that his apparatus might be used successfully in locating the position and depth of the bullet in the President's body, requesting the position of which the physicians in attendance upon him may known to entertain diverse opinions, and which a sudden crisis in the patient's condition may render highly important to verify. The instrument was sent to Washington by request, but at the time of this writing it had not been used.

Mr. Hopkins states positively that if the missile were of iron or steel, there would be no difficulty experienced in locating it at a depth of even four or five inches; but being of lead, he thinks it doubtful if it would disturb the electrical balance if it is located at a greater depth than two inches from the surface of the body.

Fig. 2 shows the apparatus properly connected and in the act of being used to locate a bullet. The diagram, Fig. 1, shows the arrangement of battery, microphone, and primary and secondary circuit wires. The induction balance in use in connection with the coil-less telephones patented by Mr. Edison. The number of the apparatus is A,1,13, and it contains twenty-five figures and six alphas. The two figures given herewith will, however, serve to explain the new invention, which is clearly capable of many modifications. According to the one mode of carrying out this invention, a current battery is caused to circulate through the telephone, and a weight is employed, with a pendulum-arm passing through it, and resting upon the carbon button. Rod-springs bearing upon the weight, and attached to the carbon button, serve to hold the weight in position. The amount of initial pressure may be regulated by the screw. The circuit wires are connected to the primary coil of an inductorium with the battery in circuit. Owing to the inertia of the weight, and its not being able to follow very rapid movements of the diaphragm, there results a difference of pressure between the screw and the carbon. The screw may also be tipped with a point, so that the initial pressure of the carbon upon the weight, or upon a piece of any proper metal placed between the carbon and screw, hold round, oblong, oval, or in any configuration as long as it is a weight. It may be a hollow sphere, cube, or any other shape, and be filled with mercury or any other heavy substance. The springs may be bent or warped, and may be bent in any shape between the weight and disc upon the diaphragm.

Fig. 1.—Diagram Showing Circuits of the Induction Balance.

In some cases two pieces of carbon or other finely-divided conducting matter are secured to the diaphragm, each carbon being connected to the circuit. When in a state of rest the two coils are in contact with each other. The amount of initial pressure being regulated by the bowing outwardly of the diaphragm by a spring of adjustable curved metal upon a screw, or two flat carbons may be employed screwed to the diaphragm and adjusted so that the ends are in contact, the bowing outwardly and inwardly of the diaphragm regulating the position tending to increase or decrease the initial pressure.

According to another modification an inertia transmitter is constructed, consisting of a diaphragm having a rubber fixture thereon, a flat or other spring serving to hold the weight in position, and an adjusting screw whose office is to rest upon a carbon disk. A double inertia transmitter may be constructed having two carbons connected together, hence the difference of pressure takes place at two points of contact, as in the device first described and in the two latter inertia transmitters the carbons may be their cups permanently, or they may be loose; the latter is preferable.

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According to another modification, an inertia telephone is constructed in the following manner:—A diaphragm, carbon button, and rubber or other fixture employed, with a helix or helix of iron, and is secured to a spring which may be made adjustable. A permanent magnet is also provided, which may be made to approach or recede from the weight, and so regulate and decrease the initial pressure on the carbon. One of these transmitters may be screwed to the diaphragm, which in its turn may be poised in a frame, and a weight secured to the center of inertia constituted of carbon filings, or any suitable quantity of mercury, both in a tube with an opening. Rubber fixed to one of the wires secures the whole being secured to the diaphragm. In another form, supports are secured to the rubber piece, which is secured to the diaphragm; the carbon rests on the platinoid surface of a screw, which serves also to connect the rubber piece with the diaphragm. A weight is provided, which may be made of a pointed shape, and a spring which serves to give to the weight an initial pressure and hold it in position; a screw may be connected from the spring to the point of the weight, and thereby made adjustable. A diaphragm, with the inertia-transmitting devices upon it, may be secured in a wooden case by stringer elastics. A further variation of this type of transmitter consists of an upright attached to the diaphragm, the upper end of the which upright is platinoid and rests upon a carbon disk, which is in an adjustable cup. The movements of the diaphragm increases and decreases the pressure upon the carbon. In this transmitter may consist of a diaphragm and a weight, the latter being held in position by the instrument of a diaphragm by means of a bowed piece which connects the lever with the diaphragm. The carbon button applied with which the spring rests suitably suspended. Close the circuit, the pressure is regulated by the movement of the diaphragm. A double lever may be employed, the carbon being between the two; the bowed piece serves to separate both levers simultaneously, and they carry their carbon button with them. The block connected to the diaphragm may receive a hard carbon rod against which the springs rest; they are berylled, any outward movement of the diaphragm tending to increase the pressure. A carbon which may be used in lieu of the rod, and between double springs.

According to a further modification, an inertia telephone is constructed with two carbons resting on a flat bed-piece, and resting on the carbons a weighted which is kept upon them by springs and adjusting screws, the weight and bed-piece forming the instrument, or decreasing the tension of the spring. Or the diaphragm may have a block to which is secured a carbon, while on the latter rests two springs, the forward movement of the diaphragm increasing the pressure at both points of contact. Or a cup may be employed with carbon rod in it, while upon the carbon rests a lever, the initial pressure of which may be varied by an electro-magnet, which may be the primary coil of the inductorium or disconnected therefrom, or may be a permanent magnet, or even a spiral or flat spring may be used, or if the diaphragm is held in the right position its own weight may be used. Another modification consists of an upright, to the bend of which is the carbon; on this rests a lever, to the end of which is secured a weight which passes the rod around which it is held by a spring to yield, the rod serving to hold the weight in position; by these means the initial pressure of the carbons is regulated. Or the carbon connected with a diaphragm may be acted upon by a pendulous spring with carbon disc upon its extremity resting against the carbon, the tension being also employed. According to a further modification of inertia transmitter, weights are secured to a lever pivoted from an arm which connects with a diaphragm; the carbons on the lever rests upon a carbon button in a cup upon the diaphragm; one of the weights is adjustable so as to adjust the initial pressure. Or four weights may be used secured to the underside of block upon the diaphragm; the current enters by the first spring, thence passes through the carbon tips to the carbon tips of the second chain, and from thence to the fourth and last spring.

According to another part of this invention a receiver is constructed upon the electro-motive principle in the following manner:—It consists of a diaphragm, a small cylinder or cup of wood or other suitable material impregnated with phosphate of soda or other proper chemical, to produce the electro-motive action, and a spring connecting the diaphragm with the disc tipped with platinum or gold. The shaft of the disc is raised by a worm and worm-wheel, or by inertia telephone may be secured to a strip of elastic material instead of a diaphragm. In a bevel gear may be employed, springs which are tipped with rubber or other soft substance. The magnetograph receiver may be arranged as a transmitter, the armature resting on a diaphragm; a spring connecting the armature with the chalk; the chalk in this case is made to rest upon a carbon disk. In a magnetograph receiver of an induction coil having a high resistance, a battery is provided; a metal-to-metal receiver may be used or a receiver as constructed as follows:—When the milliter. The action is as follows:—When the diaphragm is vibrated by the voice it acts to widen the spring, this instantly deprecates the point of contact between it and the chalk, thus increasing the flow of current from the battery; the instant the spring ceases to rest it pinches it and weakens the current from the battery. The magnetograph may also be arranged to transmit direct from one to the other without the intervention of an induction-coil, the armature of which they can by raising a lever to make receivers or telephones in circuit with the battery, the tension of the spring from the diaphragm upon the armature by depressing it; they are also provided with a handle and limiting screw are also used. A spring is further provided, also a roller, which serves to hold the lever when it is drawn up or down; both instruments are similar in construction. When receiving, the pressure is put on the spring resting upon the chalk and it is raised, but when transmitting, the pressure on the spring is light and the chalk is not raised.

The telephone may further be constructed so that each sound wave is made of an aggregation of smaller waves. A lever is provided suitably pivoted, and one its fulcrums is used for connecting it with the diaphragm, the other with the lever resting slightly upon it. Each of these is divided containing an electro-magnet, which is connected to one pole of the circuit, while the lever is connected to the other post; the armature of the diaphragm serves to recti-

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English Mechanic & World of Science, July 29 1881

EDISON'S NEW TELEPHONES.

In the sun-and illustrations are shown two forms of telephone recently patented by Mr. T. A. Edison as improvements in his carbon telephones patented in the United States on the 4th of May, 1878, and 11 subsequent dates, the latest given herewith will, however, serve to explain the new invention, which is clearly capable of many modifications. According to one mode of carrying out this invention, a current battery is caused to circulate through the telephone, and a weight is employed, with a pendulum-arm passing through it, and resting upon the carbon button. Rod-springs bearing upon the weight, and attached to the carbon button, serve to hold the weight in position. The amount of initial pressure may be regulated by the screw. The circuit wires are connected to the primary coil of an inductorium with the battery in circuit. Owing to the inertia of the weight, and its not being able to follow very rapid movements of the diaphragm, there results a difference of pressure between the screw and the carbon. The screw may also be tipped with a point, so that the initial pressure of the carbon upon the weight, or upon a piece of any proper metal placed between the carbon and screw, hold round, oblong, oval, or in any configuration as long as it is a weight. It may be a hollow sphere, cube, or any other shape, and be filled with mercury or any other heavy substance. The springs may be bent or warped, and may be bent in any shape between the weight and disc upon the diaphragm.

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3	19 46·2	19 59·6 "
4	19 47·5	19 59·7 "
5	19 47·6	11 59·0 "
6	19 48·2	11 59·0 "
7	19 48·6	0 0·1 p.m.

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procate the lever or spring over the surface of the disc. A push button is provided to open the receiver circuit when transmitting. When the lever and spring are adjusted for receiving, thus preventing the tertiary or battery coils of the induction-coil from interfering each other's currents.

When the lever and spring are adjusted for receiving, the current is carried through the primary coil; when down, the carbon transmitter is caused to be in circuit and the tertiary coil is made to be in the line with a condenser, the latter to prevent the circulation of earth currents through the coil and thus disturbing them. The tertiary coils are thus disposed with, which, batteries or discs of finely-divided conducting matter may be made of any known substance which conducts electricity, or which can be powdered, may be moulded by itself, or mixed with one or more other conducting or non-conducting substances to form the tension-diaphragm may be used.

In Fig. 1, the carbon is in a cup of insulating material, and has upon it a metal disk that electrods is in the diaphragm; the carbon rods against the disk. The other electrode is in the form of a platinum disc at the end of the screw passing through [illegible] ...to this the project ... the carbon by the ... carried by the spring, ... the diaphragm, and ... The vibrations of the ... each or other sounds ... and vary the electric ... by the disturbed ... of the weight suitably ... the armature is ... the spring ... the electric ... the current will ... carbon will ...

be diminished in pressure.

In Fig. 2, the adjusting screw is made to act upon a tongue for a proximity to the weight, upon the carbon by a proximity to the weight, which is of ... The lever the pole of the magnet is of ... the weight the more the attraction will be to draw the weight from the carbon, and hence the pressure exerted by the carbon, and hence the weight, and ... spring that carries the weight, and ... over.

LA

COMPAÑIA CHILENA

DE

Teléfonos de Edisón.

VALPARAISO.

LEGALIZACION DE SOCIEDAD.

Por decreto del señor juez de comercio fecha 19 del corriente, se ha mandado publicar por el término de diez dias la sociedad que consta de las escrituras siguientes:

ESTATUTOS DE LA SOCIEDAD.

En la ciudad de Valparaiso, República de Chile, a quince de diciembre de mil ochocientos ochenta, ante mí Francisco Pastene, notario público y testigos que suscriben, comparecieron los señores don José D. Husbands, don Pedro A. Mc. Kellar, don Santiago Mártin por sí y como socio administrador de la sociedad que jira con la razon social de Martin y Mac. Neil, segun se acreditará mas adelante, y don Lucius H. Foote, todos mayores de edad y de este domicilio, siendo los cuatro primeros comerciantes y el último Cónsul de los Estados Unidos de Norte América en Valparaiso, a quienes doi fé conozco y dijeron: que en conformidad a la escritura otorgada en esta ciudad con fecha veinticinco de agosto del corriente año ante el notario que autoriza la presente, son dueños de la Empresa de Teléfonos de Edison que funciona en Valparaiso y así mismo del privilejio esclusivo concedido por el Supremo Gobierno a don Tomas A. Edison y que al presente, habiéndose completado el capital necesario para el aprovechamiento del privilejio esclusivo y esplotacion del teléfono en Valparaiso, y queriendo independizar esos negocios de sus respectivas personas, venian en constituir una sociedad anónima con arreglo a los siguientes estatutos:

TITULO PRIMERO.

Constitucion y objeto de la sociedad.

Art. 1.° Se establece en Valparaiso una sociedad anónima que se denominará «Compañia Chilena de Teléfonos de Edison,» cuyo objeto es la esplotacion en Chile del Teléfono de Edison del sistema central de Teléfonos y de todas las invenciones o modificaciones que en estas materias se realicen. La sociedad podrá establecer empresas para la esplotacion directa del teléfono como la que tiene en Valparaiso o bien enajenar el derecho a establecerlas en las ciudades en que ello sea posible. Podrá así mismo comerciar en la introduccion y colocacion de campanillas eléctricas u otros aparatos que se relacionen con el objeto principal de la empresa a juicio del directorio.

Art. 2.° La sociedad se constituye por el término de diez años, pudiendo prorogarse por otro período igual si así lo acordare un número de accionistas que represente el 60 por ciento del capital social con que jire la sociedad a la fecha de la espiracion del término.

Art. 3.° Si en el trascurso del tiempo se hicieran modificaciones al teléfono de Edison o invenciones que sean preferibles al sistema de este invento, la sociedad podrá variar el objeto indicado en el artículo 1.° en el sentido de hacerse dueño de los nuevos inventos y de aprovechar las modificaciones que sufra el teléfono.

Art. 4.° La sociedad constituye domicilio en Valparaiso, no obstante que pueda establecer empresas particulares en algunas otras ciudades de la república.

TITULO SEGUNDO.

Capital social.

Art. 5.° El capital social es la suma de doscientos mil pesos, representado por cuatrocientas acciones de quinientos pesos cada una.

La sociedad, en junta jeneral, podrá acordar un aumento del capital social y la emision de mayor número de acciones si así conviniere al desarrollo de las operaciones sociales.

Art. 6.° El espresado capital queda desde luego suscrito en la forma siguiente:

Don José D. Husbands, doscientas acciones.

Don Santiago Mártin, cincuenta acciones.

Don Lucius H. Foote, cincuenta acciones.

Don Pedro A. Mc Kellar, cincuenta acciones.

Y los señores Martin y Mac Neil cincuenta acciones. Total: cuatrocientas acciones.

Las doscientas acciones suscritas por el señor Husbands se entenderán una tercera parte a nombre del señor Husbands y dos terceras en nombre del señor Tomas Alva Edison, a quien pertenecen en razon de los contratos existentes entre ambos.

Art. 7.° El capital de la sociedad se considera totalmente pagado en virtud de la cesion de todos sus derechos al privilejio concedido al señor Edison por el gobierno de Chile y a la Empresa establecida en Valparaiso, que hacen los suscritores mencionados en el artículo anterior en favor de la sociedad y de los cuales eran dueños en conformidad al contrato de veinticinco de agosto de mil ochocientos ochenta, citado en el encabezamiento de esta escritura. El documento especial que el señor Edison debe dar en conformidad a su contrato con el señor Husbands será estendido a la Compañía chilena de Teléfonos de Edison para confirmar así el traspaso que se conviene en favor de la sociedad anónima y radicar en ella el dominio de los inventos y privilejios de Edison.

Art. 8.° La Sociedad no reconoce cuotas de accion.

Art. 9.° Las acciones se estenderán en favor de determinada persona y no podrán ser transferidas sino por endoso, del cual se tome nota en los libros de la Compañía.

La sociedad no reconoce otro dueño de acciones que el propietario primitivo o el último endosatario que figure en sus libros.

Art. 10° Todos los accionistas deberán estar representados en Valparaiso por apoderados que tengan las facultades necesarias para intervenir y resolver en todos los asuntos que se relacionen con la Sociedad. En los casos en que fuere necesario suscribir instrumentos públicos por todos los accionistas, las personas que llamadas para que comparezcan personalmente o por apoderado mediante un aviso en dos diarios de la ciudad, no comparecieren, se entenderán legalmente representadas por el Presidente de la Sociedad, quien firmará por ellos los instrumentos necesarios.

TITULO TERCERO.

De la direccion y administracion.

Art. 11 La Compañía será administrada por un Directorio elejido por los accionistas y por un Jerente nombrado por el Directorio.

Art. 12 El Directorio se compondrá de tres propietarios y dos suplentes elejidos anualmente en la junta jeneral de enero de entre los accionistas que posean cinco acciones a lo menos, las que deberán conservar mientras ejerzan el cargo y principiarán a funcionar al dia siguiente al de su eleccion.

Art. 13 Los Directores elejirán anualmente de su seno un Presidente que lo será tambien de la junta jeneral y un Vice-presidente para el caso de ausencia o imposibilidad del Presidente.

Art. 14 Son atribuciones del Presidente representar a la Sociedad en sus relaciones u operaciones con estraños, en los casos que por su naturaleza no incumban al Jerente, sin perjuicio de poder asumir las funciones de éste en caso de ausencia o urjencia.

El voto del Presidente será decisivo en todo caso de empate que ocurra en el Directorio o en las juntas de accionistas.

Art. 15. Son atribuciones del Directorio:

1.° Convocar a junta jeneral de accionistas cuando lo crea conveniente y en los casos que determinan los estatutos.

2.° Nombrar el Jerente, fijar su remuneracion y removerlo cuando juzgue conveniente; nombrar, remover y dotar a los demas empleados a propuesta del Jerente.

3.° Dictar y modificar el reglamento interior.

4.° Determinar y variar las tarifas de los trabajos ordinarios que ejecute la compañía.

5.° Delegar en el Jerente, por medio de acuerdos escritos en el libro de actas, las facultades que crea convenientes.

6.° Resolver los puntos no previstos por los presentes estatutos.

Art. 16. Son deberes del Directorio:

1.° Reunirse en sesion ordinaria, a lo menos una vez al mes, y estraordinariamente siempre que fuere convocado por el Presidente, por exijirlo así el buen servicio de la compañía. El Directorio no podrá entrar en sesion ordinaria o estraordinaria sino con asistencia de todos sus miembros propietarios. Si no fuese posible reunir su número por ausencia o inhabilidad de alguno de ellos, se completará llamando a los suplentes y si aun así no se pudiera completar número se dará cumplimiento a lo prescrito en el inciso siguiente.

2.° Reemplazar al director o suplente que se inhabilitare por mas de un mes, nombrando interinamente en su lugar a uno de los accionistas.

3.° Velar por la buena direccion y administracion de la compañía.

4.° Presentar en las juntas jenerales ordinarias el balance, estado y memoria de que trata el artículo 27 de estos estatutos.

Art. 17. Si algun director falleciere, cayere en falencia o suspendiere sus pagos, será en el acto relevado de su cargo.

Art. 18 Son deberes y atribuciones del Jerente:

1.° Obedecer las órdenes e instrucciones del Directorio.

2.° Asistir a las Juntas Jenerales y del Directorio, haciendo las veces de Secretario.

3.° Atender al equipo y gastos del servicio, nombramiento de empleados que bajo su direccion deben ocuparse en los negocios de la Compañía, fijar sus sueldos y detallar sus obligaciones.

4.° Hacer y firmar los contratos y convenios con estraños.

5.° Proponer las medidas que crea conveniente para la marcha próspera de los negocios de la Compañía.

6.° Hacer las publicaciones de los documentos que ordena la lei de Sociedades Anónimas.

7.° Representar en juicio a la Sociedad, pudiendo conferir poderes especiales para esa clase de dilijencias.

Art. 19 Los directores, el jerente y demas empleados de la Compañía son individualmente responsables por las infracciones que cometan de estos Estatutos, del Reglamento interior y de las órdenes del Directorio, y por cualquier abuso que autoricen.

TITULO CUARTO.

De las Juntas Jenerales.

Art. 20 Toda convocacion a Junta Jeneral de accionistas se hará por medio de avisos en uno o mas periódicos de esta ciudad con ocho dias de anticipacion.

Art. 21 Diez minutos despues de la hora señalada se considerará constituida la Junta con el número de accionistas que esté presente y sus resoluciones serán obligatorias para la Compañía, con escepcion de los casos que requieran cierta mayoría, segun otros artículos de los Estatutos.

Art. 22 La Junta Jeneral tendrá dos sesiones ordinarias en cada año, una en enero y otra en julio, y cuantas estraordinarias juzgue necesarias el Directorio o pidan por escrito diez accionistas, espresando su objeto.

Art. 23 Los accionistas tendrán un voto por cada accion, no escediendo de cincuenta votos, y pueden hacerse representar por apoderados legales o por un accionista, bastando en este caso una simple carta dirijida al Presidente de la Junta. Ninguno tendrá derecho a mas de cien votos, sea cual fuere el número de acciones que represente.

Art. 24 Para dar derecho a votar, las acciones deben haber sido rejistradas en los libros de la Compañía a lo menos treinta dias antes de la junta.

Art. 25 Las votaciones serán secretas, a no ser que la Junta determine lo contrario. Si se decidiera por mayoría absoluta de los votos representados, no resultando tal mayoría, se hará segunda votacion, y no obteniéndose aun la mayoría requerida, se considerará el asunto como no discutido.

Art. 26 En juntas estraordinarias no podrá someterse a votacion otro asunto que aquel o aquellos para que la junta ha sido convocada; pero esto no impide que en ellas se hagan indicaciones sobre otros asuntos, los cuales serán discutidos y votados en una reunion posterior llamada con ese objeto.

Art. 27 En las Juntas Jenerales ordinarias, el Directorio presentará el Balance de los libros y un Estado de las Ganancias y Pérdidas del semestre fenecido, con el informe de los inspectores y una memoria sobre la marcha de los negocios de la compañía, cuyos documentos hará publicar ocho dias antes. En dicha junta se nombrará dos inspectores y un suplente para el exámen de la contabilidad del semestre.

TITULO QUINTO.

Del fondo de reparaciones y seguros, fondo de reserva y dividendos.

Art. 28 De las ganancias de la compañía se rebajará en cada semestre la suma que acuerde la junta jeneral para formar un fondo de reparaciones y seguros, mientras el saldo de este no alcance a cinco mil pesos ($ 5,000.)

Art. 29 De la ganancia líquida que resultase, segun el artículo precedente, se pasará en cada semestre al fondo de reserva la suma que determine la junta jeneral, no bajando del dos y medio por ciento de las ganancias líquidas hasta completarse la cantidad de diez mil pesos.

[illegible] junta jeneral, a indicacion del Directorio, determinará el dividendo que deba repartirse entre los accionistas, pudiendo el Directorio hacer distribuir dividendos interinos despues de deducida la parte del fondo de reserva.

TITULO SESTO.

De la liquidacion y disolucion de la sociedad.

Art. 31. Por pérdida de la mitad del capital social queda de hecho disuelta la compañía, sin otro trámite que la aprobacion del presidente de la república. La compañía podrá disolverse ántes del plazo señalado si así se acuerda por una mayoría de accionistas que represente las tres cuartas partes del capital social, cuyo acuerdo no tendrá valor si no fuese aprobado en otra junta jeneral convocada con ese objeto con intérvalo de dos meses, ni se llevará a efecto ántes de obtener la correspondiente aprobacion del presidente de la república. La espiracion del privilejio esclusivo no se mirará como pérdida del capital.

Art. 32. Llegado el caso de liquidar la sociedad, los directores en ejercicio serán de hecho los liquidadores y procederán a realizar los bienes de la compañía a los precios que estimen mas ventajosos, sin sujecion a trámites judiciales, teniendo ademas todas las facultades que la lei comercial confiere a los liquidadores en tales casos.

Art. 33. Los liquidadores rendirán cuentas a los accionistas del progreso de la liquidacion cada seis meses a mas tardar.

Art. 34 Ninguna distribucion de fondos que menoscabe el capital social podrá hacerse a los accionistas hasta que se hayan estinguido todas las deudas sociales de cualquiera clase que sean. Llenando este requisito, los liquidadores repartirán rata por cantidad entre los accionistas las cantidades realizadas, sin pérdida de tiempo.

TITULO SEPTIMO.

De la reforma de estos estatutos.

Art. 35. Estos estatutos pueden reformarse si así se determinase en dos juntas jenerales, con intérvalo de un mes, por una mayoría que represente las tres cuartas partes del capital social y prévia la aprobacion suprema.

TITULO OCTAVO.

Disposiciones jenerales.

Art. 36. Todas las diferencias y cuestiones que se susciten con ocasion de la Sociedad o de su liquidacion, serán resueltas por jueces árbitros arbitradores y amigables componedores, nombrados por las partes, con renuncia de todo recurso. Si los interesados no se avinieren con el nombramiento de un solo individuo, elijirán uno por cada parte y un tercero en discordia; y si tampoco se acordare en la eleccion de éste, lo nombrarán los árbitros y en discordia la justicia ordinaria.

Art. 37. El fallecimiento de los accionistas no obliga a liquidar la sociedad. Los herederos o representantes no tendrán otros derechos que los que corresponderian al socio difunto si viviese.

Art. 38. La compañía podrá comprar, vender, alquilar, edificar y poseer edificios, terrenos y útiles y otros artículos que se crea necesarios para la marcha de la empresa, haciéndose con acuerdo del Directorio los contratos que no sean materia de la administracion ordinaria del Jerente.

ARTÍCULOS ADICIONALES.

Art. 39. Queda nombrado un Directorio que funcionará hasta la junta jeneral de enero de 1882, compuesto de los señores Pedro A. Mac kellar, Lucius H. Foote y Santiago Martin, quienes nombrarán los suplentes cuando sea posible.

Art. 40. Queda nombrado Jerente don José D. Husbands.

Art. 41 Queda facultado [illegible] Husbands para todo lo relativo a obtener aprobacion, legalizacion toma de razon, publicacion y autorizacion, para aceptar cualquiera modificacion del Supremo Gobierno.

Art. 42. Mientras se obtiene la aprobacion suprema, las personas nombradas en los precedentes artículos adicionales obrarán como mandatarios de los accionistas con las facultades indicadas en estos estatutos.

Art. 43 Es condicion esencial de la cesion a que se refiere el artículo séptimo de los estatutos, que la compañía mantenga un servicio de teléfono en la casa particular de los señores Pedro A. Mac Kellar, Lucius H. Foote, Santiago Martin, José D. Husbands y Vicente Santa Cruz, que han contribuido al establecimiento de la compañía.

La sociedad Martin y Mac Neil ha sido celebrada por escritura otorgada ante el notario don Julio César Escala, con fecha 17 de diciembre de 1872, entre don Santiago Martin y don Guillermo H. Mc. Neil, en la cual se encuentran los artículos siguientes:

1.° La sociedad se establece en este puerto bajo la razon social de Martin y Mc. Neil.

13. Ambos socios tendrán derecho de usar el nombre de la casa.

Es copia de que certifico. Lo otorgaron y firmaron con los testigos que lo fueron don Manuel T. Felin y don Belisario Varas.

Se dió copia en papel timbrado de valor de cuarenta pesos.

Doi fé.—*P. A. Mac. Kellar.—José D Husbands.—Lucius H. Foote.—James Martin.—Martin y Mac. Neil.—Manuel T. Felin.—Belisario Varas.*—Ante mí, *Francisco Pastene*, notario público y de hacienda.

Es conforme con la escritura matriz de su tenor a que me remito, de la cual es segunda copia — Valparaiso, febrero 17 de 1881.—*Francisco Pastene*, notario público y de hacienda.

Anotado con el número cuarenta y cinco a fojas setenta y ocho del Rejistro de Inscripcion del Conservador de Comercio.—Valparaiso, mayo trece de mil ochocientos ochenta y uno.—*José María Vega V.*, Notario y Conservador de Comercio.

MODIFICACION DE SOCIEDAD.

En la ciudad de Valparaiso, República de Chile, a cuatro de abril de mil ochocientos ochenta y uno.—Ante mí, Francisco Pastene, notario público y testigos que suscriben, comparecieron los señores Pedro A. Mac Kellar, Santiago Martin por sí y en representacion de Martin y Mac Neil, segun se acreditará mas adelante, don Lucius H. Foote y don José D. Husbands, todos los comparecientes mayores de edad y de este domicilio a quienes doi fé conozco y dijeron: que son accionistas de la Compañía Chilena de Teléfonos de Edison, cuyos estatutos se firmaron ante mí con fecha quince de diciembre de mil ochocientos ochenta, y que habiendo notado una equivocaciones en los artículos que se refieren al Directorio de la sociedad por la presente escritura modifican los artículo doce, dieziseis, treinta y nueve y cuarenta del instrumento de quince de diciembre de mil ochocientos ochenta, los cuales quedarán en la forma siguiente:

Art. 12. El Directorio se compondrá de cinco propietarios y dos suplentes elejidos anualmente en la junta jeneral de enero de entre los accionistas que posean cinco acciones a lo menos, las que deberán conservar mientras ejerzan el cargo y principiarán a funcionar al dia siguiente al de su eleccion.

Art. 16. Son deberes del Directorio: Primero: Reunirse en sesion ordinaria a lo menos una vez al mes y estraordinariamente siempre,

que ha sido nombrado por el accionista, por cuyo motivo cesará en el servicio de la Compañía.

El Directorio no podrá entrar en sesion ordinaria ó extraordinaria sin la concurrencia de tres propietarios. Si no fuese posible reunir con número por ausencia ó inhabilidad de alguno de ellos, se completará llamando á los suplentes, y si aun así no se pudiere completar número, se dará cumplimiento á lo prescrito en el inciso siguiente: Segundo: Reemplazar al director ausente ó que se halle inhabilitado por mas de un mes, nombrando interinamente en su lugar á uno de los accionistas: Tercero: Velar por la buena direccion y administracion de la Compañía; y Cuarto: Presentar en las juntas jenerales ordinarias el balance, estado y memoria de que trata el artículo veintiocho de estos estatutos.

Art. 30. Queda nombrado un Directorio que funcionará hasta la junta jeneral de enero de mil ochocientos ochenta y cinco, compuesto de los señores Pedro A. Mac Kellar, Lucius H. Foote, Santiago Martin y José D. Husbands, quienes nombrarán en la primera sesion que celebren despues de la apertura de los estantes, al director propietario que falta y los dos suplentes.

Art. 40 de nombres al señor J. D. Husbands, director gerente y firmará así por la sociedad. La sociedad de Martin y Mac Kellar solo celebrará operaciones otorgadas ante el notario don Julio César Escala, con fecha diez y siete de diciembre de mil ochocientos setenta y dos, entre don Santiago Martin y don Guillermo H. Mac Kellar, en la cual se encuentran los artículos siguientes:

1.° La sociedad se establecerá en calle puerto bajo la razon de Martin y Mac Kell. Pero Andrés Soton tendrán derecho de usar el nombre de la casa.—Confirma esto un artículo á que me remito. Los otorgantes y firmaron con los testigos que lo fueron don Manuel T. Feliú y don Benjamin Dodd.—Sigue á esto un papel de un peso.—Hoy fe.—José D. Husbands.—R. Ante mí.—Pedro Alcántara Mac Kellar.—Pedro Martin y Mac Kell, ámbos.—Manuel T. Feliú.—Benjamin Yeomans.—Ante mí *Francisco Pastene*, notario público y de hacienda.—Confirmo con lo escrito arriba de su tenor á que me remito, ante la presente segun dicho.—Valparaiso, abril siete de mil ochocientos ochenta y uno.—*Francisco Pastene*, notario público y de hacienda.—Certifico que la escritura que precede queda anotada en mi protocolo del último de instrumentos del Conservador de Comercio con el número cuarenta y tres á fojas setenta y cuatro. Valparaiso, mayo trece de mil ochocientos ochenta y uno.—*José María Tapia V.*—Notario y Conservador de Comercio.

APROBACION DE ESTATUTOS.

En la ciudad de Valparaiso repúblicas de Chile, á diez de mayo de mil ochocientos ochenta y uno. Ante mí Francisco Pastene, notario público y testigos que suscriben, compareció don José D. Husbands, mayor de edad y de esta domicilio, á quien doi fé conozco y dijo: que en uso de las facultades que le confiere el artículo cuarenta y seis de los Estatutos de la sociedad anónima titulada Compañía Chilena de Teléfonos de Edison, que ha otorgado con fecha quince de diciembre de mil ochocientos setenta y cuatro ante el notario don Julio César Escala, con fecha diez y siete de diciembre de mil ochocientos setenta y dos, entre don Santiago Martin y don Guillermo H. Mac Kell, en la cual se encuentran los artículos siguientes:

1.° La sociedad se establecerá en calle puerto bajo la razon de Martin y Mac Kell. Pero Andrés Soton tendrán derecho de usar el nombre de la casa.—Confirma esto un artículo á que me remito. Los otorgantes y firmaron con los testigos que lo fueron don Manuel T. Feliú y don Benjamin Dodd.—Sigue á esto un papel de un peso.—Hoy fe.—José D. Husbands.—R. Ante mí.—Pedro Alcántara Mac Kellar.—Pedro Martin y Mac Kell, ámbos.—Manuel T. Feliú.—Benjamin Yeomans.—Ante mí *Francisco Pastene*, notario público y de hacienda.—Confirmo con lo escrito arriba de su tenor á que me remito, ante la presente segun dicho.—Valparaiso, abril siete de mil ochocientos ochenta y uno.—*Francisco Pastene*, notario público y de hacienda.—Certifico que la escritura que precede queda anotada en mi protocolo del último de instrumentos del Conservador de Comercio con el número cuarenta y tres á fojas setenta y cuatro. Valparaiso, mayo trece de mil ochocientos ochenta y uno.—*José María Tapia V.*—Notario y Conservador de Comercio.

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«República de Chile. Intendencia de Valparaiso. Número novecientos veintisiete. Valparaiso, mayo siete de mil ochocientos ochenta y uno. El señor Ministro de Hacienda, con fecha de ayer, me dice lo siguiente:

«Con acuerdo con esta fecha dictado lo que sigue:

Número novecientos veintisiete y nueve. Vista la solicitud precedente, los Estatutos y demas documentos que se acompañan y lo informado por el Fiscal de la Corte Suprema de Justicia, he acordado y decreto:

Apruébanse los Estatutos de la sociedad anónima titulada «Compañía Chilena de Teléfonos de Edison» que constan en la escritura pública otorgada ante el notario de Valparaiso don Francisco Pastene, con fecha quince de diciembre del año próximo pasado, cuyos los artículos nuevos, valorizados y que van agregados.

Art. 1.° Los cuotas se celebrarán á favor de determinada persona y no podrán ser en lo sucesivo por ordenes del ó al tenedor ante en lo. libros de la sociedad.

Art. 28. De las ganancias de la Compañía se rebajará en cada semestre la suma que acuerde la junta jeneral para formar un fondo de reparaciones y seguros subsiros del saldo de esta fondo no pase de cinco mil pesos.

Art. 31. La Compañía quedará disuelta por la pérdida de la mitad del capital social. La disolucion de la Compañía podrá tener lugar antes del plazo señalado á su duracion, si así lo acuerda por mas mayoría de accionistas que represente las tres cuartas partes del capital social, cuyo acuerdo se tomará valer. Ante ella se procederá en otra junta jeneral convocada al efecto y con intervalo de diez menos, si se ejecutará antes de obtener la correspondiente aprobacion del Presidente de la República. La cantidad del privilejio exclusivo no se sacará como pública del capital.

Se aprueban las modificaciones de los artículos 12, 16, 29 y 30 de los artículos espresados en la forma que consta de la escritura otorgada ante el mismo notario don Francisco Pastene, con fecha 4 de abril próximo pasado.

Habiéndose comprobado que la «Compañía Chilena de Teléfonos de Edison» ha cumplido el capital social de diez mil pesos, se le declara legalmente constituida y se fija el dia 20 del presente para que se proceda á sus operaciones.

El Directorio de la espresada Compañía cumplirá con las requisitos prevenidos por el artículo 450 del Código de Comercio.

Tómese razon, comuníquese y publíquese. Lo trascribo á V. S. para los fines consiguientes y en á usted para la mia.—Dios guarde á usted.—*E. Altamirano*.—El Jefe de la Compañía Chilena de Teléfonos de Edison. Conforme con su original.—Valparaiso, mayo trece de mil ochocientos ochenta y uno.—*José María Tapia V.*—Notario y Conservador de Comercio.

APROBACION DE ESTATUTOS.

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«República de Chile. Intendencia de Valparaiso. Número novecientos veintisiete. Valparaiso, mayo siete de mil ochocientos ochenta y uno. El señor Ministro de Hacienda, con fecha de ayer, me dice lo siguiente:

«Con acuerdo con esta fecha dictado lo que sigue:

Número novecientos veintisiete y nueve. Vista la solicitud precedente, los Estatutos y demas documentos que se acompañan y lo informado por el Fiscal de la Corte Suprema de Justicia, he acordado y decreto:

Apruébanse los Estatutos de la sociedad anónima titulada «Compañía Chilena de Teléfonos de Edison» que constan en la escritura pública otorgada ante el notario de Valparaiso don Francisco Pastene, con fecha quince de diciembre del año próximo pasado, cuyos los artículos nuevos, valorizados y que van agregados.

Art. 1.° Los cuotas se celebrarán á favor de determinada persona y no podrán ser en lo sucesivo por ordenes del ó al tenedor ante en lo. libros de la sociedad.

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Tómese razon, comuníquese y publíquese. Lo trascribo á V. S. para los fines consiguientes y en á usted para la mia.—Dios guarde á usted.—*E. Altamirano*.—El Jefe de la Compañía Chilena de Teléfonos de Edison. Conforme con su original.—Valparaiso, mayo trece de mil ochocientos ochenta y uno.—*José María Tapia V.*—Notario y Conservador de Comercio.—Conforme con su original.—Valparaiso, mayo catorce de mil ochocientos ochenta y uno.—*Gustavo Lemus*, secretario.

6466-may 25-1me.

Ag.t Gazette. Almonte &c. Sept. 1881.

TELEPHONIC.

A New and Important Invention by Worcester Man.

Ever since the introduction of the telephone into general use, one serious annoyance has presented itself, which will soon be done away with. It is the constant ringing of the call bell of subscribers at central office.

The invention is a device by which call bell, which has been perfected by Mr. James Kotzel of this city. By its use only the subscriber wanted by the central office is called. It does away entirely with the ringing of the bell when a subscriber at central office touches any other subscriber. For all practical purposes there been in constant use on the line of the city. The subscriber during that time had been constantly bowled and has worked every time with perfect satisfactorily to all. The only trouble which was noticed, is the inability of a subscriber to ring without pulling in the instrument that belongs to him. This trouble has to-day been found to be of little moment, as complaint has been on an indicator being put in colored disk is put in sight whenever the bell rings, and which disappears as soon as the circuit is broken.

The arrangement by which the wants are obtained are all to a line 19 or 12 twelve lines, and upon the face of the instrument there is this is the brass rack of an ordinary clock. On the front of the box at the center is a small key, with the number of each station, and a pointer or hand. When a station is desired, No. 6 for instance, the hand is pointed on this dial is placed on the figure 6. A push button is then pressed, and the action starts the electric current down the line, which connects with the other stations in automatic manner, and rings the bell only at station No. 6. As soon as the subscriber at No. 6 takes the telephone to answer it is operated at the central office, he is notified by the bell ringing on the operating table. The central office now has the other subscribers can not call the line is in use by the subscriber at No. 6 until he has finished. The call by the subscriber is the same as before.

The apparatus used is very simple and there is no reason why it should get out of repair any more than any good clock. It works if kept wound up like a clock, and will run from 8 hours to 24 hours without winding. It is so arranged that when the subscriber sends down then a lever will strike the crank to the call bell and it must turn be wound up before the subscriber can call the central office. The machine or clock at the central office will run for a week without winding.

The advantage to the Central Office will be that it will give better service in less time than the present. It does away with the constant ringing and the annoyance of answering. That it will give prompter service is self-evident, as the bell only rings when wanted. An advantage to the public right is that it will not so often client, as the call can be made as long as he long as the subscriber wishes, and can soon be put on be more stations and not on all if it is desired. It has been tested by private parties, and by the Telephone Exchange in this city until now they are so well satisfied that they have equipped one line with it, and their subscribers do not complain.

Sonn, Nov. 11.th 1881.

THE TELEPHONE AS AFFECTED BY SOME METEOROLOGICAL PHENOMENA.—Several continental observers appear to have been lately studying the sounds which may often be heard in a telephone that is connected with a wire stretched, say, between the roofs of two houses, and connected with the water of gas pipes. On the occurrence of lightning, more especially, sounds are heard, and at the time nearest preceding to M. Rossi Thery, of Geneva) as much as 3 secs, whatever the distance of the latter. Even when a thunder was heard, and the discharge must have been at least 25 kilometers off, M. Thery observed these induction effects. The sound was not like that of a Swedish watch rubbed on the box. The telphone affords an easy method of studying the velocity of thunderstorms, and other features of this electrical influence. M. Lalande, who has experimented similarly for some time past, thought to amplify the sounds, and did so by placing two microphones on the plate of the receiving telephone. The arrangement is set up in a quiet room, where all foreign vibrations are guarded against, and the author is able to hear the least sound at a distance of one mètre or more from the second telephone. Again, M. Landerer, at Tortosa, finds currents produced in his telephone-circuit by atmospheric electricity in three different ways. First, the condensation of aqueous vapour results in a sound resulting the cry of tin. A sensitive galvanometer in the circuit is not, or hardly, affected. These sounds are strongest at night. Next, there are the sounds which occur during lightening (and the currents producing which affect a galvanometer considerably). Thirdly, the wind generates currents which do not act on the telephone, but act on the galvanometer strongly. At Tortosa, the very dry west winds produce the greatest oscillations. Telluric or earth currents act both on the galvanometer and on the telephone; they are distinguished from atmospheric currents by the regularity and continuity of their action, during pretty long intervals.—*Times*.

LA

COMPAÑIA CHILENA DE TELÉFONOS DE EDISON

VALPARAISO

Organizada segun leyes de Chile en 1881

AVISA A TODOS AQUELLOS a quienes pudiera interesarles, que habiendo comprado el derecho exclusivo para usar el único Teléfono práctico, como tambien el sistema central relacionado con este, y habiendo tal mismo obtenido del Supremo Gobierno un **PRIVILEJIO ESCLUSIVO** el 29 de abril de 1880, SE HALLA DISPUESTA a entrar en arreglos con cualesquiera personas idóneas para el establecimiento del servicio telefónico en **CUALQUIER PUNTO DE CHILE** y todo cualquier plan que facilite del modo mas eficaz el servicio, ya sea por medio del **SISTEMA CENTRAL** ó por líneas privadas.

Solo esta compañía puede vender derechos exclusivos para territorios dados y proporcionar materiales bajo condiciones convenientes.

Es una práctica será comunicar con 4 ó todos las ciudades, pueblos y personas en una estension territorial de 200 MILLAS, desde un punto dado, y proporcionarles comunicacion instantánea, como tambien de casa en casa, en una ciudad.

Todo propuesta relativa a los servicios indicados deberá dirijirse por escrito al que suscribe, debiendo las de aquellas personas que no sean individualmente conocidas, venir suficientemente garantidas por alguna casa responsable de la localidad a que pertenezcan.

Recibidas dichas propuestas, no dará a conocer a los interesados las condiciones y precios para el referido servicio.

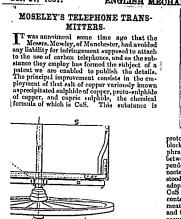
Valparaiso, mayo 21 de 1881

JOSÉ D. HUSBANDS,
director-jerente.

6466-may 25-1me.

MOSELEY'S TELEPHONE TRANSMITTERS.

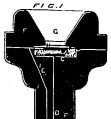
IT was announced some time ago that the Messrs. Mowley, of Manchester, had avoided any liability for infringement supposed to attach to the use of carbon telephones, and so the substance they employ has formed the subject of a patent we are enabled to publish the details. The principal improvement consists in the employment of that salt of copper variously known as precipitated sulphide of copper, proto-sulphide of copper, and cupric sulphide, the chemical formula of which is CuS. This substance is



used either in a compressed or in a pulverulent state.

The proto-sulphide of copper is made to form

FIG. 1.



part of an electric circuit, and is so placed that it may be influenced by the vibrations of a diaphragm when the latter is set in motion by the action of sound waves. The variations in the rapidity and amplitude of the vibrations of the diaphragm produce corresponding variations in the conductivity of the proto-sulphide of copper and therefore in the undulations of the electric "current" in the circuit in which it is inserted. The invention may be applied in various ways, but some typical examples will serve the purpose of explanation.

Fig. 1 is a section showing the method of employing the proto-sulphide of copper in the pulverulent form. A is a cavity formed in a non-conducting material such as wood; B and C are two conductors of electricity, such as platinum or other metal, carbon, or the compressed proto-sulphide of copper, which are attached to the cavity at D, E, communicating respectively with the opposite relaxed tube battery; F is the body of the transmitter; G is an open mouth piece, and H, H diaphragms. The cavity A is loosely filled with the pulverulent proto-sulphide of copper, which, being then in contact with the conductors B, C, forms part of the electric circuit. In Fig. 2, compressed

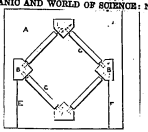


FIG. 2.

proto-sulphide of copper is employed for the blocks B, and the pastils C. A are the diaphragms upon which are mounted the blocks B, and the pastils C, are freely suspended. In this opposite blocks are connected with the wires E, F. It will be understood that a great variety of forms may be adopted both with pulverulent and with solid CuS; but in all cases the patentee makes the contacts with the proto-sulphide of copper by means of a conducting material, between which and the proto-sulphide no chemical reaction can occur under ordinary circumstances, for which purpose he prefers to use platinum.

Scientific American.

[FEBRUARY 18, 1882.

The Telereduphone.

M. Mercadier, the eminent French electrician, has ingeniously adapted the photophone of Professor Bell to telegraphy. In the photophone a ray of light is reflected by a mirror, so as to fall upon the sensitive surface of a "selenium cell" joined up in the circuit of a voltaic battery and a speaking telephone. When the light strikes the cell its electric resistance is diminished, and a wave or pulse of current flows through the telephone, causing it to sound. By eclipsing the ray of light a great many times per second, this sound can be caulked into a continuous hum, like that of a tuning fork, and by again occulting the intermittent ray for long and short intervals corresponding to the flashes of a signalling lantern, this hum or drone can be broken up into audible signals. Thus, if the Morse telegraphic code is used, a short occultation, producing a short pause in the note of the telephone, will stand for a "dot," and a long occultation, producing a long pause, will stand for a "dash."

This photo-electric telegraph is realised by M. Mercadier with the help of a gas flame forming the source of light, a mirror, and lenses to direct its rays upon the selenium cell in circuit with a battery and the line wire. The beam is regularly eclipsed by means of a rapidly rotating disk, perforated with a circle of holes, and the telegraphic occultations of the intermittent beam are effected by means of a signalling key, which interposes a dead screen in the track of the light whenever the key is pressed. These apparatus form the transmitter; and the receiver at the other end of the line is, of course, the telephone, which is fitted with a resonator to re-enforce the sound. There is no gain in such an arrangement over the ordinary telegraph now in use; but it has the merit of lending itself to multiple telegraphy. Thus by multiplying the number of transmitters at one end of the line and the number of telephones at the other, several different messages can be sent along the same wire at once. In order to do this it is only necessary to rotate the eclipsing wheels at different speeds, so as to produce notes of different pitch in the receiving telephones, and to fit each resonator so as to enhance a particular note. Then, although the complex current flows through all the telephones in turn, each telephone will only render to the ear of the clerk the particular note for which he listens, and the snakes and breaks of that note will be interposed as dashes and dots. Not only can several messages be sent in one direction along the same wire together, but from opposite ends simultaneously without confusion, and M. Mercadier reckons that with 10 transmitters and 10 receivers at each end of a line he can send 200 dispatches of 30 words each per hour, or 100 words per minute, in either direction. The effects of induction, so troublesome in speaking by telephone, are not experienced in this process, owing to the employment of musical notes and resonators.

ADER'S MAGNIFYING TELEPHONE.

M. Ader showed, at the Electrical Exhibition, a new instrument that possesses the power to magnify reproduced sounds. If a song is hummed in front of the microphones attached to the instrument, the song will be reproduced as a full quartet.

This instrument is formed of four trumpets whose mouthpieces are attached to a vibratory diaphragm (see illustration), but its interior arrangement has been kept secret by the inventor, as it is the only known instrument that is able to increase sounds transmitted through the air.

It is rightly named a microphone, as it does for the ear what the microscope does for the eye.

At present it is only able to reproduce musical sounds, but M. Ader hopes soon to magnify and reproduce articulate speech of the human voice, so that a person whose hearing is defective can hear without placing the instrument to his ear. He may possibly do this, for all telephones commenced by transmitting musical sounds only.

If M. Ader succeeds, instead of the present style of telephone, there may be telephonic offices and rooms where one can sit and talk comfortably to any distance without moving from his chair.—*La Lumière Electrique.*

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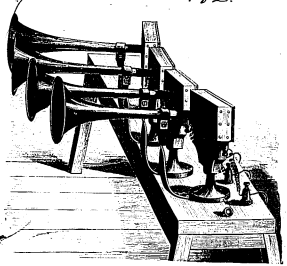
Scientific American. Feb 18/82.



ADER'S MAGNIFYING TELEPHONE.

Daniel Drawbaugh's Telephones.

The People's Telephone Company has obtained the testimony of about one hundred and thirty witnesses at Harrisburg, Pa., to show that Daniel Drawbaugh, who resides in the adjoining county of Cumberland, invented the first magneto-telephone, and its side of the great case will soon close in this city with the examination of an expert electrician who has tested all of Drawbaugh's inventions. The testimony given thus far goes to show that Drawbaugh invented at least half a dozen speaking telephones before Bell conceived the idea that sound could be transmitted by electricity. Drawbaugh, according to this testimony, began thinking about sound transmission in 1861, and in 1867 invented a machine which carried sound by means of a voltaic battery. In 1871 he made a magneto-electrical instrument which transmitted speech, and which is said to embody all the principles of the Bell telephone of to-day. In 1874 and 1875, it is claimed, he made marked improvements on this invention before Bell had any thought of telephonic communication. Since the Bell telephone went into operation Drawbaugh has invented a machine which he claims, according to tests made, will carry speech at least one thousand miles, and will not be affected by atmospheric influences. This same instrument, he thinks, can be made to transmit sound an indefinite distance. The American Bell Telephone Company, which is resisting the claims of the People's Company will begin taking testimony in a few weeks. In New York, next summer, it will be decided whether Bell or Drawbaugh invented the first magneto telephone.—*Operator.*

Telephones and Electric Lights in Brazil.

The *Rio News* reports a condition of things in Rio Janeiro not at all creditable to certain public officers of the empire. The Director-General of the State Telegraph Department in particular has seen fit to take a position of violent hostility to the introduction of telephones not under his control, and the indications are very strong that his hostility extends also to electric lights, while his methods of manifesting his dislike are not such as public officers customarily resort to.

The *News* says: "Ever since the telephone company of this city—which is unfortunate as to be a foreign enterprise—began to stretch their lines from the central office to the various suburbs, there has been a systematic effort on the part of certain interested parties to impede the work and damage the property. The means usually employed is the cutting of the wires. Regardless of the fact that this is an injury to private parties as well as to the company, this contemptible work has been prosecuted not only without lenidemess, but with the well known approval of influential parties in this city."

After describing at some length the course of the Director-General of the Telegraph Department in this connection, the *News* remarks:

"It is no longer a personal matter; the good faith of the government is at stake. If a privilege to a foreign enterprise is worth one straw in Brazil, then the government is bound to guard and protect it. If, however, a foreigner has no protection for his labor and investments as against the malice of influential per-sonages, then let us know it at once. If matters go on in this way a little while longer—in the confiscation of property, the breach of contracts, the destruction of electrical machines, and the cutting of telephone wires—this country will be satisfied with a reputation which will not only keep enterprise and capital at a distance, but will even drive away those that are now here. It is full time that the steady, thinking portion of this community take those occurrences into consideration, and determine where they are being led."

The destruction of electrical machines referred to occurred during the late National Exposition, the victims being the Edison electric light people, the aim being to prove that system of lighting irregular in its action and untrustworthy.

"It was thought a suspicious circumstance that two armatures in succession should be burned, but when a third was ready to be put in place, an examination of the upright columns of the dynamo developed the fact that a sharp instrument had been inserted beneath the canvas covering at their lower ends, and that the wires had been cut. That the cutting was done by an expert is evident from its location and character. The damage was examined by a committee of the Engineering Club, who are satisfied that the cutting was done willfully and maliciously."

Speaking of this outrage the *News* observes:

"We have heard of no effort on the part of the Associação Industrial, in whose charge the Edison apparatus was at the time of the accident, to ferret out the guilty party; who should make every effort to guarantee fair play, does not seem to have noticed the fact. Fortunately, however, the Edison light has been placed in the Dom Pedro II. railway station, where the public may judge of its merits without interference."

TELEPHONIC MUSICAL PERFORMANCES.—It seems incredible that the musicians on organ stands should serve miles in opposite directions at the same time, so that while the human voice should travel along the wire at the rate of 2 miles a minute, the music from the organ pipes, which can be heard with unaided electrical energy, travels with the steam music, in two hours 24 miles apart. Such, however, appears to be the case at the present time between Woodlands, Norwood, in the residence of Mr. Woodland, and Woodland House, Sydenham, in the residence of Mr. Flood-Page. These houses are 24 miles apart, and connected by a telephone wire which passes through the organ in the concert-room of the Crystal Palace. Every Saturday evening at Mr. Ayre during the past week has Mr. Ayre been present in the Palace, he has also played to his audiences at the Woodlands, who have been sitting in Middlesex House and the Woodlands rent in acknowledgment at the close of the concert. They have heard the Palace organ played, but Mr. Ayre and Mr. Fairy, Mr. Higgs and Mr. Henry Parker, the Palace choir, in fact gentlemen who have been "in the policy" Mrs. Gounard and Mrs. Flood-Page, have been still more astonished to hear simultaneously with the musical interventions which Colonel Gounard and Major Flood-Page, R.A., in his new home occasionally shows them a duet, telephonic wire conveys music and the human voice simultaneously, and without the slightest confusion of sensation, in the same moment in opposite directions. The public will soon have an opportunity of testing this for themselves, as the [Edison-Howard-Tel] Telephone Company of Great Britain, in connection with the Telephone Co.-opany, are about to establish musical telephonic entertainments at the Crystal Palace. Negotiations [illegible] concerned for such purposes, and before the electric exhibition was determined upon, and they will form one of the permanent attractions of the Palace. They have nothing to do with that exhibition, and will continue so long as the visitors are interested enough to support them.

Scientific American.

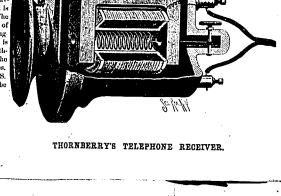
A NEW TELEPHONE RECEIVER.

We illustrate a new telephone receiver, the senses of which be due to the construction of a spiral magnet core under the influence of the currents traversing the bobbin. The spiral core is attached at one end to the diaphragm, and is connected at the other end with an adjusting screw. The spiral core is perfectly free to work in the helix, and the contraction or expansion of the spiral under the influence of the current from the transmitter acts on the diphragm in much the same manner as though it was attracted by a magnet, the results being the same as in Bell's, Gray's, or Phelps' instruments.

A permanent magnet placed outside the bobbin magnetizes the "spiral core" by induction, so that the spiral is very sensitive, thereby making it sensitive to the influence of currents passing in the bobbin. The inventor expects to partially, at least, overcome the influence of induced currents in the receiver, and to obtain more distinct articulation.

The construction of the telephone will be readily understood by reference to the engravings, in which a portion of the instrument is broken away to show the internal parts. The diaphragm is mounted on a mouthpiece of the usual description, and the permanent magnet and bobbin with the inclosed spiral is placed in a small casing attached to the mouthpiece. This instrument is provided with the usual binding posts and flexible connections.

This receiver is the invention of H. S. Thornberry, of Winona, Minn., who may be addressed for further particulars.



THORNBERRY'S TELEPHONE RECEIVER.

THE TELEPHONE.

A company, calling itself the Oriental Telephone Company, has been started with a view to introduce the speaking telephone of Bell and Edison into India, China, Japan, Australia, Fiji, and various scattered dependencies of the British Crown. The chief advantages of the telephone for those countries consists in the fact that it is portable and will answer all kinds of speech. There is word, too, of a National Telephone Company to spread the use of telephones in the provincial towns of the United Kingdom. On the Continent the installation is proceeding rapidly, especially in Germany, where it is under the management of the Telegraph Administration. From France an important advance has been made in Dr. Cornelius Herz, who has succeeded in dispensing with magnetism, and has produced a non-magnetic telephone differing from Ellsworth. His apparatus has been on trial for some time back on the French lines, and was publicly tested lately before M. Cochery, the Minister of Posts and Telegraphs, M. Jules Ferry, Prime Minister, and several well-known scientists. With a single Leclanché cell, Dr. Herz succeeded in transmitting audible speech along a wire from Tours to Bourg, *viâ* Paris, a total distance of over eight hundred miles.

A WONDERFUL TELEPHONE.

N.Y. Times — April /82

WHAT A NEW-YORK ELECTRICIAN IS SAID TO HAVE SEEN IN BOSTON.

A very remarkable improvement in the telephone, by means of which vocal messages can be transmitted over the wires thousands, instead of tens and hundreds, of miles, as heretofore, is reported to have been recently demonstrated in Boston, where the main office of the Bell Telephone Company is situated. The report has created some impression among electricians in this City, as it seems to open, if verified in all its details, a future for the speaking telephone not second to that of the telegraph itself, indicating, indeed, in the opinion of the most sanguine, that vocal transmission will ultimately supersede the written message for many practical purposes. It appears that Mr. C. E. Chinnock, who is employed by the Metropolitan Telephone Company, of this City, in the capacity of electrician, had occasion, a couple of weeks ago, to pay a visit to Boston in order to confer with the Bell Telephone Company. While there he was shown by Mr. Jaques, the electrician of that company, the workings of an invention by the use of which parties as distant from each other as New-York and Boston can converse with each other intelligibly and rapidly. It is stated that the only alterations required in the construction of the telephone as now in use in this City consist in the substitution of batteries of four cells each for the feeble ones employed for telephoning in the present state of the science, and in the substitution of carbons treated in a particular manner, which is kept secret as yet, in place of the simple carbon vibrating surfaces with which even the ordinary observer is familiar. In other words, transmission at long distances, as from New-York to Boston, Philadelphia, Washington, Cincinnati, St. Louis, or even San Francisco, requires simply the application of a battery power four times greater than that in use by the Metropolitan Telephone Company for its purposes, and the use of carbons subjected to a process of preparation that the inventor is not yet ready to divulge. Mr. Chinnock was not in his office yesterday afternoon, and had gone to the opera last evening, rendering an interview with him as to what he had seen in Boston impracticable. It was gathered, however, from conversation with his associates that experiments have been tried with the new invention that demonstrate its probable success. Messages have, it appears, been passed between New-York and Boston by way of the American Rapid Company's lines that have proved wholly satisfactory. It is not expected, notwithstanding this alleged great advance in the capacity of the telephone, that any immediate effort will be made to construct lines for communication at long distances, the value of the invention and its practicability requiring more thorough tests than have yet been instituted. Sanguine electricians express the belief that many years will not pass ere New-York and London will converse with each other at pleasure by telephone as to the fluctuation of stocks and the momentary condition of the money market, but before an Atlantic Cable Telephone Company is formed the availability of this, and possibly of many other, inventions will require to be thoroughly tested. Mr. Chinnock is reported as saying that the articulations of the human voice are transmitted with astonishing precision and distinctness by the prepared carbons that form the main feature of the new invention, the tones being so loud and clear as to be heard at a considerable distance from the instrument.

Another modification of the existing telephone, in which the use of carbon is discarded altogether, has lately been exhibited by parties in this City. The material employed to transmit the vibrations is cork, which the inventor alleges, after many experiments, is the only material whose molecular arrangement is perfectly adapted to transmit the sounds of the human voice. The construction of the transmitting instrument is extremely simple, consisting of a hollow hemisphere of cork, fitted like a cap upon a cork disc of smaller diameter, the frame-work being of cast iron so accurately wrought as to prevent any slipping of the disc and hemisphere from their places.

ÆGIS AND GAZETTE.
FEBRUARY 11, 1882.

The Growth of the Telephone System

It is now about two and a half years since the telephone system of communication was introduced to any extent in this city, and two years since the two exchanges were consolidated.

The growth of the telephone business has been very remarkable, exceeding the expectation of even its most sanguine friends, while its use, and necessity as well, has become indispensable in business. The Heart of the Commonwealth has taken hold of the invention with more than its usual vigor. The Worcester Division of the Bay State Telephone Co. is one of the best equipped for business as well as the best managed Exchange in New England if not in the country. Its management have not spared time nor expense to make it a grand success. They have given to its subscribers every new improvement of merit as soon as it has been put upon the market. One result of all this is that it now has over 800 subscribers. Thus far this year one new subscriber per day has been the rate of increase; a record unparalleled in the history of the company.

This general use of the telephone is not confined to Worcester. The banner town in New England, if not in the country is Portland, Maine, where there is a telephone to every 51 persons; Worcester is close behind with one for every 75 persons; Lowell one for every 81 persons, and Manchester, one for every 91 persons. The following statistics have recently been prepared to give some idea of the magnitude of the business:—

New York, which includes Brooklyn, Jersey City and suburbs, has some 4000 subscribers, and makes 14 000 connections daily; Chicago and suburbs, 3000 subscribers, 16 739 connections daily; Cincinnati and suburbs, 2500 subscribers, 14,100 connections daily; Philadelphia and suburbs, 1800 subscribers 9000 connections daily; Albany, 1200 subscribers, 7000 connections daily; Buffalo, 1090 subscribers, 2500 connections daily, charging for each connection; Baltimore, 1030 subscribers, 4000 connections daily; Louisville, 1000 subscribers, 4000 connections daily; at St. Louis, 900 subscribers, 4200 connections daily; Milwaukee, 700 subscribers, 3800 connections daily; Lowell, 734 subscribers, 4000 connections daily, Worcester, 800 subscribers, 4200 connections daily; Fitchburg, 200 subscribers, 400 connections daily.

The first Exchange in the world was the Lowell; its subscribers were canvassed for in October 1877. The first Exchange in London was started in January, 1879, only a few months before the first Exchange in this city. In these few short years the introduction of the telephone has become quite general, and the "rings and talks" of the little machines are heard all over the world. In India, Australia, Japan, China, Egypt, Greece, Turkey, South Africa and Hawaiian Islands, exchanges are being operated by the Oriental Telephone Company. All over Europe it has been introduced as well as in Mexico and Central and South America.

Recent experiments made, as well as those in progress, all tend to strengthen the belief that the instruments can be used on long distances as well as short ones, and it is believed that it will not be long before the evil of induction, which causes long circuits to run together and "hum," will be done away. New wires, with that object in view, will be constructed for long distances during the coming season.

THE ENGINEERING AND MINING JOURNAL.

[JUNE 11, 1881.

The Telephone in the Coal Regions.—The Reading *Times* says that the telephone lines between that city and Pottsville and other points in the coal region are completed. Distance does not seem to have any effect on the sound of the voice, which is as readily transmitted over a wire many miles in length as when parties are conversing with each other at only short distances. In about two months, a line will be completed between Reading and Pottsville, and as soon as practicable thereafter will be extended to Philadelphia. Connection will also be had shortly with Hamburg. The places to be connected are: Pottsville, Mahanoy City, Shenandoah, Minersville, Cressona, Schuylkill Haven, Port Carbon, St. Clair, Frackville, Orwigsburg, Ringgold, Gilberton, Mahanoy Plane, Lost Creek, Girardville, Ashland, Centralia, Gordon, Raven Run, Locust Dale, Locust Gap, and Mount Carmel. Connection has already been established at some of these places.

TELEPHONIC MUSIC.—Since the Paris Exhibition the notion of telephonic music has become familiar to the public; but a development of such music has recently taken place which is exciting great interest amongst scientific men. In order to enable the Edison-Gower Bell Telephone Company of Europe to know exactly what they could accomplish in this respect, Colonel Gouraud, the chairman, connected his own house with the house of Major Flood-Page, which is 2½ miles distant. The connecting telephonic wire passes through the organ of the Crystal Palace; not only is the organ heard with remarkable distinctness at each house simultaneously, but Colonel Gouraud and Major Flood-Page have been able to converse by means of the same wire, at the same moment as the music from the organ was travelling to their respective houses, without either the music or the voice being affected. This multiple use of the telephone seems to open out an extended view of the uses to which it may be put. As soon as this discovery was known Mrs. Gouraud and Mrs. Flood-Page invited their friends and many scientific men to their houses, and these interesting facts have been verified in the past week by nearly 200 persons. The public will now have an opportunity of hearing these musical telephonic performances at the Crystal Palace, where it is intended they should form part of the permanent attractions.

TELEPHONE PATENTS.

A very important action was tried in Edinburgh last week before Lord McLaren, in which the patents taken out in this country by Professor Graham Bell for the magneto telephone, and also by Mr. Thomas Alva Edison for the carbon transmitter, came before the Scotch Courts. The action was one brought by the United Telephone Company (Limited), who are the proprietors of these patents, against McLean, of Edinburgh, to restrain him from selling, supplying, or using a carbon transmitter and a magneto telephone. The counsel for the complainer were the Lord Advocate, the Solicitor-General, and Mr. Dickson. The counsel for the respondent were Mr. MacIntosh and Mr. Salvesen. The witnesses called in support of the complainer's case were Sir William Thomson, Sir Frederick Bramwell, Professor Fleeming Jenkyn, Mr. John Emery, Mr. E. H. Johnson (of Menlow-park, New York), and Mr. King, analytical chemist, of Edinburgh. The trial occupied five days, as the respondent not only questioned the similarity of the instruments used by him, but attacked the validity of both patents on various grounds. Lord McLaren gave judgment yesterday in favour of the complainer. He upheld the validity of the patents, and he also held that the respondent had infringed both, and granted the injunction asked.

Engineering Oct 1883

THE FIRST INVENTOR OF THE TELEPHONE.

An important decision has been made by the American Patent Office examiner on the title to the first invention of the speaking telephone. The chief claimants for the honour were Bell, Edison, Gray, and Dolbear, but many other inventors set up claims to a share in the invention. The whole invention or subject-matter in dispute was divided under a number of heads. The first of these relates to the art of transmitting sonorous vibrations of all kinds and quality by varying the strength of an electric current, and Bell is declared the first to have invented this. In the second article, which relates to the means of transmitting speech by varying resistance in the transmitter, Gray was declared the first to conceive and disclose the invention in his caveat of February 14, 1876, but failed to take action and complete it until others had done so, hence the priority is awarded to Bell. Edison is declared the first to employ an "electro-hydro-telephone, the fluid holding vertically an adjustable tube, within which the ends of the platinum points are immersed," he having exhibited this feature in a water telephone at the end of December, 1876. Bell is awarded priority for the magneto-induction, transmitting, and receiving telephone; the date of his patent being February 14, 1876. An important decision relates to "a telephonic receiver consisting of the combination in an electric circuit of a magnet and a diaphragm supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality. May, 1875, is the date of McDonough's invention of this device and priority is awarded to him. The well-known Bell receiver is therefore a mere variation of McDonough's earlier invention; but the "combination with an electro-magnet of an iron or steel diaphragm secured to a resonant case" is declared to be Bell's. Edison is awarded priority in the case of a spring carrying one electrode and pressing it against the other electrode and diaphragm. While upon this subject, we may refer to Professor Silvanus P. Thompson's recent researches into the earlier works of Philip Reis, which he has recently published in the form of a biography. Professor Thompson shows that Reis is the original inventor of the speaking telephone, that he intended it to speak, and that it did speak more or less perfectly. In short, each organ of the telephone system of Reis bears a remarkable resemblance to the working telephone of to-day, his platinum-pointed transmitter being a metal microphone, and his electro-magnet receiver being a crude Bell telephone.

FRENCH TELEPHONES AT THE PARIS EXHIBITION.

THE collection of telephones in the French telegraph annexe at the Exhibition is an interesting one. The accompanying figure represents the "watch" form of Bell telephone as exhibited by M. Bregnet. The outer case, which is of mahogany, is about 3 in. in diameter, so that this form is very convenient for the pocket, and may also be hung up anywhere like a watch. Its novelty lies entirely in its form; the principle, and the several parts of it, being the same as in the ordinary Bell telephone. The permanent bar magnet, instead of being straight, is curved round itself, after the manner of a volute, and the small coil of insulated copper wire is seated upon the central pole. The price of a pair in mahogany cases is 24 francs in France. The price of a pair of "mirror" telephones, which are similar to the watch telephone, but fitted with a straight side handle, like a hand-mirror is 25 francs. The ordinary hand telephones in mahogany and box are 20 francs, and those in ebonite, rose-wood, or nickel-plating, from 40 to 50 francs a pair. A powerful telephone for long lines, formed of a horseshoe magnet, with a brass board and a mouthpiece, costs 102 francs a-piece. Those prices are independent of the "cells" and other fittings.

An improvement effected in the construction of these telephones by M. Alfred Ninuket deserves mention. As formerly made the Bell telephone was by no means constant in its action, and required adjustment. The distinctness of the articulation depends in a high degree on the position of the diaphragm with respect to the pole of the magnet—as far as possible, while leaving sufficient space for it to vibrate in without touching the latter. It was found, however, that differences of temperature affected the vocalisation of the telephone even more than they do the delicate threads of some of our most celebrated singers. The hot breath playing impaired the articulation; and holding the telephone to the face for a few moments has even rendered it dumb altogether. In certain cases heating, on the other hand, improved the speaking. This inconstancy was traced to the expansion and contraction of the diaphragm, which, being clamped all round by the wooden frame of the instrument, could only expand in the middle, so that it became more or less convex there, and, in consequence, receded from or approached the pole of the magnet. To correct this variation, it was necessary to give the magnet a slight longitudinal play, so as to move it nearer to the diaphragm or further from it, as the case might be. M. Ninuket obviates this necessity by leaving the diaphragm free round its edge, not clamping it there between the two parts of the frame; and in order to fix it in its place and prevent its moving about, he overlaps it round its edge by a circular spring made of steel brass wire. This holds the diaphragm down all round, but leaves it free to expand at the edges without buckling in the centre. A telephone of this kind, therefore, requires no adjustment, a point greatly in its favour with the public at large.

M. Ninuket has also effected improvements in Edison's singing call for telephones. This consists essentially in connecting up a small local battery with the telephone, so that on singing against the diaphragm the latter is made to rapidly interrupt the circuit of the battery, and a singing note is heard on the receiving telephone loud enough to call attention. The local battery is connected up for calling by pressing a button in the back of the telephone. This carries a small platinum contact pin forward, within vibrating range of another contact attached to the diaphragm itself. When the call has been responded to, the press button is released, the contact pin springs back, the local circuit is withdrawn, and speaking can be carried on in the telephone in the ordinary way. M. Ninuket gets a considerable improvement in the sound of the call by making the frame of brass instead of wood. A speaking tube covering the diaphragm, with holes in it for the escape of the breath, is also an advantage. The merit of this alarm is that with the exception of the battery it is all comprised within the ordinary telephone itself. The singing note given out by the receiver may be easily heard a distance of 20 yards, with a battery of four two to four cells.

EDISON'S CARBON TELEPHONE.

THE great interest which the discoveries and experiments of Professor Hughes have excited in a branch of physics which he has made his own, and which were first described in this journal,* induces us to bring before our readers some of the experiments in a similar direction made by Mr. Thomas Alva Edison, the eminent scientific adviser to the Western Union Telegraph Company, who, we need hardly remind our readers, is a co-inventor of the quadruplex system of telegraphy and is the inventor of the now well-known electric-pen and of the famous talking phonograph.

Mr. Edison's carbon telephone, which has been referred to in former articles in this journal, is in outward appearance, very similar to the magnet telephone of Professor Graham Bell. Its internal construction, as well as the principle upon which its action depends, are, however, altogether different. Fig. 1 (on next page) represents a longitudinal section through the instrument, in which there is a diaphragm or membrane of thin fernetype iron, which vibrates under the influence of sonorous vibrations exactly in the same way as does the diaphragm of Professor Bell's instrument. Below the diaphragm is a cake of compressed carbon held between two plates of platinum, and attached to a sliding piece passing down the stem of the instrument, by which it can be made to approach or recede from the diaphragm by turning a screw at the lower end of the stem. The motion of the diaphragm is communicated to the upper platinum plate through the intervention of a small piece of india-rubber tubing fastened to the underside of the fernetype disc, and its action is to cause the pressure upon the cake of carbon to vary in

* See ENGINEERING, page 259 ante.

Could not find any entry relative to this
F. McFarlan
June 4, 1878.

The Electrical World
March 16, 1878.

THE TELEPHONE.

THE NEW ENGLAND COMPANY'S INCREASE.—The net increase of telephones by the New England Company in March was 186, making 17,838 instruments in use March 31.

ERIE INCREASE.—The northwestern division of the Erie Telephone Company increased its subscribers 16% in March, and has ordered 80 instruments on account of April. It is estimated that as many as 60 were added in the Northern and Cleveland divisions, making a total increase for March of 225.

THE AMERICAN PORTABLE TELEPHONE CO.—A meeting of this Company was held at their office, 108 Temple Court, on the 10th inst. It was decided to put 10,000 shares of treasury stock on sale at $7.50 per share. Capt. Border made a report of progress in the further utilization of the apparatus, especially for fire department purposes.

THE DRAWBAUGH CLAIMS.—The list of the subscribers to the Bell vs. Drawbaugh case has been given to at Harrisburg, Pa., during the last few days. It is not expected that the case will come to trial in June or July. The Drawbaugh representatives consider that the last evidence materially strengthens their testimony already obtained and makes them impregnable.

AN "ANTI-BELL" TELEPHONE.—The Boston *Herald* says: A new short distance telephone has entered the field—the "Anti Bell"—whose chief merit appears to consist in its phosphor-cop per bronze wire. It disclaims infringing American Bell patents, but maps out its own destiny as a "formidable rival" to that telephone and the system of exchanges generally. It has but this virtue—that it offers telephones and not shares to the public.

THE NEW ENGLAND CO.'S CHARTERS IN BOSTON.—The change of location of the central office is necessitated, says the Boston *Herald*, by the growth of business, as the company is about to introduce the multiple switchboard, which will increase the capacity of the Pearl street office to 4,200 subscribers, exclusive of 1,500 in other parts of the city. The costs of operation will be reduced about 25 per cent. by this change. The expense of the change is not stated.

ALTON, ILL.—The last telephone directory to hand is that of the Alton, Ill., exchange, working under the Central Union Telephone Company, third district. It now has nearly 150 subscribers and about 40 outside connections. Mr. S. H. Brobst is the manager. We note that books of coupon tickets for toll line service are offered at a 10 per cent. discount on all sales up to $20, 15 on from $25 to $45, and 20 on sales from $50 up. The directory is tastefully printed, and contains numerous local "ads."

March 22, 1883.

ELECTRICAL REVIEW.

The Telephone in Moscow.

Our Russian correspondent, located at Moscow, states that the Telephone Exchange in that city had 260 subscribers connected on January 18th. The rates of rental are 250 roubles per annum. The rates are considered very high, or there would otherwise be many more, but even at present rates they are coming in rapidly.

A New Telephone.

Knowledge describes the receiver of a new telephone, which is based upon the principle that when an iron wire or rod is magnetized it suffers a slight increase in length with a compensating decrease in cross section. The inventors claim "the construction of a telephonic receiving instrument consisting of a magnetic wire attached to a sonorous disc or plate, and wound with a primary coil connected to a local battery and with a secondary coil connected to the telephonic line wire, as described." *Knowledge* anticipates very satisfactory results from the new instrument, which, even in its crude form, it says, reproduces sounds with remarkable clearness.

A Long-Distance Telephone.

WASHINGTON, March 16.—Myron L. Baxter, of this city, has been awarded letters patent for a long-distance telephone, which, it is said, recent tests have shown to be capable of overcoming in a remarkable degree the difficulties arising from inductive and other disturbing influences.

M. D'Arsonval, the well-known telephonist, has devised a new form of Bell receiver, which is, for its size and weight, the most powerful yet constructed. The chief modification consists in enclosing the bobbin entirely between the poles of the magnet. This is done by making one pole of the magnet the core of the bobbin, and the other pole as enclosing ring of iron. The inductive plate vibrates over the poles and upper surface of the coil as before. The complete instrument only weighs a little over five ounces and is stated to be as powerful as the heavy Gower-Bell receiver. M. Lecraenky has applied magnets of steel tempered by compression after the manner introduced by M. Clemen dot, and since this mode of tempering does not deform the magnets, a neater article is the result.—*Engineering*.

The Bell Telephone Company in its annual report does not show any great surplus for this year, but no man can set down definitely the present earnings upon Bell Telephone stock, by reason of the unknown quantity of its income upon investments in local exchanges. Earnings of 25 per cent. upon Bell Telephone in 1883 is a moderate estimate. No one can estimate the future value of such a patent. It is the most valuable franchise ever secured to any corporation, and if not interfered with by the courts or the legislatures may pay an income, in time, upon a capitalization of one hundred millions.—*Boston Transcript*.

When some time ago we wrote that the telephone interests of this country would surpass in value the telegraph interests, we were not aware how quickly this would be the case. Despite the fact that the Western Union Telegraph Company has a share capital of $80,000,000, double the capital of the same company some time after the telephone was invented, this $80,000,000 of capital, at its market price of 84, does not equal in value the market price of the Bell Telephone capital, combined with the market value of the sub-companies working under its patents. That the commercial value of telephone, five years after its introduction to the public service, should be greater than the value of the telegraphic system of this country after twenty-five years of operation, no one would have dared to predict until very recently.—*Ex.*

Mr. C. Langdon-Davies in writing to the London *Standard* says of the Van Nyssel-berghe system of electrical communication, "Anything which any telephone can do, and also anything which any telegraphic instrument can do, are, by means of this system, made practicable simultaneously. That is to say, if the system were applied to the telegraphic wires of this country, the whole network would become available for the transmission of telephonic messages, conveying the full force of the voice to long or short distances, without interfering with or receiving interference from the telegraphy, which would be continued precisely as before, on the same wires at the same time." Perhaps if this system were tested by the English postal authorities Mr. Langdon-Davies might have cause to modify his statements to a considerable extent. At present such public communications on the subject of telephony and telegraphy must be taken *cum grano salis*.

THE ELECTRICAL WORLD

VOL. III.—No 16. NEW YORK, APRIL 19, 1884. $3 PER ANNUM. 10 CENTS A COPY.

The Gillett Long Distance Telephone Apparatus.

In the few years that have marked its growth the art of telephony has already fulfilled most extraordinary promises and realized most wonderful possibilities, and it may justly be masked, even now, among the most valuable of the arts with which electricity has endowed our civilization thus far. Yet it is far from having exhausted its resources and reached the limit of its development. There is a new and almost boundless sphere of usefulness into which it had scarcely thought of entering before now, and where it is destined to play a role of the highest importance—the transmission of articulate speech to long distances. Before its task is completed the telephone must yet fulfill this promise—it must conquer distance. The now indispensable conveniences and facilities which it places at our command for intercommunication between different parts of cities and neighboring towns, must also be made available between cities and towns widely distant from each other. It is, indeed, to this new development, this wider extension of the art that the public is now looking forward with the most interest.

Long distance telephony has been the dream of both scientist and inventor ever since Bell inaugurated the art by demonstrating the possibility of the electrical transmission of speech. But it is only within a comparatively short time that we have begun to approach the realization of this dream. The art of telephony, like all others, "had to crawl before it could walk." When the telephone left the hands of Bell its voice was too weak even for ordinary distances. In order to "cultivate" and strengthen it a certain process of evolution and improvement under the fostering care of the inventor was needed. The microphone transmitter had to be invented, the induction coil and other important accessory devices had to be brought into regulation. It was only after the telephone had succeeded in attaining its natural growth by assimilating these necessary elements that the higher development tending to make its voice reach "our hill and dale" began. At first it was the successive improvements made in the transmitters and receivers intended for ordinary use that enabled the distance of transmission to be gradually increased. But the practical limit to the increase is reached usually within a few hundred miles, with these forms of apparatus. This has since led some inventors to experiment with modified forms of apparatus specially constructed for the purpose of transmitting speech to long distances.

Mr. Webster Gillett, of Ypsilanti, Mich., appears to have been particularly successful in this line of invention. His "long distance" apparatus, the various types of which we take occasion to illustrate herewith, presents features of considerable novelty. The special interest which attaches to this apparatus, from the very fact that it is designed for long distance transmission, is greatly enhanced by the flattering success obtained with it in numerous long distance tests lately made over the wires of the Postal Telegraph Company. Mr. Gillett has been interested in the development of telephony almost from the very first, having obtained patents for improvements as early as 1878. Of late years it may be said that he has made a "specialty" of long distances, for all his efforts have been concentrated on the task of perfecting his apparatus, so as to make it powerful as well as sensitive.

The most important problem to be solved at the outset was to provide a suitable microphone contact, for, as we know, the clearness, the distinctness, the fullness, even, of the articulation, depend greatly upon the manner in which this contact performs its function. In ordinary microphone transmitters all the sound vibrations which make the diaphragm vibrate cause the carbon or metallic pieces between which this delicate contact exists, to move relatively to each other so as to make the contact alternately looser and closer. The resistance to the passage of current through this contact diminishes considerably as the pieces are pressed more closely together; but it increases greatly, on the other hand, when they move away. The difference may amount to several ohms. It results therefrom, that at each sound vibration, the resistance of the local circuit, through the contact and including a battery, and the primary coil of a transmitter, is increased and diminished, thus causing a fluctuation in the current. These fluctuations or "undulations" react upon the secondary wire of the induction coil, and give rise to impulses of current of higher electromotive force that are transmitted over the line. For the perfect transmission of speech each one of these impulses must act individually on the receiver at the other end, and for this they must be well defined.

The problem of long-distance telephony consists precisely in giving to these impulses a sufficiently sharply defined character, for they are expected to withstand a certain amount of retardation in transmission that tends to

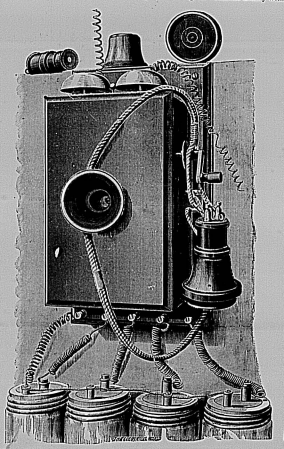


FIG. 1. THE FOUR-POINT TRANSMITTER—CLOSED.

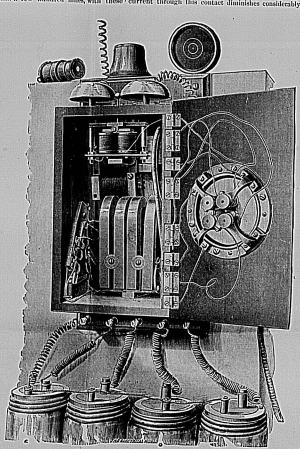


FIG. 2. THE FOUR-POINT TRANSMITTER—OPEN.

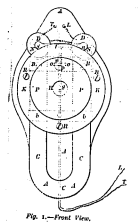


Fig. 1.—Front View.

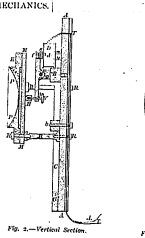


Fig. 2.—Vertical Section.

Fig. 3.—Perspective View.

THE LABYE TELEPHONE.

The Labye Telephone.

At the Paris Electrical Exhibition of 1881 M. de Locht Labye, of Liége, Belgium, exhibited an ingenious and very efficient telephone transmitter, shown under the name of the pantelephone. The remarkable feature of this transmitter, as described in *Engineering*, was its extreme sensitiveness. It would receive and transmit clearly the vibrations caused by the articulations of a speaker standing with his back to the instrument and thirty yards from it, and it was thoroughly efficient at a distance of four yards in transmitting whispered sentences. The instrument consisted of a single rectangular plate of cork, hung freely from two thin brass or steel strips. To the bottom of the block of cork was fixed a button of hard carbon, held in light contact by a slight inclination of the plate with a piece of platinum. This constituted the whole of the transmitter, which has now been supplemented by the equally ingenious and efficient receiver, which we illustrate on page 445. Considerable interest attaches to this latter instrument. Its articulation is as least as clear as that of the Bell telephone, while its action differs considerably, and the diaphragm common to other telephones is replaced by a thick and mechanically rigid aluminium plate.

Mr. Bell claims as a point of vital importance that, in order that speech may be transmitted and reproduced, a flexible plate should be employed, and this must be put into undulatory movement corresponding to that of the air waves, in order that such undulations may reproduce the air waves, and that to effect this it is necessary that the connecting line between transmitter and receiver should be constantly traversed by a continuous current, the undulations in which produce the vibrations of the diaphragm. On the other hand, M. Labye maintains that in his telephone articulate sounds are reproduced by a series of rapidly succeeding, but absolutely intermittent, blows struck on the aluminium plate, the amplitude and rapidity of these blows depending, of course, on the impulse transmitted through the line, and being rendered audible by an exact reproduction of continuous sounds, the ear not being sufficiently sensitive to mark the intermissions, supposing them to exist. Without dwelling on this theory, we may describe the telephone, which is illustrated by a front view and section, Figs. 1 and 2, and by a perspective view, Fig. 3. To a wooden plate, A, is secured by brass brackets, B B, a powerful horseshoe magnet, N C S. To each pole is attached a small core of soft iron, *d*, surrounded by the coils D D of silk insulated copper wire; these coils are included in the telephonic circuit, the conductors of which are shown at L and T. Opposite the cores of the small electro-magnets D D, which are covered with gold-beater's skin, or some other thin material, are the ends of a bar armature, a a, kept from actual contact with the cores by the film just mentioned. This armature, which is of soft iron and relatively heavy, is rigidly attached in the centre of its length to a bar-f brass, *f g*, which swings on the axis *o*, fixed to the post, *p*, which is made in one with the strap H. The lower end of this lever, which is thus free to oscillate, is traversed by a screw, carrying at one extremity the small hammer H. This hammer rests against the centre of a thick disk of ebonite or other material, M, which is screwed rigidly to a resonator, P, the whole being secured to the base-plate A by means of the metal posts B B. By means of the screw V at the end of the hammer the space between the poles of the magnet and the armature necessary to give the clearest articulation can be very accurately adjusted.

Like the Bell telephone, the instrument we have described can be used either as a transmitter or a receiver. The form, thickness, and practically the material, of the aluminium plate M are indifferent, although the circular shape illustrated is probably the most convenient. Ebonite, hardwood, cork, metal or stone give clearly articulate vibrations, and paper or leather folded to as great a thickness as the range of armature lever will allow may be interposed between the aluminium plate and the hammer without checking the clearness of the transmitted speech. The two parts—the aluminium and the resonator—may be made in one piece, and the more rigidly this organ is fixed the more efficient the telephonic duty appears to be. If, on the other hand, a thin flexible sheet is substituted for the aluminium plate—such as the ordinary Bell diaphragm, disks of mica, aluminium, &c.—the sounds are very considerably reduced, and if the armature lever be connected to the aluminium plate, all audible transmission ceases.

The inventor thus describes the action of the instrument when used a receiver: "The telephonic currents circulating in the bobbins cause the armature to be alternately attracted and repelled. By reason of the reaction of the rigid obstacle against which the armature lever rests, the repulsion alone is effective in producing the first movements of the armature. The latter, in moving away from the pole, momentarily separates the hammer at the end of the lever from the buttress or rigid obstacle. This repulsion is succeeded by the attraction of the armature caused by the following current, and the armature is then pulled back to its original position, and tends to pass beyond this position by reason of the attraction and its own *vis viva* or momentum, but is stopped in this direction by the rigid piece or obstacle against which the hammer strikes. The intensity of the blow or shock consequently results from the combined effect of these two actions, and is in direct ratio to the electro-magnetic forces which produce the repulsion and attraction of the armature. The number of shocks is equal to the number of electrical charges produced in the telephonic circuit."

(2) *Brix's Zeitschrift des deutsch-oesterreichischen Telegraphen Vereins*, 1882, Vol. IX., p. 153. This article is also reprinted in *Hughes's Telegraphisches Journal*, 1883, Bd. 67, XIX., p. 23.

This is a report by Inspector van Legat on Ader's telephone in its developed form. Inspector van Legat says that this instrument was able to reproduce single words uttered as in reading and speaking, though not so distinctly as it reproduced chords and melodies, which latter it transmitted with marvelous fidelity. It even added that the "gestures of the voice, the modulations of interrogation, exclamation, wonder and command attained distinct expression.

So much for Bell's references. Edison's reference is the same as No. 2 of the preceding.

As to the publicity of these documents, permit me to refer you to the shelves of the British Museum and other public libraries.

I do not say that there is not plenty of further evidence, were such needed. But here I am quite content to accept the references given by such unimpeachable authorities as Bell and Edison. When they refer me to papers wherein Reis says, in substance: "I am the inventor of the telephone. My instrument is intended to transmit human speech and all other kinds of sounds that a human ear can hear, and it succeeds in doing so, though I find to my disappointment that it is not yet quite perfect, because, though single words and consonants come through all right, the vowels are not clear"—I am bound to believe, on the authority of Bell and Edison, who give me these references, that Reis's modest claim is just. And I am bound to this belief still more strongly because I find, when I make careful trial of Reis's own telephones, that they will do exactly what he said they were intended to do, namely, transmit human speech at a distance by the agency of the galvanic current.

You have, Mr. Editor, most aptly said that the question is, What was *the kind of sorrow-stained* air attained by Philipp Reis? and I entirely agree with you that this question is not in the least degree affected by whether Philipp Reis is dead or alive. Though himself he is dead, and the task of defending his memory from outrage falls to others, his words still live to testify in the most unmistakable manner to the aim which he set before himself, and to the measure of success which he attained in his invention of the telephone.

Yours, &c.,
SILVANUS P. THOMPSON.

Bristol, March 4, 1883.

P. S.—There is a slight *erratum* in line 12, from bottom of p. 373, where, by mischance, the word which I wrote has been altered from *pe-fect-i to perfect*. Philipp Reis's telephones of 1862 were not perfect, but were perfected instruments, compared with those he showed to the Physical Society in 1861.

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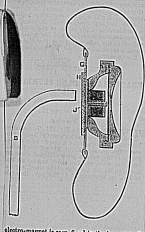
Engineering, Feb 2, 1883

BERLINER'S OPERATOR'S RECEIVING TELEPHONE.

RECEIVING telephones used by operators and others whose chief duties consist in listening to and reporting telephonic messages, require to be made as light as possible, in order to avoid the fatigue of holding up the telephone so constantly constructed. Mr. E. Berliner, of Boston, Mass., has recently patented a device which can be readily strapped to the ear and retained there without discomfort. It inserts in the receiver, and is made to make a receiving telephone which is strapped to the ear, and is so light as not to interfere with the comfort of the operator, and at the same time be efficient in service long continued. The secret is that the practical receiving telephone a certain amount of magnetic strength is required to polarize an electro-magnet, and as this magnet, then, represents a certain weight in steel, for a certain weight to be installed wire and iron which an electro-magnet is substituted for a permanent magnet) it has been found that carrying this weight on one's head interferes with one's comfort and health. It has been tried to substitute steel springs for the ordinary bar steel, and to so adjust as that they will exert pressure only to the sides of the head; but in such steel springs the magnetism is not permanent, and rapidly loses its strength. In his invention, Mr. Berliner discovers that by removing from the receiving tube, phone, and making the former part of the station, a features near the operator's ear, so that the remaining parts of the telephone—viz., the sounding-chamber, electro-magnet, and diaphragm—which are arranged to that are used in the magnetic field. In the figure the core of the



electro-magnet is seen fixed to the iron plate *J G* is another plate forming a holder, and to this plate the strap is attached. A cushion H of soft material is preferably glued to the back of the telephone, in order to prevent any noise in case the operator should strike against the telephone against the magnet N, which is held to a spring by a screw and nut, thus permitting the magnet to yield in case the operator should strike it, while the height can also be adjusted. It is evident from the above description that the requirements sought after in the invention are perfectly met—viz., a receiving telephone of light weight is strapped to the operator's ear, and magnetism of maintained strength is supplied without additional weight to the operator's head or discomfort of any kind. The line wires are connected to the binding posts D D in the usual manner.

THE JAVA EARTHQUAKE AND THE TELEPHONE.

It has been before observed that earthquake and volcanic eruptions have a disturbing effect on telegraph lines, setting up powerful earth currents in them, and rendering communication difficult. Recent advices from Mr. Worsnop, the superintendent of the Oriental Telephone Company at Singapore, also announce the fact that during the recent earthquake of Java and eruptions of the volcano of Krakatoa, the telephone lines in Singapore were unworkable owing to a deafening roar which drowned the voice. Only shouting could be heard on the lines because of the noise, which resembled that of a distant waterfall. On one line, in which a small subterranean cable about a mile in length from Singapore to Johore formed part of the circuit, the roar was mingled with occasional reports like that of a pistol. The volcano of Krakatoa is situated on the island of that name in the Straits of Sunda, between the southern end of Sumatra and the northern end of Java. It is about 600 miles south of Singapore with a corner of Sumatra intervening. The noises in question were heard during the eruption on August 27th last, but can hardly be considered as due to acoustical effects, notwithstanding the violence of the eruption. The cause is perhaps rather to be sought in the disturbance of the terrestrial magnetic field or in the electric state of the atmosphere, by the hurtful explosions. The first signs of the eruption were noticed on August 20, when shocks or earthquakes were felt as far as Batavia, and a fine rain began to fall, mingled with reddish stones. The waters of the straits then began to boil, their temperature rising some 20 degr. C., and great blocks of lava fell on the neighbouring coasts of Java and Sumatra. On the 26th the earthquakes became more pronounced, and at most the Malay-Mere, the largest of the craters, began to break forth into flame. The Gounung-Gunter and the number craters then joined in, until forty-five neighbouring craters were in action. Torrents of sulphurous mud and lava burst out, and at intervals tremendous explosions were heard, followed by showers of stone and ashes. The clouds were heavily charged with electricity, and lightnings played vividly. Next day the shocks and eruptions increased, and were accompanied by tidal waves. The island of Krakatoa entirely disappeared, and the destruction was frightful, as the newspaper reports have already testified.

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The Providence Telephone Company.

WHAT EFFICIENT MANAGEMENT HAS ACCOMPLISHED IN THREE YEARS.

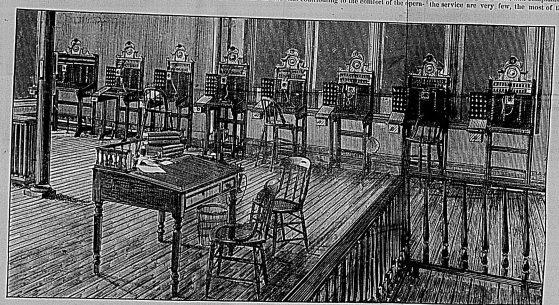
The operating-room of the Providence Telephone Exchange, one side of which we illustrate herewith, was referred to briefly some time since in these columns, but on account of the excellent manner of its construction, and the general management of the business, which has been so remarkably successful, we have thought it important and interesting to our readers to illustrate the description given so fully in our issue to day.

The rapid growth of the telephone business in the territory of the Providence Telephone Company is shown by the following statement of the manner of telephones in use at their various exchanges in the several years which have elapsed since the organization of the present company:

Providence.	Total in all other towns.	Total in Providence and other towns.
Number of telephones rented Aug. 2, 1880	641	802
Number of telephones rented Jan. 1, 1881	857	1,072
Number of telephones rented Jan. 1, 1882	1,661	1,541
Number of telephones rented Jan. 1, 1883	1,482	2,136
Number of telephones rented April 1, 1883	1,725	2,480

The increase of the present year bids fair to continue at the rate of about one hundred per month. The exchanges operated by the Providence company are located as follows: the principal office in Providence City, in which about sixteen hundred subscribers are connected directly with this one room; one branch office in Olneyville, some two miles in the suburbs, where about one hundred residences are connected; Pawtucket, Woonsocket, Attleboro, North Attleboro, Warren, Bristol, Pascoag, and Westerly. The territory within fifteen miles of Providence, which includes all of the above-mentioned places, with the exception of Pascoag and Westerly, is considered as a part of the regular Providence exchange, the offices being worked as branch offices, and nowhere territorial charges made for communication between any of them. As Providence is the business center of this locality, of course the work upon the trunk lines is very large, in some of the offices exceeding the local communications; and the number of communications in the Providence office alone average about nine thousand a day.

The operating-room of the Providence main office was established in the present year of '81, and an entirely novel system of making connections between the switch boards adopted. The peculiar features of which are drawing a portion of the work upon the subscribers by, in most cases, calling them by give their order (wire, doing away with an communication between operators or the necessity of message boys around the room; which system has worked very satisfactorily, as may be judged from the fact that it has not been found necessary to modify it in any way with an increase of the number of subscribers from the hundred, the number at the time the system was adopted, to about seventeen hundred, the same room, which is the number at the present day.



OPERATING ROOM, PROVIDENCE TELEPHONE EXCHANGE. (VIEW OF ONE SIDE ONLY.)

Other novel appliances have been added from time to time, as experience has found them desirable, in the main and branch offices. One important peculiarity is that the central office telephones are invariably looped into the lines under all circumstances, so that no interference is given to the parties conversing if the central office connects into the circuit for any purpose whatever. In the rapid increase of long-distance telephoning this is a very essential feature, and one which will undoubtedly be found indispensable in every large telephone exchange.

Young ladies are employed in the operating rooms, which are provided with many novelties contributing to the comfort of the operators, and speed in making connections from switch to switch. A retiring-room, to be used during meal hours, &c., for the ladies, away from the operating room of the main office, which is furnished elegantly, and adorned with fine pictures and flowers, while upon the tables are found the best periodicals of the day as soon as they are issued. In fact every endeavor has been made by the management of the operating department to render the service rendered by the first-class, and, while holding the operators to a strict performance of their duties, to aid them in all ways which may tend to their comfort and good nature.

The company have about two thousand miles of line in operation, and a number of cables of thirty to fifty wires each, all constructed in the most thorough manner, and are constantly adding to the property in this direction, particularly in the use of cables extend from the central offices within a quarter of a mile. No movement has been made yet in the direction of underground lines, although there has been considerable discussion made both in the city and State governments on the subject. The lines entering the exchanges are of all descriptions known to telephone people,—special wires, two party wires, four party, bi-polar, Bliss clock lines, carrier individual bells, and a few battery lines. A good evidence of the advantage of the system in vogue in this exchange is the fact that these various classes of lines are worked together in harmony, and to the satisfaction of subscribers. Connections average about a half a minute in regular work, and complaints of the service are very few, the most of them resulting from disarrangement of the instruments of the subscribers.

The original capital stock of this company was $75,000, which has been increased to $150,000, as required for the development of the business. The value $50 per share; but few transfers have been made; the price having steadily advanced from $10 in 1881 to over $250 per share, where it now stands firm. Most of the stock is held in Providence, and the president and board of directors are prominent business men of Providence and vicinity.

We attribute the great success attained by this company to the energetic and able management of its general superintendent, Mr. Duxbury, and his assistants Messrs. Gardner and White, who are too well known as old-time telegraphers and electricians to need any praise at our hands.

The officers of the company and board of directors we give herewith: Hon. Henry Howard, president; Henry C. Comstock, vice-president; Charles W. Harnett, secretary and treasurer; J. W. Duxbury, general superintendent; F. H. Gardner, A. C. White, assistant superintendents; Henry Howard, Henry G. Russell, Henry C. Comstock, R. G. Hazard, Jr., Charles Bradley, H. M. Lamed, James H. Chace, H. F. Burrows, C. H. Greene, William H. Pope, directors.

The Blake Transmitter.

reported discussed at the same institution, Subscribers of the stage, the operator could and a careful adjustment showed this position to be a very favorable one for distinct trans- mission, but in some hundreds of later experiments no more satisfactory results were ever been secured. The battery was two cells of gravity, kept on closed circuit until it attained a maximum working strength, and then placed within a few feet of the transmitter. On connecting with the line the effect was most gratifying. The footsteps of the soloists, as they came forward to their places, their parts in the programme, whether in heavy or subdued, the harmony of the co- rus-ses, dividing itself to the ear of a near listener, as with the theatrical experiments, it was found that the suspension of the trans- mitter in any manner which cut off the reinforcement of the vibrations of sonorous bodies weakened the results. Often this would not be noted on exchange lines, which a con- nection with a wire of 20 to 50 miles would instantly detect the lowering of the electro- motive force of the current, or the reduction of the amplitude of the vibrations. A small ornamental bracket, fashioned to correspond with the style of the desk and placed back of the opposite the speaker in front of the Blake, when connected rigidly with the desk and the transmitter, shouted the clearest and most far-reaching tone. Thus disposed, with two cells of gravity battery at hand, the short line from the switch-board grounded on a gas-pipe in the church, has repeatedly been at one time connected satisfactorily with Boston, Salem and Gloucester on the north, and Taunton and Fall River on the south, in- cluding at least six switch-boards and 120 miles of lines, with other grounds at the ex- tremes. Operators at these offices could hardly be made to believe that the speaker was four feet and the choir eighty feet from the transmitter, while in favorable weather they could hear every word spoken in the pulpit from invocation to benediction, and follow all the choral selections from the further end of the church.

It is a lamentable fact that privileges of this kind encourage extreme laziness on Sun- day morning, and probably influence some careless ones to lie on the lounge at home, with telephone at their ears, during the ser- vices of the sanctuary, when they are physi- cally able to lend their bodily presence to the inspiration of its exercises.

When confined to the short wires of a small exchange, the Blake gives, if possible, still more remarkable evidence of its ef- ficiency. As many as fifteen circuits, of three to six subscribers each, have been been attached, to one church, with no great reduc- tion in volume of tone, except on an occa- sional wire of extra resistance. If a change of preachers at the First Congregational Church displeased my hearer, it was an easy matter to signal the office and ask for a connection with the Central Methodist.

The microphone is one of the most remark- able of the many instruments which science has given us. The delicate action of its most perfect and practical representative, the Blake Transmitter, in responding to faint and distant sounds, has often been the theme of remark, and perhaps no illustration will more fully exemplify its varied application than its use in churches and public halls.

It is with no idea of presuming to offer any new suggestion to the veteran telephone man- ager that these few reminiscences are sent to the Review. But if this brief outline of early experiments and later successes should catch the eye of a pioneer in some yet unin- vaded territory, the record of four years ago of sound may stimulate him to interest and instruct his few subscribers, and illustrate in a very attractive way the capabilities of this most marvelous invention, the speaking telephone.

Early in 1879, while Blake's improved mi- crophone was yet very young, the writer secured the first specimen which was loaned from the Boston factory, at 109 Court street, for public-hall experiment. Its power was so little understood that no specific instructions accompanied it beyond the simple matters of battery and line connection. In form it was somewhat longer and larger than the standard pattern afterward adopted, with a heavier induction coil, and its adjusting screw was brought through the base, facilitating ready modification without opening. It is probable that but very few of this variety were ever made, as none appear to have been supplied to the exchanges of that date.

A few experiments showed not only the superior powers of loud and distinct trans- mission now so well known throughout the civilized world, but also the wonderful deli- cacy of action by which faint sound vibra- tions from a distance might be caught up and reproduced miles away. At that time a Tasmian musician was rehearsing a Brockton chorus for the cantata of "Queen Esther," and the idea of obtaining an echo of the hall entertainment at the residences of a dozen subscribers at once suggested itself as pecu- liarly a valuable assistant was secured, in the person of C. E. Austin, of Peterboro, then as now in the employ of L. W. Clarke, the well-known electrician of that city. Though so intimately acquainted with Bell's instruments as to be mentioned by Prescott as one of the pioneers in experiments with receivers, Mr. Austin had never before seen a Blake. After some exhibition, the "trans- mitter was attached to a device known in theatrical men as the "rain-box," in this case suspended midway by an iron axis about twenty feet above the stage, and fastened at an angle of forty-five degrees. The mouth- piece of the little talking machine thus

Thus all reasonable requirements were grat- ified. A gravity battery, if left open on cir- cuit, or closed on a high resistance, lasted for two or three months without renewal, and in many cases the increase of internal resistance has seemed to be far from disadvantageous.

In some few experiments the past year one and occasionally two cups of "prima" battery have been used to advantage, and with their high intensity have been found to show an unexpected constancy. Even when left on closed circuit for three hours, they re- cover in two or three days, and so last for some months. The main difficulty seems to be the rapidification of the current on the car- bon surface, necessitating a frequent use of a fine abrasive, and careful polishing with plumbago, preferably with finely-powdered stove blacking, slightly moistened.

The tone of such instruments, as well as of those constantly used for extra territorial lines, is also deepened and improved by an Edison induction coil, with a secondary re- sistance of about one hundred ohms in place of the regular Blake coil. The recent ex- periments in long-distance transmission indi- cate that practical improvement is to be looked for not alone in new and more power- ful microphones, and perhaps not as much in these as in lines of high conductivity, like the copper wires of the postal telegraph, and in such connections as will secure the strong- est action of our present instruments. The Blake transmitter, with its carbon carefully polished with plumbago, secured either di- rectly or by a wooden bracket to a wooden partition, reinforced by an Edison coil and retained by a deep mercurial cup, will now prove a serviceable instrument on good lines of fifty to one hundred miles, while a less careful arrangement will limit its usefulness to less than one-half the distance.

A word regarding the use of special de- vices for entertainments. E. F. Greenfield, well known as the former superintendent at the Bell Exchange in New York, now with the Edison Electric Illuminating Company, secured very good results in sending music from one transmitter by connecting the primaries of two or more coils in multiple, with one battery and carbon, and attaching two circuits to the secondary of each coil. Thus with two coils, four lines might be connected as two, with grounds only at their remote ends, and without possibility of in- terference.

The article published in your columns some time ago by T. D. Lockwood, refer- ring very kindly to some little tests here, suggested a trial of transmitters for music. A block-walnut board three feet square and one-quarter inch in thickness, was suspended over a piano by heavy electric cords from the ceiling. Three transmitters were fixed near its center, their carbons connected by long spirals to the primaries of three Edison coils a few feet away, and each with two pairs of pilon battery. By a combination of small jacks on the base holding the coils, the secondaries of any or all combined could be coupled instantly in series or in multiple arc, and careful tests showed a decided advant- age in the use of more than one, and the loudest tones were secured by the three in multiple. Unfortunately the twenty-five mile line to Boston was heavily grounded, and the connection with Manager Manson's residence in Chelsea for mutual pleasure failed of complete success, but the results were undoubtedly the best ever attained here.

Now, will not some of your many tele- phone readers follow this long and gossy talk with sketches of their own experi- ments?

OCCASIONAL.

Brockton, Mass., April 28, 1883.

Underground Telephone Wires.—In an article in a late issue of the *Popular Science Monthly*, by Dr. W. W. Jacques, the author says:

"The American Bell Telephone Company has recently constructed two short lines of underground wires in business sections of Boston, and those give us excellent data from which to judge of the extent of the econ- omy, practicability and the expense of putting all wires underground. We have seen and in Paris the retardation and induction are both almost entirely done away with and twisted wires in metallic circuit. It is necessary that all of the wires be in metallic circuit; for, if a metallic circuit be connected with a single-line circuit, the disturbances are not removed. If a subscriber in one city wishes to talk with a subscriber in a neighboring city, both cities must have metallic circuit systems and metallic circuit between the two cities. As the two lines constructed in Boston are short, only about one-quarter of a mile each, it was deemed best to use single- line circuits, hoping that the induction and retardation on so short lines would not be serious. The system is constructed as follows: Eight wrought-iron pipes, 2 inches in diameter, are laid side by side in two rows, about 4 feet below the surface. At each street corner, is built a brick chamber, large enough to admit a man, and with a cover flush with the street. The cables, of which several kinds are in use, run out from the basement of the central office through these pipes and up the side of buildings to roofs, from which they spread out to the subscribers by means of ordinary overhead lines. Conversation over these lines is not so easily carried on as by means of overhead wires, and it is frequently possible to overhear a conversation. This pro- hibits further extension of the single-wire system underground, for tech- nical reasons. The cost of the piping and chambers, in round numbers, $50,000 a mile, and those pipes are intended to accommodate one thou- sand wires. The cost of the cables is from $60 to $100 a mile for each circuit, according to the kind of cable used. In round numbers, we may estimate the total cost for one thousand wires at $100,000 a mile, or $100 a mile per circuit. The cost of piping and chambers would be nearly as great for one hundred circuits as for one thousand, as the cost of cham- bers and the labor of excavating and filling would be the same; and that the cost for one hundred wires may be estimated at $50,000 a mile, or $500 a mile per conductor. The cost per conductor thus increases enor- mously as the number of conductors diminishes, so that it would be clearly impossible to follow out the wires of an exchange system in all their bifurcations."

INVENTION OF THE TELEPHONE.

Counsel for the People's Telephone Company, of New York, filed in the patent office at Washington, on the 25th ult., a brief, giving their side of the application of Daniel Drawbaugh for a patent for a telephone. It contains the following statements: The first telephone patent was granted in 1876, and since then the patents of Gray, Edison and Bell; with the Blake (transmitter), have been consolidated into what is known as the Bell Associated Telephone Company. The stock was originally sold at $50 a share; and afterward was quoted and sold as high as $1,000 a share. The stock has been watered since, and the company is now in the market borrowing money. No dividend has ever been paid. The company has made and is making immense sums of money; but all this and the money it is borrowing has gone into the plant, which rapidly increases in extent and value, and the original stock is probably now worth $1,000 a share or more. It spent a large sum of money, too, in buying patents for improvements on the instruments. This is the only existing telephone in operation. The People's Telephone Company, against which the Bell company brought suit in the United States Circuit Court in New York, is composed of a number of gentlemen who have formed a company and purchased the interest of Mr. Daniel Drawbaugh, of Eberly's Mills, Cumberland County, Pa. Mr. Drawbaugh, as is proved by about 100 living witnesses, neighbors and others, invented the first and in practical operation a speaking telephone between 1865-1-72-73, the result of no acknowledged invention of his in 1865. He was very poor, in debt, with a large and helpless family depending upon him for support, and was, from this cause, unable to patent or cover his invention, or manufacture or introduce it, and is claimed that he never abandoned his claim to his invention to anybody. The men composing the People's Telephone Company bought his claim and some patents that completed the instrument, and made application for Mr. Drawbaugh in 1880 and prosecuted to furnish telephones for about one-third the cost of the Bell telephone. Presuming upon the validity of their claim, they pooled the company's stock; spent about $50,000 and started in the beginning of the work with plenty of capital to go ahead on. The originators were wild with great hopes; but the Bell company caused an injunction and suit. The best of lawyers were engaged on both sides, and the Drawbaugh patent was rejected about two months ago on the grounds that patents had been granted to others, and printed descriptions published by others prior to the date of Drawbaugh's application and that telephones were in use more than two years before Mr. Drawbaugh's application. The hearing proceedings now comes before Judges of to-day, and is presented on three specific points of law: First, the defendants claim that an application is not barred by a patent granted, or description published, more than two years before the application, provided the applicant's invention was prior to the granting or printed publication; second, that the application of the first inventor is not barred by a two years' public use or sale of another man's subsequent invention, without the consent, or allowance of the first inventor, except under such circumstances as to prove a voluntary abandonment of the invention to the public; third, that the Commissioners of Patents cannot lawfully allow anybody to contest the application except by interference proceedings. These points are upheld by high legal authority and pointed judicial decisions, and the belief is that either Drawbaugh will get a patent or the invention be given to the public.

BERLINER'S TELEPHONE TRANSMITTER.

THE principal feature of the invention which has been patented by Mr. E. Berliner of Boston, Mass., is the disposition of the carbon contact surfaces, one being attached to the diaphragm and the other being supported by a metal socket attached to a hinged plate secured to an arm that projects from the back of the mouthpiece downward over the diaphragm. This arrangement of the double purpose of supporting the free carbon electrode, and clamping the diaphragm in its place

against the back of the iron mouthpiece. The diaphragm is bound around the edges with soft rubber, and is separated from the mouthpiece by a ring of the same. The iron mouthpiece is hinged to a casting from which a circular box which contains the induction coil and carries the binding screws for the battery line, and receiving wires. To this frame of the induction coil is attached a plate connected with the battery wire, and carrying a spring having in its free end a screw which presses against a spring connected with the centre of the diaphragm. The spring is of such a degree as well as a conductor through which the current passes to the carbon electrode in the centre of the diaphragm. The terminal current colors at one of the binding screws, passes through the primary wire of the induction coil, through a spring and carbon electrode at the centre of the diaphragm, through the carbon electrode, metallic mouthpiece and the hinge, and passes through a binding screw to the battery. The variation of the current in the secondary circuit occurs at the contact of the two carbon electrodes, the contact being formed by the vibrations of the diaphragm, started to the diaphragm. When the receiver is used as a transmitter, the spring presses the resistant carbon electrode is made harmless by the free resistance in the local current and to amplify the electrical undulations. The terminals of the secondary wire of the induction coil are connected with the two remaining binding screws, which are connected, one with the ground and the other with the line. In connection with this transmitter Berliner connected with this transmitter many of the usual character. It will operate very well, but the well known forms of receiver, and is easily managed and thoroughly efficient. The transmitter has been well introduced, and large numbers of them are, according to the *Scientific American*, in use in this country. They have been adopted in several of the leading German railways, and are extensively used in the German postal service.

ELECTRICAL REVIEW

A WEEKLY JOURNAL OF

ELECTRIC LIGHT, TELEPHONE, TELEGRAPH AND SCIENTIFIC PROGRESS.

(Formerly Review of Telegraph and Telephone.)

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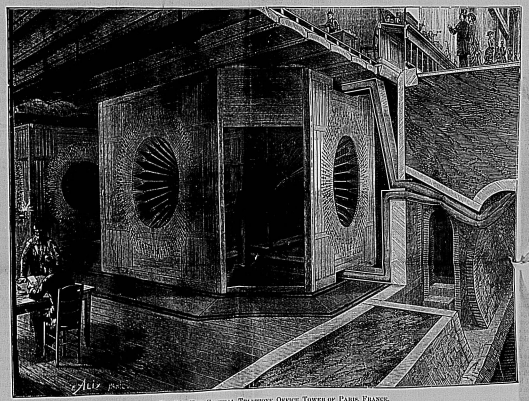
The Telephone Central Office of Paris.

(*Continued.*)

(*Translated for the* REVIEW *from La Lumière Electrique.*)

In our last article we have given an idea of the organization of the Parisian telephone system, and the manner in which it was connected with the different central offices. In this article we shall enter into more details with the same end in view, taking as an example the central office of the Avenue de l'Opera, one-half of the collecting sewer, which runs throughout the whole length of the Avenue de l'Opera under the sidewalks, and the small branch sewer, which, connects the house at No. 27, of that street with that sewer. The walls of the sewer are supposed to be removed in front of the spectator, in order to expose to view the rosace chamber; and above the sewer and the ground covers it one can see the sidewalk of the Avenue de l'Opera, where some pedestrians are represented as passing. One can even distinguish the show-window of the store



(FIG. 2.)—THE CENTRAL TELEPHONE OFFICE TOWER OF PARIS, FRANCE.

There are, as will be observed, two rosace chambers. The first, which is in front, is appropriated to the wires of the subscribers who are in direct communication with the office; the second is appropriated to the auxiliary wires, which, as we stated in our preceding article, connect with all the central offices, which are in this manner placed in communication with each other. The tube which is suspended from the vault of the ceiling of the room is used for the ventilation of the whole office. The wires which to the number of 2,000, end at the office of the Avenue de L'Opera, the most important of all; and for greater clearness in our description we shall follow the wires from the sewer, where they are united in bundles, up to the switches of the central office, where they are distributed, to constitute the private circuits of the different subscribers.

To render our description more clear, we give, in Fig. 1, which represents the rosace chamber of the central office in the Avenue de L'Opera, the section of a portion of the street at the place where the wires enter the office. Thus we see at the right of the figure which forms the entrance to the office, and where are exposed for sale the telephonic apparatus manufactured and sold by the company. The interior of the store, even, may be partly distinguished in the upper part of the figure, above the rosace chamber, which is really one of the cellars of the house. The door, which will be noticed in the branch sewer, corresponds in position to a glazed opening placed in the sidewalk, and consequently allows access to the sewer from the outside, just at the point where the wires enter the office.

Avenue de L'Opera, are enclosed, as we have mentioned, by groups of fourteen in tubes of lead, which of themselves constitute distinct bundles, and these bundles, in entering the office, are separated into the cables of which they are composed in several parallel lines, which correspond to ranges of openings in a large bronze plate, through which all the cables pass by insulators. On leaving these openings the cables are again connected in two large bundles, which enter by two wooden conduits placed at the upper and lower parts of the room in the interior of the rosace chamber. There they are separated, and the lead-covered cables are distributed around circular openings made on the few sides of each chamber, and to which has been given the appellation of rosaces. Being fixed on the interior side of these chambers, each cable is stripped of its lead covering, and the wires which were there enclosed are separated by couples of two, forming seven two-wire lines, which pass through the partition, and are attached exteriorly to double screw-posts placed all around the rosace. To easily distinguish the wires belonging to the same circuit, they are covered with braid of the same color, but each couple is of a different color, so that each cable contains of seven couples of wires of seven different colors, which are always placed in the same order around the rosace.

On a larger circle are placed little plates of horn on which are engraved the names of the subscribers, and on a still larger circle are fixed other tickets showing the number of each cable.

From each screw-post there start two wires covered with gutta-

SCIENCE;

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JOHN MICHELS, Editor.

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THE PHOTOPHONE.

Mr. Alexander Graham Bell, whose contributions to electric science have been recognized at home and abroad to their fullest value, has written a paper on his latest invention, the Photophone, which we reproduce and abundantly illustrate.

It is a beautiful application of the telephone to the registration of the mechanical action of electricity set in motion by light; but it is not (as the world was led to suppose by some ill informed journalist) a method of transmuting light pulsations into electrical ones, and then changing these back again into light. A beam of light is reflected upon a mirror diaphragm, which is set in motion by the voice or otherwise; the concentrated ray is then reflected so as to affect a piece of selenium in a telephonic circuit, which, by its varying conductivity, acts intermittently on the diaphragm of the telephone, and thus in the usual way reproduces the sound. The instrument is simplicity itself, but the results are of the highest popular and scientific interest.

That it is possible for even the ray of a star to produce a mechanical effect, was demonstrated when Edison used his Tasimeter for measuring the waves of radiant energy of Vega. We thought Bell had solved the problem, upon which Edison was at work when he became interested in the perfection of his electric light, but our hope has not been realized. The subject, however, is one of extreme interest, and it is not strange for the discoverers of the two telephonic systems to be simultaneously engaged in solving the natural corollary to their great propositions. But Edison has an advantage in the pursuit. His employment of the varying electrical conductivity of carbon allows him to introduce any amount of reserve power for mechanical purposes.

It is much to be regretted that Edison can not find leisure from the practical applications of his science to turn his attention to those problems which he is so eminently capable of solving. We vividly recall some experiments in this direction which he carried out during the Spring of 1878, while on a visit to his laboratory at Menlo Park. He allowed a beam of light to fall on the surface of a diaphragm connected with his carbon button, in the hope that by a surface and molecular action, it would be possible to transmit its motion to a receiving diaphragm, where a similar molecular tension would result in the reproduction of the original vibrations. A faint halo is said occasionally to have surrounded the diaphragm. We could not but believe this due to the excited imagination of Mr. Edison, for at the time he was enthusiastically engaged in testing the wondrous capacity of the tasimeter, which he was soon to use in eclipse observations on the Draper expedition.

He also tried to observe the effect of a beam acting on the diaphragm of a phonograph, whose cylinder revolved at enormous speed, hoping a line of phosphorescence might arise from the tinfoil where it came in contact with the needle. Mr. Edison said he employed the direct action of the light (in the last case), in preference to using electricity as a medium for it, because he feared there existed a difference between the vibratory periods of light and electricity, although their velocity was nearly the same. For a similar reason he sought to realize the instantaneous transmission of light by using his motograph, in preference to the magnetic telephone which for this purpose is valueless, owing to the time required to charge and discharge the iron core. But the most interesting of these experiments is to come. He threw a beam of lamp light on a small mirror, fastened to a tuning fork, and reflected a ray upon a strip of hard rubber in the tasimeter, the button of the latter being in circuit with a telephone and battery. On setting the fork in motion, the Lissajous figure caused a movement of the rod, which resulted in the reproduction of the musical note.

But all these pretty experiments are but introductory to the more subtile question, how to translate light through other forms of motion back into light. We wish a hearty rivalry between the two discoverers; for Messrs. Bell and Edison will find the fields of science (like those of trade) yield best fruit when fertilized by competition.

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Swiss Telephone Systems.

In the Telephonic Review, which we published in the number of July 14th last of this paper, we have sketched a few of the particulars relating to the state of telephony in Switzerland, and we even went so far as entering into some details on the organization of the lines which are used in that kind of telegraphy. To-day we are going to complete our statement by examining, according to Mr. Bothen's report, the organization of the central offices.

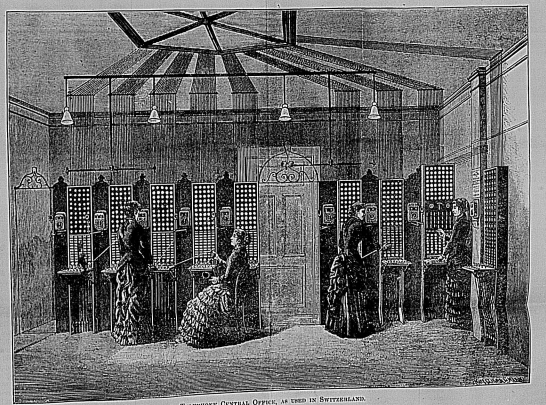
As it has been seen in the article just referred to, the telephone lines in Switzerland are formed of aerial (elevated) wires, which cross over the houses, supported every hundred yards in a suitable way by iron horses. Such horses are placed astride on the apex of the pointed roofs, and generally provided with six horizontal cross-bars of iron, upon which are screwed, from six to eight in number, small insulators, in porcelain, with a single bell. By this system the iron horses simply rest on the roof without any fastening, that permits to remove them in the most easy manner. Such distance of 100 yards is not fixed by any regulations, and, in fact, it often happens to be reduced to thirty yards or prolonged to 900 yards, according to the possibility of selecting convenient resting points.

These horses are made of buttressed corner irons varying in size from 2 to 2½ inches in width and from four to five-sixteenth of an inch thick, and the cross-bars for the insulators are made of T irons, having 1¼ to 2 inches in width, by two three to five-sixteenths of an inch thick. Their weight may be somewhat over 1,000 pounds. The two feet of the two upright bars are consolidated together by means of small cross-ties. The horse, moreover, may be placed in a parallel line, normally or obliquely, with the ridge of the roof according to the direction of the line wires; but a matter of disposition in the placing of the cross-bars on the base irons straddled on the ridge of the roof, and the number of wires which they bear varies from 36 to 60. In order to avoid the breakage of the tiles and slates by these iron horses, pads, made of tarred cloth and filled up with mineral wool, are placed between their feet and the roof; and further, they are maintained in a vertical position by wire strands fastened on the rafters of the roof. The space between the wires on the horses varies, in proportion of the span length, from about 12 to 20 inches, which latter distance corresponds to a span of 200 yards. The size of the horse consequently varies not only according to the number of wires they bear, but also in proportion to the length of the span from one horse to another, and they must always be placed squarely with the direction of the wires in the longer span. The wire adopted is, as has been seen, galvanized cast steel wire, having a diameter of one-sixteenth of an inch; it can bear a traction of 800 to 900 pounds, capable of being strongly twisted, and does not stretch more than two per cent. at the maximum for the highest tractions, but it offers a resistance of 90 to 65 ohms per kilometer (about three-fifths mile).

The setting up of that wire is delicate, because it should not be stretched, and to unroll the same, reels of a special kind must be used. Weldings are made with very soft iron wire, about ¼ of an inch in diameter, and must be placed within 10 yards of the points of support. Finally, the maximum tension to be given to the wires must never be over 80 kilogrammes (about 175 pounds), on account of the rigor of the climate.

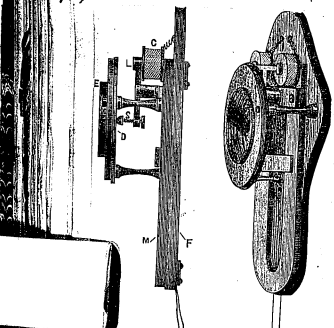
The insulators are made of small porcelain cylinders, thinned in the middle, and presenting at their lower part a fuller-shallow cavity, at the bottom of which an excavation is made, provided with a screw thread, in which the support of the apparatus is fastened.

By means of repeated divisions in the series of the telephonic networks, we arrive at lighter lines with a limited number of wires, and then the points of support become more simple; instead of having two upright bars there is only one, which is fastened on the beams and the wall gables. When lines fall, their place is supplied, with posts like those of the telegraphic lines, but in such cases the insulators become different and take the shape of those which are used on the telegraphic lines and where the distance becomes considerable, the steel wire is replaced with



TELEPHONE CENTRAL OFFICE, AS USED IN SWITZERLAND.

Electrical Review, Sept. 24, 1883.



THE "HAMMER" TELEPHONE.

The "Hammer" Telephone of M. De Locht-Labye.

The London *Electrical Review* says: This telephone constitutes, it is claimed, quite a new and original arrangement for transmitting speech. It can be so, up to the present, almost universally supposed that for the telephonic reproduction of speech the employment of continuous undulatory currents is indispensable. Professor Bell is looked upon as the originator of this theory, and his great influence in the scientific world, and especially his invention of the telephone with stretched membrane or flexible disc as an application of this theory, supported him, and for the time silenced all contradiction.

It is claimed for the De Locht-Labye telephone that it has no flexible organ, no parts susceptible of the undulatory movements which are, as Bell said, for reproduction of the shape of the sound waves of the air.

We will explain, in a few words, the construction of the receiving apparatus, which we have shown in perspective and in sectional elevation in the accompanying sketch. A horseshoe magnet, *M*, has at its poles two little cores of soft iron, on which are placed coils *C*, of insulated copper wire. This magnet is fixed immovably to a wooden frame *F*, which serves as a support to the whole apparatus. In front of the poles of the magnet, and at a very little distance from them, although this distance can very easily be regulated, as we shall soon see, is an armature, consisting of a thick inflexible bar of iron. This bar forms part of a fixed lever, *L*, moving freely on a fixed axle, placed on a little rod of copper, brass, or any other material. As we see, by its position, the armature lever is thus apparently a free reel, and as in itself, in no way of the nature of a flexible disc. It is only fixed to the support by its axis, and is not connected with any membrane or other organ. It is terminated by a little hammer of metal, or some other substance, fixed to the extremity of a regulating screw, *S*. This hammer, in its normal position, rests upon a thick, rigid, inflexible piece of wood, glass, ebonite, or any other material, *B*, of any shape whatever, but which, for the sake of symmetry, has been made cylindrical in the apparatus, and to which is fixed an ear-piece, *E*. We must observe that, as the inventor, who is now in London, has shown us, the ear-piece may form the part which supports the hammer, which shows, he thinks, that in no way is it of the nature of a membrane or flexible disc. The position of the armature lever is determined by the magnetic attraction of the poles of the magnet, the effect of which is counterbalanced by the reaction of the fixed portion supporting the hammer which terminates the lever. By the help of the screw which carries this hammer, we can easily regulate the distance between the poles of the magnet and the armature, so as to obtain the maximum telephonic effect.

These are the essential characteristics of the De Locht-Labye telephone.

Bell, in his original specification (Morgan-Brown patent, June 9, 1877), made the following statement:

"In all previous systems of telegraphy, messages have been received either by means of chemical changes produced by the action of the electrical current, as in the various forms of automatic and autographical telegraphs, or by means of the mechanical movement of a portion of the receiving instrument, operating to produce a visible signal, as in needle telegraphs, a mark upon paper, or other material, as in printing telegraphs, or a sound, as in the Morse system."

He immediately adds:

"Until there and all other plans it has been found difficult, if not impossible, to distinguish between more than four messages transmitted simultaneously over the same circuit, two in each direction," and as Mr. Webster, Q.C., for the United Telephone Company (Limited), said, in his pleading:

"In no single case could it be pretended that Professor Bell intended his instrument to act as reeds."

Now, in the De Locht-Labye telephone, it is claimed that the armature is a free reed. It is arranged in a manner that reminds one of the armature of the Morse telegraph, or, better still, of that of the Hughes printing telegraph, and, nevertheless, the transmission of sounds of all kinds and of speech is effected with complete success.

Numerous experiments have been made by experts with the instrument, of which we give a sketch, and it is declared unanimously that it works at least as well as the Bell telephone, as regards clearness and loudness of sound.

The inventor is convinced that he can make his instruments effect far more, and that, consequently, his results will considerably exceed those of the Bell telephone, so that his telephone can be employed for very long distances.

This, in order to allow the essential points of difference between the De Locht-Labye and Bell telephones, from a mechanical point of view, one might say: That the Bell telephone is characterized by the combination of a magnet, provided with a coil or coils at its ends or poles, and a thin and flexible plate of iron or other metal, surrounded or fixed round its edge, over all the flat circumference near and at right angles to the magnetic pole; whereas the De Locht-Labye telephone is characterized by the combination of a magnet provided with coils at its poles, with a right armature of soft iron or steel, turning freely on a fixed reel or axle, and terminated by a hammer striking against a rigid inflexible body of wood, ebonite, or any other substance. Du Locht-Labye's hammer telephone can work under the same conditions as Bell's flexible disc telephone—*i.e.*, it can be employed in the double function of Bell's transmitter and receiver.

It now remains for us to explain clearly the inventor's idea of the working of the telephone as a transmitter. Every sound wave, on reaching the rigid part, imparts to it a sudden shock, which it transmits instantaneously to the hammer. The latter then separates from the rigid part, and gives rise to a slight movement, the extent of which is in proportion to the intensity of the shock—*i.e.*, to the intensity of the sound. But immediately the magnetic attraction acting continuously and with great force upon the armature, stops the movement of the armature lever, and restores it to its original position so that the movable part can receive a fresh sound shock.

These sudden movements (of the lever) of the armature before the poles of the magnet, engender in the coils covering the poles instantaneous electric currents, equal in number to the movements of the armature, and therefore to the sound shocks. These instantaneous currents, passing through the line, on reaching the end of it, are received by a similar apparatus.

The working of the telephone as receiver is then easily explained. The intermittent instantaneous currents, of variable force and duration, traversing the coils of the telephone, says the inventor, magnetize and demagnetize at each emission. If the magnetizing current is produced first, it is powerless to produce the movement of the armature lever, on account of the reaction of the poles. We leave on which the hammer rests. The demagnetizing current alone is capable of drawing back the armature, and consequently of detaching the hammer from the part on which it rests. The current being instantaneous, the movement is instantly arrested by the continuous action of the magnetic attraction, which restores the armature to its original position, and forces the hammer to strike against the block. It is this shock which produces the sound at the receiver. For each emission of the current there is one shock, and only one. Its force is proportionate to the energy of the current, and therefore to that of the sound shock at the transmitting telephone.

All these movements are sudden, and can in no way possess a duration equal to that of a sound wave or air. The armature and the hammer are, therefore, nearly always in a position of rest, ready to receive new shocks and to transmit them to a distance.

The telephonic transmission of speech, then, according to M. De Locht-Labye, evidently results from a series of shocks, and the bellows from the working of this apparatus that, in order for speech and any kind of sound to be transmitted and reproduced, there must first be an equal number of sound shocks. Little movements of the armature in the transmitter, and consequently of intermittent instantaneous currents of magnetism and demagnetization causing so many sudden movements of the armature at the receiver, and therefore so many blows of the hammer on the fixed part. There must be an exact interval of equal duration between two successive sound shocks, and finally the intensities of all these forces, the transformations of which reproduce the sound, must be in direct proportion to one another.

This is the conclusion to which M. De Locht-Labye's hammer telephone directly leads him.

We think that the description of this apparatus, and the explanations that we have given, may excite some interest, and M. De Locht-Labye has given us permission to state that he will be glad to receive, either through the medium of our journal or directly, any objections or requests for explanation that may suggest themselves, and that it will be both a duty and pleasure to him to answer them. We shall describe in a future number M. De Locht-Labye's "Pantelephone."

Electrical Review, Sept. 20, 1883.

Terrestrial Telephoning.

It is said that M. Hitter, an eminent German philosopher and electrician, in the month of May, 1805, communicated to the Royal Academy of Sciences of Munich the fact of successfully magnetizing pieces of gold by Voltaic electricity. That gold needles or compasses when thus magnetized "obeyed terrestrial magnetic influences for several months, displaying directive qualities," etc. And William Sturgeon, a learned scientist and author of that period, was led to make the following remarkable statement, the truth of which has recently been demonstrated at Washington. Professor Sturgeon says: "This simple process of exciting electric currents, when transferred to the vast apparatus of nature, opens to view the most magnificent theory of terrestrial magnetism that the mind of man can possibly conceive. The sun would thus become the exciting agent, whose uniform tide heat, sweeping the tropical zone, would be productive of an immense westerly circumflowing electrical flood, and convert this terrestrial globe into a grand thermo-electric magnet.

"Thus the earth may be considered as an equivalent to an immense Faraday coil, of which the poles are on one side sufficiently isolated by the waters of the ocean. The action of this pile has produced great chemical changes in the materials of the earth—changes which have differed according to the poles, and of which pile the poles at the other extremity have always such an abundance of electricity as to cause its splendor to appear in magnetic radiations in the vast spaces in the heavens, and usually termed Aurora Borealis."

The foregoing magnetic principle of our earth has remained unchanged for centuries prior to the appearance of human life upon the planet. Then, when comparing the progress of electrical science of the present with the past, the gain has been slow indeed. Professor Morse often spoke of the earth's magnetism, and in his experiments in 1844, suggested a galvanometer attached to plates of metal in the earth, by sending a powerful current of electricity across a stream of water. So, too, will the telephone of to-day receive and transmit signals or sounds of various kinds by powerful batteries connected to the earth without the use of wires, on this terrestrial telephonic principle of the magnetism of the earth and atmosphere.

The principle of the magnet is little understood; and now, when the telephone has only been in operation a few years, and hundreds of thousands of magnets formed and used in all manner of shapes and sizes, is it any wonder that we should be so anxious to learn all about the law of magnetism that permits each magnet installed, whether in the telephone or other electrical device?

February 7, 1884.] ELECTRICAL REVIEW. 7

The American Bell Telephone Company.

Our esteemed contemporary, the *Postal Telegraph and Telephone Gazette* (London), makes the following interesting commentaries on the Bell Telephone Co., showing the English view of our telephone affairs in this country:

"The question of the telephonic centre in the United States after vibrating between Boston and New York, finally settled upon the former place, which might now be aptly termed the vobs and zur of the Union. The telephone interest radiates from Boston to the uttermost parts of the earth. The American Bell Telephone Company, the parent company of the United States, have here their business offices, as have also the principal companies which are operating in the countries to the south of us, Mexico, Central America, South America. When we consider the short space of time since the first telephones were commercially introduced, the progress is telephony has been simply marvelous. Now the number of telephones in actual use in the United States is over 300,000, and a steady stream of them rear from the manufactory to the awaiting subscribers, adding many thousands each month. A few years ago the original company found a difficulty in raising a few hundred dollars for business purposes; now bonds are sold at a premium by the hundred thousand. The various telephone companies operating in the southern foreign countries, obtain all their instruments and apparatus from the American Bell Telephone Company, with which they have contracts to this effect, so that in addition to the large consumption there is a large and constantly increasing export demand. The management to secure, hold, and enlarge its enormous interests has been of a bold, aggressive character, and at the same time is conservative enough—very liberal in its outlay and policy, and yet not wasteful or extravagant. It has been fortified, and the future has not been sacrificed to the present. All the telephones and transmitters are manufactured in this city, by the Western Electric Co., as are also many of the telephonic accessories, such as magneto-bells, switch-boards, &c., although the greater part of the latter are made in the company's manufactories in other cities, only one branch being located here. It is not to be supposed that such an extensive enterprise has been allowed to continue in existence without being questioned or pursued by rivals. No great invention ever flowered in fruit that had not to meet enthusiasts and enemies, but so far the Bell Company has been able to evade or throw off all the shackles which have threatened to blind it. The policy of a *sub rosa* nature has been adopted concerning its affairs—it is quiet while its stock makes large vibrations downward, when a weed, officially, so to its business standing, would restore the equilibrium. It never notices the various questions, allegations, or rumors officiated from time to time, except in the courts, where the answers have been to the public, but has devoted itself wholly to business, to the enlargement of its plant and the earning of dividends for its stockholders. The usual 3 per cent. quarterly dividend has been declared by the American Bell Company, although it is generally understood that their earnings would warrant a higher rate."

The Telephone Problem in England.

The condition of the telephone in that country must be considered an anomalous one, and the *Postal Gazette* says that it is one which will demand the serious attention of the Postmaster-General at no distant period. There is no denying it, that the progress of the telephone is retarded in some measure by the relative position of the postal authorities and the telephone companies. The latter are anxious to develop their systems as rapidly as possible, in order to make the most of the time during which their patents are secured to them. The rules on their part is natural enough, but as it tends to create a formidable feeling in the postal telegraph system, there is naturally a desire on the part of the postal telegraph authorities not to let the telephone grow out of leading strings. The principal patents will run out in about seven years, and we suppose it is thought that if matters can be kept on the present footing for that period, it will be easier and much less expensive for the post-office to take over the telephone. We take it for granted that the latter step will have to be taken, sooner or later, unless the post-office authorities are prepared to see the revenue obtained from the telegraph dwindle down very rapidly. It is no use mincing matters. The telephone will become a very serious competitor to the telegraph, so soon as the ordinary telephonic exchanges in the country are placed in direct telephonic communication by means of trunk wires. It must come to that eventually, and we do not think that the English public will submit to being kept without telephone facilities, which are being provided throughout the neighboring continental countries. We do not pretend to know whether the monopoly held by the Postmaster-General absolutely prevent the connection of the different telephone systems. It appears, however, to be the opinion of the telephone companies that a non-liberal policy might with advantage, both to them and to the public, be pursued in the matter. There are other facilities, such as the connection by telephone of certain trial telephone exchanges with the chief telegraph stations in the same cities, which are already in operation to the ease of the Government employés, but which have not yet been introduced into the telephone exchanges of the companies—as the latter say, because the conditions on which the Post-master General is inclined to grant the connection are too onerous. The question of the establishment of cheap telephone messages, as proposed by Mr. Batten, of the Edison Telephone Company, will also have to be dealt with, and we may expect an unfavorable decision of the matter in this year's session of Parliament. The long, and, we opine, will resolve itself into the following two questions: Is the telephone eventually to be taken over by the post-office and to be worked in connection with the postal telegraph? or are the private companies to continue the *exploitation* of the telephone? If the former is to be the solution of the problem, it will be useless to still further spread the net the only proper policy will be to leave the matter and buy the companies out. If the companies are to continue to provide the telephonic communication, reasonable facilities ought to be given so as to allow the telephone to develop itself as rapidly as in other countries. Of our nearer neighbors, it is notably Belgium which has lately adopted a very progressive policy in this direction. We feel comforted, from the well-known liberal views current out by the Postmaster-General in all his departments, that he will give due weight to public exigencies, and that the public will demand a free and speedy development of the telephone through out the United Kingdom as a most useful instrument for trade, and a great convenience for the entire community.

The Telephone Situation.

Our esteemed contemporary, *Bradstreet's*, comments as follows on matters telephonic:

"The telephone interference case between the Bell Interest, on the one side, and the McDonough Interest, on the other, upon which a decision was rendered by the chief examiner of the Patent Office last summer, promises to reach a final decision soon. It will be remembered that the examiner's decision awarded to Bell priority in the art of telephony, and to McDonough the priority in the construction of the magneto receiver—the one in universal use to-day. On the face of it, the effect of this decision is to give McDonough the right to introduce the use of the magneto receiver by the Bell Company, while McDonough himself is debarred from embarking in the telephone business by the decision awarded to Bell. The net of telephony, to which Bell is adjudged to be entitled, is that of transmitting speech electrically by means of undulating currents. As it is claimed by the Bell Company that the transmission of speech is impossible except by the use of undulatory currents, it would seem that the two contestants are left by this decision in a position in which each can prevent the other from using a complete telephone system which neither can himself employ. It is claimed, however, on the McDonough side, that the examiner's decision, in fixing the date of the McDonough receiver, was also the date of his transmitter, and that, hence the award of priority to Bell for the latter telephony cannot be upheld.

"McDonough, in fact, claims to have constructed both a transmitter and receiver, and to have sent and received articulate speech by means of them prior to Bell. Whether Bell was the first to use an undulatory current for the transmission of speech is evidently of no consequence if instruments were made prior to his which would transmit speech. In view of this state of the case, the decision of the examiner has a greater significance than the McDonough interest thus at first appears; and, if it be sustained by the higher tribunals to which it can be appealed, the control of the telephone will pass from the hands of the American Bell Co. There are three appeals within the finals of the Patent Office—the first from the examiner to the Board of Examiners, the second from this latter to the Commissioner of Patents, and the third and last to the Secretary of the Interior. That the latter is final, so far as the Patent Office is concerned; but that will remain the adjudication of the courts, before which the case can come up as a matter of infringement. The Bell Company has all the merits of delay on appeals, the hearing on which was set for the 11th of January, and the chances of success by the examiner-in-chief of the case now having been before the office for about three years—and the probability of substantial exhaustive, it does not seem probable that a decision will be long delayed. For the same reason, delay will be in favor of appeals, if they are taken, will probably not be decided before 1885, so that the final decision may be reasonably expected in the following year.

"How a final decision in these fundamental patents against the Bell Co., will affect the users of the telephone it is difficult to say. The present telephone system is owned by a number of local companies operating local telephone systems or exchanges, as they are called, which are leased by the Bell Telephone Company, to which they pay royalties for the use of all the telephone patents controlled by it. The Bell Company, or companies is a very large one; their plant is in place, and it almost all ares a paying business is being done. No new company would, therefore, find it a desirable or a profitable thing to attempt to enter into it. It would, therefore, in all probability, take years for the new organization now occupied by the Bell Company, in fact, this is now the programme of the McDonough Company. With such a disposition of the telephone forces, the benefit accruing to the user from a change of ownership would be but slight. The McDonough Company claims to be able to offer to the local companies greater facilities for the transaction of their business in the form of improved and automatic switchboard devices, in place of the apparatus now in use in the exchanges, and to be content with lower royalties than those exacted by the Bell Company.

"From the point of view of the stockholders of the Bell Company, even much more sweeping decisions than are at all likely to be obtained would not be cause for any disquietude. Nothing is more difficult in the commercial world than to wholly dislodge a large financial interest once thoroughly in the possession of the field. Its acquired strength always gives it the ability to compromise with any or all opponents, and, if it cannot remain in control, to at least retain the major part of the advantages of its position. That the Bell Company is no exception. The most that it can lose by the loss of its patents are the royalties now paid it by the local companies. It does not seem to be generally known, or, at least, to be sufficiently taken into account, in estimating the effect of this patent litigation, that the Bell Company is a large holder of the various local stocks—a controlling interest in the majority of them. Whatever the transactions, then, of patent litigation, the Bell Company is still possessed of a very substantial property, of which nothing but the dissolution of the present local companies can despoil it. As indicated above, the probability of this occurring is too small to be taken into consideration.

"McDonough is, however, not the only contestant in the field. There is another, who claims to antedate both McDonough and Bell, and whose claim, if substantiated, may seem at first sight to wholly alter the telephonic situation as above presented. This is Daniel Drawbaugh. He claims to have made a crude, but still a working telephone, as far back as 1867, and it is claimed further that he has since been engaged in perfecting the invention as diligently as his means would allow. It is claimed by his opponents, however, that, admitting his invention of telephone at the time claimed, he abandoned it, as I hence is not entitled to patent protection. The plea of abandonment is set up in the Supreme Court of the District of Columbia, in which the case is pending in the United States Court for the Southern District of New York, and is expected to be decided soon. If Drawbaugh is finally adjudged the inventor of the telephone, the McDonough as well as the Bell patents become worthless, and if it be held that there was abandonment on the part of Drawbaugh, the cannot secure a patent, and the original telephone therefore becomes open and public property.

"It must not be supposed, however, that in this will throw the telephone field open to all and sundry. The telephone field open to all and sundry. The telephone field is but a comparatively simple one. Without the central exchange and at which different subscribers can communicate with each other on a party line basis, the usefulness of the telephone is practically nothing. The value of the telephone entirely. Both the Bell and McDonough and the Bell interests claim to have patents, without infringement upon which a complete telephone exchange can be operated. After the settlement of the question of priority in the invention of the telephone, the contest will very probably be carried into the question of mutual infringement of their devices, unless the contestants in the meantime make a mutually satisfactory adjustment of their claims.

"Whichever comes the most probable upshot of the matter. This will leave the actual distribution of the telephonic forces practically well unchanged, and the question of improved telephonic service at reduced rates will be determined by the business interests of the companies engaged in the business.

"That such an arrangement will result in giving the public a cheaper and more efficient telephone service than the present hardly seems probable. But at the same time, it is by no means certain that this would result from the competition of many companies. In a commercial enterprise of this sort, a comparatively small plant conducted of necessity to particular districts, the duplication of companies, gives no guarantee of cheaper or better service.

"The dividends have to come out of the consumer, and the capital upon which dividends have to be earned is always certain to be larger if distributed among several than if confined to one company."

The Brush Electric Light & Power Company, of Philadelphia, has increased its capital to $1,500,000. Also that Supt. S. A. Duncan, of the Brush Co., of Pittsburgh, Pa., operated during 1883 38 standard Brush lamps (2,000 candle power each) 19 hours daily, using a 1-horse power engine, having the new armature. The circuit was of No. 8 wire.

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On each board there are twenty trunk lines secured when the sun drops and one hundred subscribers' drops. When the boards full The excessive rushes of business which with the operators' keep sometimes occurs in the larger part of the numbers, and the s by one operator only fifty subscribers and ten trunk lines to attend to. One important advan arrangement is that it s The system is at present equipped for six hundred subscribers' lines, and one hundred trunk lines. There are two boards, one with twenty trunk lines between the operators and two hundred subscribers' lines, board and three upon t two six boards, but when the system is com pleted there will be ten. At each end of the system there is a special board containing an upright row of spring jacks, to enable the operator at each end to make connections without reaching across the boards. Care has been taken to make the keyboard circuits reliable and at the same time some special features are in use which avoid a motion for the operator. The two most important requisites in switchboards for large telephone exchanges are speed and economy. It so happens that these two requisites go together; for whatever tends to reduce the amount of work to be done, also enables the operator to do it quickly, and therefore diminishes the cost of the work. The rapidity of speed and economy are met with in a high degree in the multiple switchboard. This system is elaborated from the fundamental idea of having each operator reach all the subscribers' lines in an exchange with one motion for each line, and to enable each operator do all the work involved in effecting the connection of calls wanted by her subscribers. There is no repeating of orders, either by word of mouth or by tickets. The operator to whom a call is made by a certain number of subscribers whose calls she answers. When one of these subscribers is exhausted for connection with any other subscriber, on the exchange, the operator who takes the order makes the connection of the two lines in question, and rings the bell of the subscriber wanted. When the conversation is finished, the same operator who connected them together receives the notice by the subscribers.

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RECENT PROGRESS IN TELEPHONY[1]

THE Telephone was first introduced to the British public at the meetings of the British Association. In 1876, at Glasgow, Sir William Thomson startled his hearers by announcing that he had heard, in Philadelphia, Shakespeare quoted though an electric wire, by the aid of the invention of Mr. Graham Bell, which he then pronounced to be "the greatest by far of all the marvels of the electric telegraph." In 1877, at Plymouth, I had the pleasure of showing in actual operation the finally developed instrument now known as the Bell Telephone, which I had just brought over from America; and conversation was easily maintained between Plymouth and Exeter. Five years have elapsed since then, and it is fitting that the British Association should hear of the progress of this astonishing apparatus.

In 1877, it was a scientific toy; it has now grown to be a practical instrument. A £50,000 capital is already embarked in its extension in England, and it is earning a revenue of £60,000. Hitherto it has been practically a monopoly in the hands of a private company, to which the controlling power, and of the Post Office, who, however, have the controlling power, have never exercised. It is often said that competition in any business will have the effect of reducing the charges to the public, but the experience of the past is always and telegraphs recently teaches this lesson. Unless competition tends to lower the rates for a time, but it eventually leads to amalgamation—to the absorption of the weak by the stronger, swollen and watered capital, and, finally to more than twice higher rates to a non-existing public. Competition, however, induces better service, and ultimately, in this respect alone the public gains.

The free traffic in patents, however, leads to jobbery and speculation of the worst type. We have recently seen a number of patents transferred for almost fresh the South Sea Bubble period. The public have wildly rushed into ill-matured schemes for the latest novelties the prizes of gambling promoters, have turned the heads of inventors, have retarded the true progress of the beneficial application of this rare science to the wants of man, and have throughout millions upon imperfect schemes. Much has been said against the monopoly of the Post Office in telegraphy; however, but it may safely be the merit that it has checked the rapacity of company promoters and speculators in this branch of the practical application of electricity, while no one can assert that it has checked the progress of telegraphy. During the last week that the telegraphs in this country were transferred to the State, the total number of telegrams transmitted was 26,000, while in the week ending August 12th it amounted to 724,000. There is no investor who can assert that his chance has not received proper consideration, nor since a real improvements of the Post Office itself are freely adopted by other countries, and American itself—the home of the inventor—has found the advanced system of England worthy of acceptance.

Microphone.—The original telephone receiver of Bell has scarcely been improved upon; it remains in form and construction very nearly the same as that which I exhibited in 1877. The perfection of its working depends upon the truth and perfection of its manufacture. It is now more solid and substantial than it was at first, more powerful magnets are used; but still it is the same simple, unpolished, beautiful instrument that I brought over from America. Mr. Gower has increased its loudness by varying the form of its pole pieces, and using very powerful brass-bound magnets of excellent quality; but experience shows that loudness is always obtained at the expense of clearness of articulation; and, although for many purposes the Gower-Bell may be found valuable, it adapted by the Post Office and is now in contract together all the sections of the British Association stationed through the town of Southampton, at the present time, waiting for distinct articulation appears to be the original Bell.

The Paris Exhibition of last year, so fruitful in electrical novelties, did not bring forth any material improvement in telephonic apparatus. It was noticeable chiefly for its practical application of the telephone, and particularly to the transmission of singing and music to a distance. M. Ader's modification of Bell's receiver is that almost universally used in Paris. It is a very handy, pretty, and convenient form. He utilises a principle which he calls "unreaction." A thick ring of soft iron is inserted between the ear-piece and the diaphragm, and this is said to increase the attractive power of the little horse-shoe magnet upon the vibrating iron diaphragm. A simple experiment confutes all M. Ader's shows that there's some foundation for the fact; when a thin steel spring is adjusted close to the poles of a magnet without being attracted by them, the near approach of a mass of iron to the spring will cause it to be attracted by the magnet.

D'Arsonval has also modified the Bell receiver. He has placed the coil in a powerful magnetic field of annular form, and has thereby concentrated the lines of force upon the induced coil. He brings the whole coil within the influence of the field. The effects are said to be magnified, and the increased loudness is not accompanied by the usual loss of articulation. Speech is reproduced without any change of *timbre*.

Telephone receivers of the Bell type are all based upon the magnetic effects of currents of electricity flowing around magnets or bars of soft iron.

The rapid and rhythmic magnetisation and demagnetisation of a bar of iron or the increment and decrement of the magnetism of a magnet, will produce molecular disturbances, in its own mass, and in any matter which is near it, that lead to the oscillatory motions of sound, and which produce sonorous vibrations that can be made audible to any number of persons, and particularly by that pano-ted by Graham Bell.

Other principles of electricity have also been utilised for telephonic receivers.

For instance, Mr. Edison used the electro-chemical effect. The decomposition of a chemical substance, as paper or on cloth by the passage of currents, through it, produces a modification of the friction of two moving surfaces, which is reproduced sonorous vibrations, and the result is a very loud-speaking apparatus. I myself had the pleasure, in 1880, of submitting to the Royal Society a receiver based on the electro-chemical effects of the current. The passage of a current through water always heats them and therefore produces expansion. If the wire be made fine enough, so that it is heated and cooled almost so rapidly, the expansion and contraction are so quick, that sonorous vibrations are the result. Although I was able to speak through it very clearly, I have not as yet developed this instrument into a practical form. Professor Hughes has recently utilised the electro-static effects of currents. His receiver is even more delicate than that of Bell. Two flat circular discs of metal are rigidly fixed very close to each other in an insulated case of ebonite. When one disc is electrified positively by a charge of electricity, the other is electrified negatively by induction. These opposite electrical charges attract one another with a force with the strength of the signals sent, and the result is that, when telephonic currents are transmitted, certain sonorous vibrations, and, consequently, the reproduction of speech.

Many other forms of telephone receivers have been devised and exhibited, in fact I have recently seen quite a crop of them; but as they involve no new principle, and introduce no particular improvement, having now brought out chiefly to try to avoid existing patents, I pass them over, and proceed to the next branch of my subject.

Our pre-ent Patent Law is, unfortunately, in so disorganised and chaotic a condition, that almost anything is possible, and hence the questionable morality of doing a thing in another way, in order to avoid the incidence of a royalty, is practically encouraged. The possession of a patent is now no guarantee of validity, and it is granted without any investigation, and cannot be upheld without tedious litigation and vexatious expenditure before a technical and scientific tribunal. We therefore cannot hope for any virtue in English inventors or security for their improvements until our law is thoroughly revised. The question before the House of Commons, and, when weekly sages have fully examined the evidence of our legislators, we may hope for some attention to so real and pressing a want.

Transmitters.—The great novelty and peculiarity of Bell's telephone was that the receiver and transmitter were similar and reversible. Some other forms of receiver are of imagining on an iron disc caused it to vibrate in front of a magnet around one pole of which a portion of the electric circuit was wound. These vibrations of a magnetic substance in a magnetic field produced currents of electricity in the coil of wire on the magnet, varying in strength and direction with the sonorous vibrations, which, proceeding along a wire to a distant station, there varied the magnetic strength of a similar magnet so as to vary it from time to time, and at times attractive force on a similar disc, by which it reproduced the experienced it, the sound of the first disc, and thus, reproducing the sonorous vibrations of the air, repeated speech. The currents, however, the polarisation were very feeble; such energy was lost *en route*, and the effect scarcely ever such a practical standard.

Mr. Edison showed last year in Paris and to other receiver, the carbon current. Taking advantage of a peculiar property of carbon which was discovered by him in electrical resistance with the amount of pressure brought to bear upon it, he constructed the vibrating disc which was spoken against to press sideways upon a button of carbon, and thus varied the strength of a current accordingly. of electricity passing through it. This varying current, passing through the primary wire of an induction coil, set up in the secondary circuit coil many powerful currents than the bell instrument in telegraph produced, and caused louder and more articulate speech at the receiving station. Professor Hughes went a step further, and found a combination of materials that were directly related to the sonorous vibrations, which he called a "microphone," and by the idea to proved that the effect of the carbon transmitter of Edison was due to any influence of varying pressure on the mass of the button of carbon, but was a phenomenon of force contact. He found it to extend over last in nature, and he startled the scientific world by introducing the use ducing an instrument which did for minute sounds what the microscope had already done for minute objects. By the light experiment thrown on the theory of the instrument by Hughes, Edison's ing, namely carbon transmitter has been so improved by Blake, Hunnings, *tal of some* Mowday, Ader, and others, that little apparently remains to be done. The telephone as a speaking instrument is now well a, six miles high perfect. It is quite possible to speak to a friend's voice at nine apart. two miles distance. The difficulty of making the telephone a speak by a practical instrument under all circumstances is not due to any and Science defects in the instrument itself, but to disturbing influences distinct was external to it, and consequent on its surroundings. The very by so to perfection and conditions of the apparatus itself are its chief di. essence.

, and, as In the action of the microphone, or carbon-transmitter, is unattain, very little understood: it introduces into a closed electric circuit. In this circuit, though with a current is flowing, a resistance which is business, varying exactly with the sonorous vibrations impinging upon it. so, but in such a manner as to correspond in a way exactly analogous to the delicate varying sound waves. This effect is generally ascribed to be the loose that is a greater or less tendency of electrical contact to become imperfect, under conditions of varying vibration upon each other; but the instruc- there is now little doubt that it is due to a true variation of resistance, tion Phenomena because it has the remarkable property of having its resistance lowered when it is battered upon by sonorous vibrations. This observation was made by Mr. Stroh and Professor Hughes.

The resistance of microphone is very variable: some give 100, while others give 25, and some even 125. The best transmitters that I have worked with (Mowday's) give an average of 37.

Attempts have been made to apply mathematical analysis to the determinations of the best form and arrangement of microphones, but at present the microphone defies mathematics.

Every would lead to the conclusion that a good transmitter should have the lowest possible resistance, but practice does not confirm that idea.

There again asserts that the resistance of the secondary coil of the induction coil should be equal to that of the line it works, but practice proves the very never-so. On a line giving nearly 1,000 resistance, the best effects were produced with a secondary wire of only 30° resistance. The fact is, that the conditions which result in the microphonic action, and the induction in the induction coil, are very complicated, and are not yet sufficiently understood to explain the phenomena they affect within the region of mathematical analysis.

Accessories.—I cannot intend to speak here of the bells, calls, switches, etc., used in carrying out telephonic operations: there has been nothing that is particularly novel introduced, or that was not previously used in telegraphy. In fact, the whole operations carried on in connection with the so-called "exchange" working are simply telegraphic, and are still in a somewhat tentative condition.

Long-distance Speaking.—I have said that the difficulty in speaking is chiefly due to the environment of the wires employed. Were we to erect a wire from Land's End to John o' Groats,

of lightning protectors. The use of double wires diminishes the danger to a minimum. On the Continent and in America, however, telephones are invariably protected by lightning arresters

[1] Paper read at the Southampton meeting of the British Association, Section by the author.

An interesting experiment, which seems to have a bearing on the action of Edison's ferrotic telephone, has been recently described by Herr Koch. When a plate of platinum or palladium is polarised by means of an electric current, the friction of these metals against a plate of moistened glass increases immediately. To measure the friction, Herr Koch uses the mantel in the form of a horizontal button, resting on the bottom of a glass cup, filled with pure or acidulated water. The button serves as pivot to the magnetic needle, which oscillates under the action of the earth; the decrease of the oscillations measures the friction of the pivot. Polarization is produced by the currents of the Daniell element, one pole of which communicates with the glass or button, while the other terminates with a platinum wire entering the water of the cup. The polarization by hydrogen gas produces no effect, but polarization with the pole evaporation is found very effectives. The friction was increased, through this polarization, in the ratio of 3, and sometimes in that of 2 to 4. This increase of friction appears immediately the circuit is closed, and disappears slowly, like the polarization itself, when the circuit is merely opened. It increases with the electromotive force of the polarization by oxygen. Palladium behaves like platinum. Gold (18 carat) gave no effect.

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ON CURRENTS PRODUCED BY FRICTION BETWEEN CONDUCTING SUBSTANCES AND ON A NEW FORM OF TELEPHONE RECEIVER.*

In a communication to the Royal Society of Edinburgh of date January 6, 1879, I showed that "electric currents were produced by the mere friction between conducting substances." The existence of these currents can be easily demonstrated either by a telephone or a Thomson galvanometer. I have since found that these currents exist in all pairs of metals which I have yet tried, in the same direction as the thermo-electric current got by heating the junction of the same two metals. They are also approximately at least, subjugate in proportion to the metals rubbed are far apart on the thermo-electric scale—the strongest currents, as far as I have yet observed, being got by rubbing antimony and bismuth together. These observations clearly point to a thermo-electric origin for the currents; but it is possible that they may be due partly to the currents suggested by Sir William Thomson as the cause of friction, and partly, also, to contact forces between films of air or oxide adhering to the surfaces of the metals.

Having ascertained that these friction-currents are of some strength and fairly constant, I proceeded to make several kinds of mechanics for producing currents on this principle. One of them consists of a cylinder of antimony, which can be rotated rapidly, while a plate of bismuth is pressed hard against it by a stiff spring. When this machine is included in the same circuit with a microphone and a Bell telephone, the current got from it is quite sufficient to serve for the transmission of musical sounds and also loud speaking. The transmitter, which I have found most serviceable in my experiments, is made by screwing two small cubes of gas-carbon to a violin, and placing between them a long stick of carbon pointed at both ends, the points being made to rest in conical holes in the carbon cubes. The looseness of the contact is regulated by a finger-screw. This forms an excellent and handy transmitter for all kinds of musical sounds, and also serves very well for transmitting speech.

Seeing that friction between metals clearly produces a current, it seemed natural to inquire if the converse held good—that is, if a current from a battery sent through portions of two metals affected the friction of the one upon the other. I have found that this is in a variety of ways, and the results obtained have no doubt whether to attribute them to variations in the friction, or to sound striking produced by fusion of the portions of contact through which the current passes. The most noticeable effect is produced when one of the rubbing bodies is a mere point, and the other a smooth surface of metal. This form was made a telephone-form of the loud speaking telephone of Mr. Edison, in order to get audible indications of changes of friction produced by the passing of a variable current. It consists of a cylinder of bismuth accurately turned and revolving on centres. The rubber-point is made of a sewing-needle with its point bent at right angles, and its other end attached to the centre of the mica disk of a phonograph-mouthpiece. It is evident that this is only a loose contact, which can be perpetually changed. When this apparatus is included in the circuit with the violin-microphone and three or four Daniell cells, the violin sounds, as was to be expected, are heard proceeding from the loose contact, even when the cylinder is not rotated. They are increased, however, in a remarkable degree by rotating the cylinder slowly, so much so that a tune played on the violin can, with proper care, be distinctly heard all over an ordinary room.

With regard to the explanation of the effect, it is evident that electrolysis can in no sense come into play, as is supposed to be the case in Edison's instruments. I am inclined to look for the explanation rather in the direction of the effects of sound-waves, although the circumstances are considerably different in the two cases. In the rocker we have the best possible union from a mass of hot metal through two points of support to a cold block, whereas, in the other case, the heat is only local to the points of contact, the rest of the metals being comparatively unaffected. The variations in the current produced by the transmitting microphone must

*Abstract of a paper read before the Royal Society of Edinburgh by James Blyth, M. A., F.R.S.E., on May 5, 1880.

ate actions in the mandibles, just as contact of the lips with an external body sets up sucking in the infant. All these movements depend upon what we call instinct—that is to say, organic habits registered in the nervous system of the race. They have arisen by natural selection alone, because those insects which duly performed them survived, and those which did not duly perform them died out. After a considerable span of life spent in feeding and walking about in search of more food, the caterpillar one day found itself compelled by an inner monitor to alter its habits. Why, it knew not; but, just as a tired child sinks into a sleep, the gorged and full-fed caterpillar "moults" into a dormant state."

Of course all this may have been written in jobe. The writer may possibly be laughing at evolutionists. The "inward monitor" of the "gorged and full-fed caterpillar" undoubtedly looks rather suspicious, but one hardly likes to hint at anything so serious. Evolutionists will, I dare say, repudiate such "evolution" as a mere travesty, but it is quite time that half-a-dozen evolutionists who agree on main points should clearly state their belief.

In conclusion, let me ask you as students of nature's processes, whether you have not seen enough to convince you that the revival of the assumption which has been abandoned and reintroduced many times during the last few centuries, that the lifeless is the sole origin of the living—that in fact the non-living and the living are one—is now unjustifiable, and cannot be reasonably entertained. This monstrous fallacy, though taught with the greatest confidence, is based on assumption, and is supported by arbitrarily selected facts, and by not a few misrepresentations and dogmatic assertions. Whenever any form of this false doctrine has been successfully forced into popularity, it has led to the adoption and propagation of the most grievous errors and grotesque conceits.

I am, Sir, yours faithfully,
A. H. SWINTON.

Guildford, Eng., *June*, 1881.

COMET OBSERVATIONS AT PRINCETON.

The weather has been so unfavorable at Princeton, that we have been unable to make any very satisfactory measures upon the spectrum of the comet. On Saturday evening the comet was visible fairly for an hour or so, before it descended into a bank of cloud. On Sunday evening it was beautifully seen for about half an hour, and then was obscured by a fog which still continues.

The spectrum of the nucleus is very bright. It is apparently continuous, though there may be a little special emphasis at the points where the usual carbon bands ought to appear. The spectrum of the coma and of the tail is precisely like that of most comets, showing three bands which coincide sensibly with those given by the flame of a Bunsen gas-burner, presumably due to a hydrocarbon of some sort.

On Saturday evening the nucleus looked much like a star-fish, having five projecting points formed by jets of light proceeding from the central globe to a distance of from four to ten seconds of arc. These jets were not equal in length or brightness, and were not symmetrically disposed with reference to the axis of the comet's tail. Two of them were somewhat curved, they were all diffuse and blunt at the extremity, rather than pointed.

On Saturday, instead of jets, the nucleus had a nearly circular envelope surrounding it, sharply defined from the coma. Its diameter was perhaps 20", but the fog came on before any measures could be made. This disc of light, surrounding the nucleus, was not uniformly bright;—it was more brilliant on the side next the Sun, and there was a curious dark opening in it of oval form some 20" one side of the axes of the tail. We were preparing to study the spectrum of this envelope critically, when we were cut off by the mist.

Although the Comet is now receding from both Sun and Earth, it is rising so much higher in the Northern Sky each night, that if the weather becomes favorable, it may yet be possible to get something more satisfactory; but just at present the rain is pouring and the prospect is rather dreary. C. A. YOUNG.

Princeton, N. J., *June* 27, 1881.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.]

LOCUSTS AND SUN SPOTS.

To the Editor of "SCIENCE:"

SIR: Perhaps you will permit me to explain one inapposite word occurring in my communication on the above subject.

When I stated that European migrants come north and east, I should rather have said *north and west*, the set of the migrations, as far as known, is on European areas north and west; and in this direction, butterflies, spiders webs and locusts, whose point of departure has been traced to Southern Asia or Northern Africa, travel periodically; the occurrence being made known to us by their vanguard, so to speak, sweeping over the eastern shore of Great Britain. That this track is not voluntarily chosen by instinct, but rather due to a prevailing south-easterly direction of the winds, rests now-a-days on a great amount of experience.

A. H. SWINTON.

Guildford, Eng., *June*, 1881.

THE BLUE COLOR OF THE SKY.

Prof. Correa having established the fact that the atmosphere of the earth exercises an energetic absorption upon the ultra-violet rays of the spectrum, whose limit varies according to the statement of the atmosphere and the altitude of the sun, Prof. Hartley sought to attribute the limitation to the influence of ozone. His experiments have demonstrated.

1.—That the ozone is a normal constituent of the higher atmosphere, where it is more abundant than on the surface.

2.—That this quantity of atmospheric ozone suffices to limit the spectrum in the ultra-violet region, without considering the absorption caused by the great density of the oxygen and nitrogen.

3.—That the blue tint of the atmosphere is due to the presence of ozone.

In respect of this last point, Prof. Hartley remarks that, if the ozone exists in the high regions of the atmosphere, the light reflected by clouds at a great heighth has a blue appearance because it traverses a gas of this color. It is so likewise with the light illuminating the distant portions of a landscape. Experiments have shown that 25 milligrammes of ozone for every square centimeter of a layer of 80 kilogr. thick can produce this phenomenon.

We learn that Prof. H. S. Pritchett, Director of the Glasgow Observatory, has been appointed Professor of Mathematics in Washington University, St. Louis, Missouri.

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Jan 9 1884

NEW YORK, FEBRUARY 9, 1884.

THE VAN RYSSELBERGHE SYSTEM OF TELEPHONY.

For some time past electricians have been on the alert for descriptive details concerning the Van Ryselberghe system of telephony, their curiosity having been excited by the interesting and valuable results attained in experiments with this system, and repeated by the scientific journals at various times during the last two years. All publicity seems to have been avoided by the inventor and his friends, however. It has been known for some months in a vague way that this system accomplishes a desirable feat in eliminating all disturbances of an inductive character, and in admitting of simultaneous telephonic and telegraphic transmission over the same conductors; but the peculiarities of the apparatus used or of its *modus operandi* have remained a mystery. The curiosity which lingers in the minds of telephonists and electricians regarding the nature of a system which promises to do as much as this, becomes all the more legitimate in view of the fact that the system has lately been officially adopted by the Belgian government, which is now making active preparations to apply it to its 30,000 kilometers of telegraph lines, thereby inaugurating the use of long distance telephony which is destined to facilitate and cheapen inter-communication between cities and countries.

The illustrated description of the Van Ryselberghe system, of which we give the first part in the present issue, will therefore be acceptable to our readers especially inasmuch as it is the first descriptive article published about this system in the English language. It has also the great merit of being authoritative, since it comes directly from the pen of M. J. Banneux, chief engineer of telegraphs of the Belgian government, under whose direction all the experiments with this system have been made, imbued with the evident importance of the Van Ryselberghe system, we had taken prompt measures to gratify, at the earliest moment, the curiosity of our readers concerning it, by opening correspondence with both the inventor and M. Banneux. The latter has kindly sent us duplicate manuscript and diagrams of an article intended for the current number of the *Journal Télégraphique de Berne* (Switzerland), and in this way we are enabled to publish the article simultaneously with our contemporary.

The telephonic system of M. F. Van Ryselberghe is possessed of great interest, not only because it attains new results, but because it attains these results by methods and devices essentially new. The conductors, whose valuable properties have heretofore been ignored or neglected by telephonic inventors, especially on this side of the Atlantic, is assigned a rôle as important as it is unexpected, in this system. Its use insures comparative protection from the evils of induction, by furnishing the ounce of prevention rather than the pound of cure. This is indeed the fundamental object of the Van Ryselberghe system—to remove the cause of induction instead of combating its effects; to modify the character of impulses likely to produce induction, rather than to counteract the induction itself, in each of the contiguous wires acted upon. The simultaneousness of telephonic and telegraphic transmission over the same conductor, which is realized, though in itself a wonderful and a desirable result, was only attained incidentally. Its possibility suggested itself to the inventor as a logical corollary of the arrangements adopted to attain the first object—the elimination of the induction. The system is very creditable to M. F. Van Ryselberghe, who, we should state, is a scientist and electrician of note, and is Professor of Applied Electricity at the University of Ghent. He is also a meteorologist of distinction, and occupies the post of Director of the Meteorological Department of the Brussels Observatory. He is already famous as the inventor of the telemeteorograph—a wonderful instrument of precision for automatically recording atmospheric changes at a distance. It was precisely the telemeteorograph, by the way, which led M. Van Ryselberghe to experiment with a view to improving upon the ordinary system of telephonic transmission. His object was to arrive at some way of utilizing, for the purposes of telephonic communication, the special wire which connects the Observatory of Brussels with the meteorological station of Ostend, and which serves for the telemeteorograph. This line, which is nearly one hundred and twenty-five kilometres long, was laid on the poles of the government telegraph lines, which accompanied it throughout its course between the two cities in numbers varying from seven to forty. As these wires were for Morse and Hughes apparatus, it is plain that the telemeteorograph wire was subjected to serious inductive disturbances that must interfere greatly with telephonic transmission.

M. Van Ryselberghe at first sought to increase the loudness of articulation of the telephone, in order that, if possible, the voice transmitted might be heard above the din and crackle of the voices due to induction. On January 10, 1882, he made the first experiment with his improved transmitters and receivers on a line of 44 kilometres connecting Brussels (north) with Antwerp (east.) The results obtained were encouraging, but an incident occurred here a few days later which changed the direction of his experiments entirely.

M. Van Ryselberghe was in the Brussels station (north) trying experiments on the line just mentioned, and he noticed with surprise and joy that the Hughes telegraph wires going towards Ostend was creating more disturbance, by induction on the telephone wire, than a certain other wire which on the previous day was the most troublesome. The two wires seemed to have changed sides. On investigation it was found that the Hughes instruments on the two lines had changed places. The trouble was therefore due to the same instrument. On a comparative examination of the two sets of instruments, the transmitter of the less troublesome set was found defective in such a way that the currents of the battery were not sent into the line with wonted abruptness, because the contact was only gradually established. This observation was the "apple of Newton" which led M. Van Ryselberghe to think in the right direction, and furnished him the key to the solution of the problem. The disturbance was evidently due to the sudden character of the impulses of current passing over the wires. If he could in any manner make them begin and end more gradually in each wire by suitable modification of the telegraph instruments, then the telephone wire would be free from disturbance. Having thus succeeded in tracing the difficulty to its origin, the remedy was soon forthcoming in the condenser and in the graduating electro-magnets.

The history of the invention is, as we see, quite as interesting as the invention itself, and it is not devoid of elegance. Others who have explored this field of invention doubtless have stumbled repeatedly upon this little "point," but evidently without perceiving its relation to the problem. M. Van Ryselberghe stopped to study it, and thus found out its bearing. It is not the first time that a trivial circumstance, entirely accidental and apparently of no importance, has brought the experimenter or the inventor in sight of the very path he sought to reach by a more circuitous route. This goes to show once more that in scientific study every little detail is worthy of study: for it is often in the least promising quarter that the missing link to an important principle or a useful device is to be found.

THE
TELEPHONE HERALD

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The Van Ryselberghe Telephonic System.

BY J. BANNEUX.

The experiments carried on with this system for more than a year past on the telegraphic lines of the Belgian government have caused considerable excitement in Europe. They were first heard of, with a very encouraging result, in May, 1882, when correspondence was carried on between Brussels and Paris, a distance of 320 kilometres (199 miles), simultaneously by means of

FIG. 1.

the telephone and of the Morse apparatus with interrupted currents, on a single iron wire of the aerial telegraphic line extending between the two capitals. Since then the invention has been completed and improved to such an extent that it is actually applied in Holland, on a telegraphic line of 18 kilometres, from Amsterdam to Haarlem, and, after a satisfactory trial on the telegraphic line between Antwerp and Brussels, a distance of 37 kilometres, it is to be immediately put in general use on the Belgian telegraphs, to provide telephonic service between the different cities of that country.

M. Van Ryselberghe has aimed at two objects: first, to make telephonic communication possible by means of a single wire, with ground connections, and forming part of an ordinary telegraphic line, by suppressing the disturbing effects of induction and leakage due to the action of neighboring and parallel wires; second, to utilize the wires of these lines for telegraphic and telephonic transmission at the same time. He obtains the double result by the graduation of the telegraphic currents, and by the separation of the telegraphic and telephonic currents in the stations connected.

Heretofore attempts have been made to overcome induction in the telephonic induced or secondary circuit itself, and the most satisfactory method of doing this has been to use a looped or metallic circuit, the two wires of which are arranged in a helical manner, either in the cables or on the poles. M. Van Ryselberghe, on the contrary, by acting on the inducing or primary telegraphic circuit, strikes the evil at the root—that is to say, induction at its source.

GRADUATION OF TELEGRAPHIC CURRENTS.

It is well known that the most marked, and consequently the most troublesome, induced currents caused by

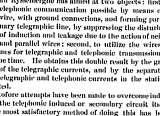


FIG. 2.

telegraphic action are those which correspond to the closing and the opening of the inducing circuit, and their intensity is directly proportional to that of the currents which have given rise to them at those two periods of the formation of a telegraphic signal; therefore to *graduate* the emission and the extinction of the primary current in such a manner that it may increase regularly from zero to its maximum and diminish regularly from its maximum to zero, is to reduce the strength of the induced currents and to *graduate* them, that is to say, in line, to make the vibrations of the telephonic receiver correspond to telegraphic signals of the same duration.

After having tried to obtain the requisite graduation by the use of keys, which automatically varied the resistance of the primary circuit, the inventor obtained infinitely better results by employing electro-magnets and condensers which accomplish the purpose in a purely electrical manner without necessitating any modification in the ordinary telegraph keys.

In Fig. 1 are shown two lines l_1, l_2, running close and parallel to each other. The key is shown at M and the relay at R. At S is shown a straight electro-magnet having a resistance of about 1050 ohms, interposed between the battery P and the key M. The currents sent over the line l_1 by the key M have no effect on telephone T_1, or are very much weakened, and their direct effect on telephone T_2 is considerably weaker than it would be without the use of the electro-magnet E. The result is better still when in addition, a condenser of about 0.5 microfarad is interposed between the line and battery connections of the key (Fig. 2). Finally, the telephones T_1 T_2 both remain absolutely silent, whatever may be the strength of the battery, when the condenser C (Fig. 3) is made to form a derivation to the ground between the two electro-magnets E_1 E_2, which then have a resistance each of 500 ohms. In order that the experiment may succeed, it is necessary that the line L_1 should have a certain length; the resistance of the relay R should not be lower than 300 ohms, and it has been found that a condenser having a capacity of two microfarads answers for the greater number of telegraphic installations. It is clear that the graduating electro-magnet S is not necessary if the telephonic currents pass through the coils of the relay R, *of the vesting station*.

In the case of the Hughes telegraph apparatus a marked retardation of the rise of induction is obtained by merely doing away with the shunt around the armature, without any other provision for graduation. It is preferable to include an electro-magnet of 1,000 ohms in this shunt; but

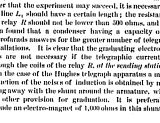


FIG. 3.

the combination which harmonizes best with all the variable conditions of the lines and apparatus is that shown in Fig. 3, namely, in each terminal station a graduating electro-magnet for the battery (E_1), another for the line (E_2), and a condenser (C) branching from the line to the ground.

A very interesting application of the anti-induction system has been made in Belgium, after experiments of M. Van Ryselberghe and M. Buels, chief of station, on a wire of 40 kilometres running the Hughes duplex, between Brussels and Antwerp. The working of this wire produced in the contiguous wires an intense telephonic disturbance, which it was necessary to overcome without interfering with the adjustment of the telegraphic balance of the line. The arrangement shown in Fig. 4 solves the problem completely. The two sides of the Wheatstone bridge are represented by two electro-magnets E_1 E_2, with movable iron cores; the balance is effected in the usual manner by means of the rheostat R; then in transmitting interrupted currents, the length of the cores presenting the coils is varied to such an extent that the equilibrium may remain constant under the influence of the static and dynamic effects produced in the electro-magnets. The graduating condenser becomes unnecessary.

It results from these details: First, that on a given telegraphic line, including a certain number of wires, a telephonic service may be established by means of a single wire with ground connections, when all the other conductors, common and parallel to it, which transmit telegraph currents, are provided with the anti-induction arrangement; and, second, that if all the wires without distinction are thus provided, any one of these whatever is capable of duplex telegraphic-telephonic working, safe from the perturbations caused by induction, and free from due to leakage of currents from one wire to another, as experience shows. In the first case, one of the wires is lost for telegraphic purposes; in the second, the absolute identity of the telegraphic and telephonic circuits would give rise in practice to such inconvenience that the combination would scarcely be acceptable. A simple observation has furnished the inventor with the directions for making the two services as independent as they can be. In Fig. 5 is shown a simple telephonic circuit T L T_1, having a shunt K M to the ground. A condenser of at least 0.5 microfarad capacity is included at C, and a resistance of 500 ohms or

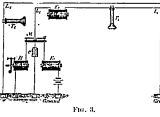


FIG. 4.

more at R; the resistance of the telephones T T_1 may vary from 0.1 to 300 ohms.

Whether the shunt K F M be connected or removed, the person listening at the telephone notices no difference in the intensity of the telephonic currents. We have tried the experiment on aerial lines of 40 to 110 kilometres, composed of iron wires 4 millimetres in diameter, and on that between Brussels and Paris, of 5 millimetres, with a length of 320 kilometres, as well as on the submarine cable between Ostend and Dover (138 kilometres). As to the proportions of resistance to be established between the line, the telephonic receiver, the secondary wire of the microphone transmitter induction coils, the battery, the microphone and the primary wire of the induction coil, experiments have shown that, *contrary to the laws* recognized in telephony, *it is better having only a few* turns of large wire *work perfectly on aerial lines of over* 200 kilometres, and that the results are the same when the factory wires into the inducing resistance at the transmitting station is diminished to the greatest extent possible. It is for this reason that M. Van Ryselberghe employs, as generators of electricity, batteries of very feeble internal resistance, such as accumulators, and that he multiplies the microphonic contacts by coupling them in multiple circuit.

(To be continued.)

Telegraph Wires Underground.

As our readers are aware, many of the telegraph, telephone and electric light companies in this country have devoted much time and money to experiments with underground wires. Among these is the Postal Telegraph Company, whose wires enter Chicago and run to its offices

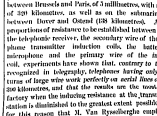


FIG. 5.

there in the heart of the city underground. They are laid in lead pipe in an iron box, and have recently, it is said, without failure since last August. For river crossings the Postal Company uses the Bishop gutta percha cables, with 300 pounds to the mile copper conductors and very heavy insulation, and also the Day kerite. Philadelphia will be erected underground with the Phillips patent lead covered cables.

In Washington the Postal Company is using a different appliance—what is called Hartlove's system. A trench is dug below the frost line; in this is placed a wooden trough, the bottom of which is first covered with asphaltum. On this asphalt bed are laid a set of wires strung

AN HOUR WITH EDISON.

Professor Edison's laboratory, in size and external appearance, resembles a country church. The interior, however, is not so church-like. The first apartment is a reception room, on the right of which is the private office, containing a large library of scientific works. Beyond these there is a large room containing materials and a number of glass cases filled with expensive physical and chemical apparatus. The machine shop at the rear is furnished with the best of machinery and tools, and is kept constantly in operation in carrying out the plans of Mr. Edison. On the second floor there is a single spacious room, which is the laboratory proper. Here, upon the walls, are shelves which are thickly studded with bottles, jars, and boxes, containing all known substances, both common and rare. It is a chronic habit of Mr. Edison to purchase every rarely discovered substance, so that it will be at hand should it be required. The Professor states that no substance can be named that is not included in his collection.

In the middle of the floor there is a stand containing a great number of batteries, from which wires run in all directions. Beyond is a table upon which, among other pieces of apparatus, there is a large induction coil, capable of yielding a spark 12 or 14 inches in length. Here also is the carbon relay, the progenitor of all existing carbon telephones, "motorphones," and other instruments dependent on the changeable conductivity of carbon under a varying pressure.

No one can pass by the phonograph, and the Professor himself does not tire in experimenting with this wonderful machine.

One phonographically cultivated can no longer be satisfied with "Mary had a little lamb" and selections from Mother Goose, now the phonograph can sing, and not only a simple melody, but a duet, and even fora-ch you with an accompaniment and applause at the same time.

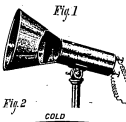
The phonograph which Mr. Edison uses in his laboratory has a double mouth-piece, and the machine will faithfully reproduce a duet sung in it; but the most interesting performance is to hear the Professor sing a duet alone. Singing first the air of "John Brown's Body," he then, and afterward the bass over the same matrix while listening to the air reproduced by the instrument, he produces a matrix which will sing both treble and bass. Not satisfied with this, he whistles Yankee Doodle, and finally, over the same matrix, talks in a loud voice, so that when the whole is reproduced we have a first-class street concert band, which is like this: Two fellows singing John Brown, another whistling Yankee Doodle, and a portwhich citizen crying from an upper window, "Get out! Go away! If you can't sing better than that the police will arrest you! Pollice! police!"

In the extreme rear end of the laboratory, among a load of tuning, jars, accumulate and pneumatic apparatus, there are telephone wires, with which are connected a carbon transmitting telephone and a receiving instrument. Standing some 8 or 10 feet from the transmitter, Mr. Edison said, in an ordinary tone of voice, "Do you take the SCIENTIFIC AMERICAN?" Answer from the other end of the line. "I do." Q. "What do you pay for it?" A. "Three dollars and twenty cents a year." Q. "What is your opinion of it?" A. "It is the best of its kind." Q. (while cramphing a paper) "What am I doing now?" A. "Crumpling a paper." Then followed music from a music-box of the smallest size, and other tests, showing the wonderful perfection and power of the instrument.

The thermo-telephone, explained by the Professor, although at present without special practical value, is certainly a novelty. It consists of a thermopile having placed in its collecting funnel a hard rubber disk, as shown in the first engraving. A sound made in front of this disk is heard in a receiving telephone connected with the thermopile.

The rationale of this is at once apparent when a strip of hard rubber is placed against the lips and heat, as shown in the second engraving, so that the strip will be alternately contracted and expanded. The difference in temperature is very perceptible, the convex surface being cold and the concave surface warm, and, however small the vibrations which render the surfaces alternately convex and concave, the result is the same.

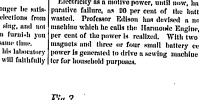
We witnessed an experiment illustrative of the principle of Mr. Edison's electro-motograph, a telegraphic instrument in which the sounder is operated without magnets. In this experiment, which is illustrated in Fig. 8, a strip of chemically prepared paper is laid upon a metallic surface, which is connected with one of the battery wires, and a platinum faced spring, which is attached to the other battery wire, is taken in the hand and pressed firmly on the paper strip; at the same time force is applied to the thumbtap of the lungth of the strip. A telegraph key is placed in the electric circuit, and when the current passes through the paper the salt contained by it is instantly decomposed, so that it acts as a lubricant, permitting the spring to slide easily on the, paper while the current passes, but immediately the current is broken the friction is sufficient to stop the spring.



THERMO-TELEPHONE.

The best solution for saturating the paper is made by dissolving 1 lb. of sulph. soda in 1 gallon of water. Any of the sodium salts will answer.

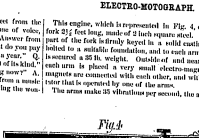
Electricity as a motive power, until now, has been a comparative failure, as 90 per cent of the battery force was wasted. Professor Edison has devised a novel electrical machine which he calls the Harmonic Engine, in which 90 per cent of the power is realized. With two small electromagnets and three or four small battery cells, sufficient power is generated to drive a sewing machine or pump water for household purposes.



ELECTRO-MOTOGRAPH.

This engine, which is represented in Fig. 4, consists of a fork 21/2 feet long, made of 2 inch square steel. The curved part of the fork is firmly keyed in a solid casting which is bolted to a suitable foundation, and to each arm of the fork is secured a 35 lb. weight. Outside of and near the end of each arm is placed a very small electro-magnet. These magnets are connected with each other, and with a commutator that is operated by one of the arms.

The arms make 35 vibrations per second, the amplitude of



EDISON'S HARMONIC ENGINE.

which is 1/4 inch. Small arms extend from the fork arms into a box containing a substance pump having two pistons, one piston being attached to each arm. Each stroke of the pump raises a very small quantity of water, but this is compensated for by the rapidity of the strokes. Mr. Edison proposes to compress air with the harmonic engine, and use it as a motive agent for propelling sewing machines and other light machinery. The power must be taken from the fork arms so as not to affect the synchronism of their vibrations, otherwise the engine will not operate.

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M. GAIFFE'S MODIFICATION OF EDISON'S CARBON TELEPHONE.

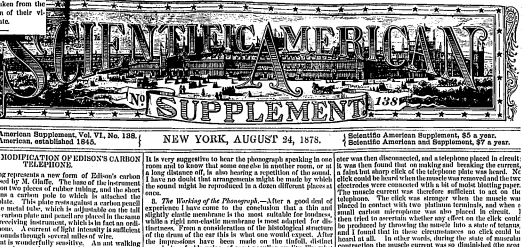
THE engraving represents a new form of *Edison's* carbon telephone, devised by M. Gaiffe. The inner face of the instrument is supported upon two pieces of rubber tubing, and the short pedestal contains the fixed pole to which is attached the square carbon plate. The lever receives against a carbon pencil contained in the metal tube, which is adjustable on the rod standard. The carbon plate and pencil are placed in the same circuit with a receiving instrument, which is preferably an ordinary Bell telephone. A current of light intensity is sufficient to transmit the sounds through several miles of wire.

The instrument is wonderfully sensitive. As not walking across the carbon plate produces a sound in the receiving instrument like the running of cabbits on a sanded floor. Scratching the surface of the carbon with a piece of paper makes a sound like the grating of iron, and rubbing the back of a feather on the carbon makes in the receiver a sound like hummers.

Blowing on the plate produces a sound like the rushing of waters.

Conversation in any part of a room in which the telephone is placed can be plainly heard in the receiving instrument.

It amplifies sounds in a marvelous manner, and is said to be the one that the microscope is to the eye. We take the engraving from *Illustration*.



LABORATORY NOTES.

By JOHN G. MCKENDRICK.

1. *Carl Zeiss' New Oil Immersion Lens.*—This is a 1/24th-objective, on the immersion system, in which the fluid used is oil of cedar-wood. For amount of light, clearness of definition, resolving power, and flatness of field, it is superior to any lens I have worked with. For use in biological investigation, it does not require any special arrangement of light. In examining such objects as blood-corpuscles or salivary cells with very high powers it is of great advantage to be able to use cover-glasses of ordinary thickness, and to have a still viscously-working distance. This is secured by Zeiss' lens. I have found that, with ordinary No. 6 and 7 Hartnack objectives, more light is obtained by using them as immersion lenses with a drop of equal parts of oil of cedar-wood and olive oil. The method of using fluids of high refractive index, on the immersion principle, seems to me likely to lead to valuable results. With oblique light, cutting off light from the mirror, the performance of *Zeiss'* lens is remarkably good.

2. *The Phonograph as a Transmitter.*—By placing Hughes' microphone on the disk of the phonograph the latter will transmit the sounds recorded on the tinfoil to a telephone at a distance. Thus we have a combination of microphone, phonograph and telephone, which promises to be of use. It is very suggestive to hear the phonograph speaking in one room and to know that some one else in another room, or at a long distance off, is also hearing a repetition of the sound. I have no doubt that arrangements might be made by which the sound might be reproduced in a dozen different places at once.

3. *The Working of the Phonograph.*—After a good deal of experience I have come to the conclusion that a thin and slightly elastic membrane is the most suitable for hearing, while a rigid non-elastic membrane is most adapted for dictiontones. From a consideration of the histological structure of the drum of the ear this is what one would expect. After the impressions have been made on the tinfoil, distinct speech, in a feeble voice, of most peculiar quality, like that one would imagine to be the toast of the fairies of old, can be heard from one of Marey's tambours, by bringing the point of the lever on the surface of the phonographic cylinder. With this method there is almost no friction, and consequently the sounds on the tinfoil are not quickly rubbed out. By connecting a tube with the tambour and carrying it from the mouth to the ear, sounds may be heard, even as speech, after the marks have been so erased from the tinfoil as to be scarcely perceptible to the eye. Thus the tambour, when so used, may be said to be a microphone.

4. *The Microphone.*—I have tried many experiments with the ingenious arrangement of Mr. Hughes, and have been much impressed with its extreme sensitiveness. It may be used in the same manner as the telephone for delivery of the inductive machine. When fixed to the box of a monochord the slightest touch of the wire with a lucifer-match will resonate loudly in the distant receiving telephone. Such a combination would, I think, have a most distinctly a compliment piece of gauze thirty yards away; when attached to the throat by an india-rubber band, the faintest whisper is magnified, and it transmits the smoothest sound from a powerful biceps.

5. *A Lecture Experiment.*—Place the heart of a frog on the electrodes of the microphone in connection with a receiving telephone, and the pulsations of the induction-shocks will then be conveyed by the sounding rod and fire of the coat of light on a transparent screen. This has often been observed by physiologists, but, considered as a lecture experiment, it is very instructive.

6. *The Sensibility of the Telephone to Feeble Currents.*—As an example of this, I may instance the following experiment: The platinum electrodes of a Bell-telephone are put in two polarizable electrodes of Du Bois-Reymond, so that the transverse section touches the one electrode, and the longitudinal surface the other; the current thus obtained, when the telephone is sensitive, gives a distinct sound. I have derive the spot of light from and to and of the scale, about three feet in front of the galvanometer; the galvanometer was then disconnected, and a telephone placed in circuit. It was then found that on making and breaking the current, a faint but sharp click of the telephone plate was heard. No click could be heard when the muscle was removed and the two electrodes were connected with a bit of moist blotting-paper. The muscle current was therefore sufficient to act on the telephone. The click was stronger when the muscle was placed in contact with two platinum terminals, and when a small carbon microphone was also placed in circuit. I then tried to ascertain whether any effect on the click could be produced by throwing the muscle into a state of tetanus, and I found that in these circumstances no click could be heard at all. In other words, during the state of muscular contraction the muscle current was so diminished the negative variation so sufficed as to be unable to affect the telephone so as to produce audible sounds. The telephone thus was used instead of the galvanometer in a physiological experiment.—*Nature.*

JABLOCHKOFF'S DYNAMO-ELECTRIC MACHINES.

AMONG recent improvements of the dynamo-electric machine, the device by M. Jablochkoff is worthy of notice. In this form, which is illustrated in the engravings, ashort bobbin of coiled insulated wire is placed between two soft iron cheeks or disks, which are fixed on a soft iron shaft that passes through the bobbin, but is insulated from it. These cheeks are curved backward, the coil either extending beyond them or coinciding with them as required. In order that the principle on which this machine acts may be understood, suppose an electric current is passed through the coil; each of the cheeks will then become magnetic, one pole, north or south, being presented at the circumference of the one and at the center of the other disk, and the opposite pole being presented at the center of the former and at the circumference of the latter. The two disks thus magnetized being united at their centers by the soft iron shaft, the shaft would form a magnet having a north or south pole at the circumference of the one disk, and the opposite pole at the circumference of the other. Conversely, when the two cheeks are magnetized so as to have polarity of the kind just mentioned, and when this polarity is alternated, then the central coil has currents of alternate direction induced in it. For thus magnetizing the cheeks the following arrangement is employed: Notches are cut in their periphery, so that they present a series of projections like those of a toothed wheel, and they are placed so that the coil exists as it were between the teeth of the wheel. They are caused to revolve in joining teeth of the wheel. They are caused to revolve in front of the two stationary magnets or electro-magnets, so arranged that as the cheeks revolve their projecting parts successively present two opposite poles of these magnets, and thus the alternating polarity required is induced upon them, and corresponding currents are induced in the central

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FRIDAY, MAY 5, 1882.

TELEPHONIC COMMUNICA

ALTHOUGH six years have elap the invention of the telepho practically useful form, it has not, i this country is concerned, at least, position which it ought to occupy are several reasons for this appare of a really useful invention, the m portant of which is probably the p the Post Office, though the diff determining the rights of the holde patents has had something to do; delay. No doubt, too, there is some dissatisfaction the part of would-be us judging by their experience of a ventions, are, perhaps, justified in t improvements which will appea instruments at present employe telephone as devised by Bell, that holding the first place as the recei strument, is rarely employed for tran purposes—the instruments in whic conjucts are used being preferred reasonthat they allow of stronger cu currents being sent than are possib a magnet alone is available. Of thes ments there are several seeking its favour, some having many carbon l as the Jobr, the Crossley, and W while others have only one, as the phone. The fact that among ad known forms as the Edison, Bl Hummings so great a difference in the of contact pointeis found, leads Col the president of the Society of T Engineers and Electricians, whoever on the subject last week before the of Arts, to the conclusion that we a long way from comprehending t meaning of the work performed pressure of the carbon. So many an however in the last two or three ye devoted to the study of the telepho we may safely assume a marked ch any importance will be made in t struction, and those who can find a it may instal it with the certainty the answer its purposes even if somethin is found next year. The history telephone affords an instance of the d of intending even a meritorious in for although it is years have passed since it was patented, it cannot yet be said widely used as it deserves to be. It that in this country the application telephone has been delayed owing existence of rival companies, par mainly in consequence of the ac the Post Office, which, according to courts, is entitled to the monopoly claimed. The merits of the now us transmitting messages are, however fully appreciated, and there is not, subscribers whenever it is proposed t fish an "Exchange." In Germa France, in Belgium, in Italy, and countries on the Continent the s system of telephoning is in full we Berlin, for instance, it has reache degree of perfection which is indee the fact that any person can ha minutes' conversation with any of t scribers to the exchange by the expe of 50 pfennige (about 5½d.), by the p of a list of subscribers, and in this exchanges are already in existence cost the members about one pe

is certain, that the telephone exchange is a growing innovation which will ultimately absorb a great deal of business that is now done by telegraph, especially local messages, for there are several reasons why those who desire to send them would prefer to speak direct to their correspondents instead of writing the words on a form, and would also prefer to receive the answer in a voice that can be recognised instead of on one of the familiar forms. It will be difficult to make a general arrangements of the nature of the existing telephone exchanges, but it is satisfactory to learn that the Post-office is prepared to extend existing facilities wherever the public demands warrant the requisite expenditure.

CART AND WHEEL-MAKING.—XV

(Continued from page 669, Vol. XXXIV.)

By J. CHARLES KNOX.

IN the course of cart-making, much of the painting may be done as soon as the body is finished. In the trade, the body is often finished painting while the carriage or cart is yet in hand, and as the body has as much contact with the rainbows and the heads, in the riders getting in and out, it is the last course to have the body finished first. It will be useful to describe in turn the process of carriage-painting as followed in the best English shops. I, therefore, proceed to give full working details of painting on the body of a carriage, with a few hints of what to do if you would desire. You may have perfect confidence that the careful accomplishment of the job in a short time if the directions are followed; the time includes hardening stoutness, and flexible dexterity of wrist and fingers.

Before commencing to paint, be sure you have a shop secure from currents of the dust, and be careful to get your body and carriings free from dust, especially in the corners, and the wood free from glue, grease marks, smoke, from any part of the wood having been scoured in the last framework. Should any be on, scrape and wash off with turpentine.

The colours, as the best pigments are termed, are the priming colour for first, second, and third coats of paint. The priming colour is first, second, and third coats. The finny colour, by some different colour, to be finished by varnish on the last coat of colour, and Japan on the iron-work, and black paint where wanted. "Filling-up" is intermediate coat of paint between the priming coat of paint, and the first proper coat of paint; the last termed colour, and is a special mixture. How to mix these colours in proper proportions of ingredients will be fully explained, but it will be seen it is the simplest part of the process of painting. To lay on the first coat, and "flat-down" between the drying of each coat, requires the care of forethought and sensitive dexterity of touch.

To give confidence to anyone disposed to try his hand at painting, I may mention that I had to appraise a painter to do the work on a large estate near London. In closing a sale I also met out of several who wanted the job, I selected a man who had done painting before, and selected a farm-labourer who had never done such work: within a week's time he added finished a first-rate oak-graining job, with a fine flowing coat of varnish. His success was due to cleanliness, forethought, method, and a critical sense of touch in handling a brush.

As briefly as possible I proceed to tell how to use the various paints, "up-on" and flat-oil for varnishing. Priming colour is made of white-lead (as sold ground in oil) 2lb.; linseed oil, 1 pint, thoroughly well mixed, then add turpentine, 1 pint. The next is cream-colour, to darken to lead colour of any shade, add lamp-black, and add up till of the consistency of milk; to insure quick drying, add to the mixture 2oz. of "Japan"—this is sold ready for use.

I am obliged to remark now that as much of your cart as can be taken easily apart, must be so done so, before beginning to paint.

The body should be upside down on trestels,

THEILER'S TELEPHONE RECEIVER.

THE telephone receiver recently patented by L. Mouse, Theiler, of Canonbury-road, S differs from its predecessors in dispensing with an armature, the lateral vibration of the electro-magnet itself being utilised. In previous systems in which an electro-magnet is used, the sonorous vibrations are due either to the motion of an iron diaphragm or armature placed close to the poles of the electro-magnet, or to the expansion and contraction of the magnet itself. In Theiler's telephone the electro-magnet may be of the usual U shape, and may consist either of soft iron or of hardened steel, permanently magnet-ized, wound with a suitable number of turns of insulated wire. This electro-magnet is fixed in such a manner that the vibration of either one or of both its limbs is communicated to a diaphragm or diaphragms. The parentees also employ two separate electro-magnets in the same circuit, and utilise the vibration of both magnets in the manner described. By attaching a light disc or discs to the vibrating limbs the diaphragm may be dispensed with. Fig. 1

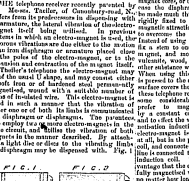


FIG. 1. FIG. 2.

represents one of the telephone receivers provided with two diaphragms or sounding boards, as usual, and in the two limbs or cores of the electro-magnet are fixed by silent tongues. These tongues are in contact with the two diaphragms and with the magnet, as shown. The poles of the electro-magnet are brought very close together by being shaped as shown, and the middle part of the magnet is firmly screwed to the case of the instrument. The ends of the bells surrounding the magnet-cores may be attached as usual to two terminals, or soldered to a flexible conductor communicating with the other parts of the telephone apparatus. When a voluntary current is sent through the bobs of the electro-magnet, the extremities are rapidly attracted and repelled and thevibratory motion of the magnet cores being communicated to the diaphragms or sounding boards, the latter are set in vibration of varying amplitude produced by a current of varying strength, as in all other telephones. Instead of using the electro-magnet in the continuous circuit, it may be employed to work the vibrations that it sets up, and it is even practicable to make it of the form shown in Fig. 2, where the electro-magnet represented consists of two limbs or cores, a sole piece, and pole caloudons, the whole being screwed together and peculiarly constituting one conspicuous piece of iron carrying the two coils. In Fig. 2 only one of the limbs or cores of the electro-magnet is attached to the diaphragm, the other limb being held fixed by a screw.

Sometimes the patentee hings one or the magnet cores, or both, in a cradle-piece in which are the diaphragms or sounding boards are to be made much thicker than when the cores are rigidly fixed to the sole-piece, because the magnetic attraction of the poles has then only to overcome the resistance of the diaphragm. Instead of using a diaphragm, they sometimes fix a stem to one of the cores of the electro-magnet, and mount thereon a light disc of cuticumite, wood, ivory, gutta-percha, or any other substance which is capable of vibrating. When using this telephone receiver, the disc is pressed to the ear in such a manner that its surface covers the aperture of the ear. When three telephone receivers are used on a line of some considerable length, the patentees prefer to magnetise the electro-magnet by a constant current from a local battery, and to employ the receiver in the constant battery arrangement inductively, and not directly. The electro-magnet is, then, not in-cted in the line at all, but is the primary circuit of an induction coil, and connected with a local battery. The line is connected to the secondary circuit of the induction coil. This device possesses the advantage that the electro-magnet can be powerfully magnetised with very little battery power, no matter how long the line may be, and that steel magnets are entirely dispensed with. It is not necessary to have a separate battery for this purpose, as the microphone battery may also be used for the telephone receiver. The shape of the vibrating electro-magnets is immaterial, as they may be made of a variety of forms.

MEASUREMENTS AND AMPLIFICATION OF TELEPHONIC VIBRATIONS.

"EVERYBODY is aware," says M. Salet, in a recent paper to the Paris Academy, "that it is impossible to hear through a thin sheet of pine, such as is known in an apartment that is otherwise quite closed. This case the sonorous vibrations transmitted by the air agitate synchronously the wooden partition, and this in turn transmits its movements to the outer air as a piston would. This familiar experiment must have struck physicists, as giving a result of the exquisite sensibility of the ear. The vibrations of the board are indeed very small, hardly greater than those of the membrane of a telephone receiver in action; but these latter are so weak that their existence has sometimes been called in question. They exist, however, and I proceed to give an idea of their amplitude."

The method adopted by M. Salet was as follows: He fixed on the iron diaphragm of a Bell receiver a small glass disc weighing 0·15 gramme, and in front of this was suspended a second, furnished with a Newton's rings. The arrangement resembles that devised by M. Forbes for study of vibrations. When one examines at a distance of about sixty centimetres from the telephone, or sends into the receiver a sound, the phonic current from a good transmitter (that of Ader, *e.g.*), the rings are observed to lose their distinctness, and disappear if the voice be a little forced. They vibrate, indeed, synchronously with the diaphragm, and nothing is simpler than to calculate, from the amplitude of their oscillations, that of the vibrations of the membrane.

It is certain, however, that the surfaces of the diaphragm with the discs must lessen the movements slightly; thus the results obtained are probably by defect rather than by excess.

To estimate the displacement of the plate, M. Salet arranges before the receiver telephone, which is connected to emit a continuous sound, a turning disc pierced with slits, like that of a physiological apparatus. He is then, with a certain velocity of rotation, the rings reappear with distinctness. On blowing a little more slowly on the disc, so as to make it act as a syren, it is found that the sound produced is so unisonous with that it is emitted by the telephone, if it be slightly lowered or raised, immediately the rings oscillate, at first slowly, then with such rapidity that they become invisible again. While they oscillate one may easily estimate their displacement; in one experiment, the is of the diaphason being emitted with the transmitter with the vowel *a* [æ], and with moderate intensity, the displacement was exactly half that the distance of two consecutive rings, and the amplitude of vibrations of the receiving plate would then be 2 to 3 one-thousandths of a millimetre.

If there be sent into the telephone currents of different intensities, but very weak, and each of which, *e.g.*, does not cause the motion of the rings beyond half the distance separating them, one may, by considering a point on the plate, infer from its brightness the intensity of the current. This singular galvanometric process, says M. Salet, might undoubtedly be utilised in the microscopic receiver.

In connection with the foregoing, we will here proceed to notice an interesting device for augmenting the dynamic effect of the vibrations of diaphragms, recently described by Mr. W. B. Cooper, before the Franklin Institute.

When a cord is passed over a resisting pulley it is well known that the tension on a pull on one side proportioned to the clearance of the surfaces in contact and the pressure on the axis. This pull is due to the friction of the surfaces on each other, and increases in nearly, if not exactly, the same ratio as the pressure. Now, if the pulley is loose on the shaft, and we pull a cord over it, we have the same forces exerted at the pulley and minus the friction of the shaft; if, however, the pulley is attached to the shaft and rotating towards the end pulled, then the result at the other end is the force applied *plus* the amount derived from friction on the surfaces of the pulley. This is the principle of the device, which, in the simple form, Mr. Cooper calls a phonic tachygraph. To one end of a wire or band by which a diaphragm or other pulsating body, then he gives a sudden or several turns round a drum or pulley which is loaded in one direction. To the other end he attaches a style, bearing a point ad-apted to indent a fixed sheet-metal passed under it at uniform speed by suitable mechanism. Mr. Cooper has thus reduced lines of the thickness of writing paper by the impact of the voice on a diaphragm of the size used in the phonograph.

The principle, he points out, is applicable to the telephone, both for the purpose of increasing the intensity of the electric impulses transmitted, and augmenting their effects at the receiving station. At the transmitting station, *e.g.*, the mouth, or by means of leverage a greater, amplitude of vibration may be given to a steater diaphragm; or an armature, compelled by a spring, playing before the poles of a magnet. The form of transmitter is, however, to my advantageous in which increased power is obtained by the use of a fit the telephone may be rendered available for greater dis-tance. For increase of power in the receiver, Mr. Cooper has devised a plan in which to applies the principle somewhat differently. A number of these electro-magnets are set rapidly in a frame, and their draft upon an armature on the face of the drum is increased by th- agency of friction of a wire or band passing round the drum, and connected with the armature and with a diaphragm. For details of the working we must refer to the original paper.

DYNAMO-ELECTRIC MACHINERY.

TELEPHONIC PERTURBATIONS.

CHRONOLOGY OF TELEPHONIC DISCOVERIES.

IN view of the partiality with which the history of telephony is presented in different semesters, the editor of *Scientific Enterprise* (M. Du Moncel) offers the following a brief chronological resume, which is as follows:—

1854.—First idea of electric transmission of sound by means of undulations.—Charles Bourseul.

1856.—Diaphragm.—M. Th. Du Moncel of the transmission of telegraphic currents by over interrupters with metallic contacts to be alternately closed, with the pressure exerted on them. Experiments proving the truth of this principle with the substances of medium conductivity.

1861, 1872, 1874, 1876, &c.

1857.—Representation of vibrations produced by the voice by means of a stretched membrane before which are spoken, by M. Leon Scott.

1859.—Application of M. Scott's system to the electric transmission of sounds, by M. Reiss.

1863.—Application of the principles of variations of intensity of currents with pressure to making tubes with variable resistance, by M. Clerac and Rimmery.

1865.—Discovery by Mr. Wright of the reproduction of sounds by a condenser.

1867.—Application of the electric transmission of sound of undulatory currents by Mr. Bell.

1874 (14th Feb.).—Discovery by Mr. Bell of the magneto-electric telephone.

1874 (19th April).—Application to the Reiss transmitter, or to Bell's liquid transmitter, of a contact with permanent action for electric transmission of sounds, by Mr. Dunnegh.

1877 (26th July).—Application of soft carbon contacts to the Reiss transmitter, to furnish more developed undulatory currents in telephonic transmission, by Mr. Edison.

1877 (30th Oct.).—Application of hard carbons with one or two contacts to the same transmitter, for the same purpose, and at the same time to form a receiver capable of repeating speech, by Mr. Hughes.

1878 (Jan.).—Discovery by Mr. Hughes of a telephonic action from conditions of the same movement in such as to magnify sound; an apparatus called by him the microphone, the cause of which was unknown.

1878.—Discovery by the same savant of the transmission of sounds by the mere contact by the voice on crushed fragments of carbon, or conductive powders, supplied to metallic electrodes connected with a battery and a telephonic circuit.

1878.—First application of the microphones to the hearing at a distance of sermons and divine service, by Mr. Crossley.

1878.—First application of the same instrument to hearing an opera, by M. Pataski.

1879.—Reproduction of speech by an iron wire used as receiver, by M. Ader.

1879.—Construction of the *telephone* of Mr. Edison.

1880.—Reproduction of speech by means of the condenser with sheets of paper, by M. Hiers.

1880.—Invention of the musical reproduction of speech, by Professor Graham Bell.

1880.—Researches of Messrs. Bell and Sumner-Tainter, of the *telephone*.

1880.—Transmission of speech without a battery by the effect of permanence between fragments of iron wires, by M. Ader.

1881.—Speaking condenser with air-layer, of Mr. Dibbern.

1882.—Simultaneous transmission a long distance, of speech and a telegraphic message, by M. Van Rysselberghe. Same problem solved in another way, and in laboratory experiments by M. Mulder, in 1880.

[It may be remarked as strange that no mention is made in the statement of the harmonic telegraphs of Mr. Varley (1870), and of Mr. Elisha Gray (1874).]

CONSIDERABLE attention has been made the subject of investigation by M. Gaulle, the well-known French electrician, and, curiously enough, his fads them to be due to the vibrations and oscillation of the two telegraph-wires in the wind. These extraneous sounds have hitherto been regarded as due to induction from neighbouring wires, but the telegraph-lines over which currents of electricity were passing; though this cause is doubtless operating, it is not the only one. M. Gaulle arranged a telephone line along the floor of his laboratory, and connected it by flexible conductors to the telephones at either end. An interruption was then purposely made in the circuit, which might be broken without disturbing the rest of the apparatus; and he soon found that the mere rubbing of the line-wire against itself generated a current which could be distinctly heard in the telephone when the circuit was broken by the key. Rubbing another metal on the line-wire produced the same effect, and the mere touching of a binding-screw upon the latter produced an audible sound, while scratching the line-wire along a file gave a comparatively loud result. It follows that the rubbing of a telephone-line against a screw or loose binding-wire will occasion currents capable of perturbing a telephonic message, and that consequently all the binding-screws should be made necessary for good telephony. A more serious drawback exists, however, in currents generated by the vibrations of the wire itself, as M. Gaulle has proved by inserting a rod of iron about 40ft. long in the circuit of the telephone, and striking it transversely with a hammer. Every stroke produced a distinct sound in the telephone, although the feeble resistance of the latter prevented a mechanical communication of the vibrations. This effect is evidently a molecular one, and reminds us of the late experiments of Prof. Hughes on electrical tension, where the mechanical vibration of iron wire was found to affect the galvanic resistance, and where the passage of a current through the wire was determined to produce a molecular twist in the latter. The vibrations produced by the wind in telephone-lines are, therefore, inimical to long-distance telephony, and the question arises, How to obviate the latter? Mr. Gaulle's action, like to obviate the latter? Mr. Gaulle's action, like that of current from zinc and carbon any such ground-lines are, of course, of no use as they are similar in construction to submarine cables, their great inductive capacity would prove a more serious hindrance than speed, and a hundred miles or less would probably render the telephones absolutely silent. Aerial wires of brass, or better still of manganese bronze, would, perhaps, solve the difficulty.—*Engineering.*

PROF. S. P. THOMPSON'S NEW TELEPHONES.

THE telephonic apparatus recently patented by Prof. S. P. Thompson, of University College, Bristol, is so simple and in many respects so suggestive, that it may be useful, as it certainly will be interesting, if we illustrate some of the forms devised by him. The improvements relate to telephonic transmitters based upon the principle discovered by Philipp Reis in 1861, namely, that of employing current-regulators actuated, either directly or indirectly, by the sound-waves produced by the voice. By the term current-regulator is meant a device similiar to that employed by Reis, wherein a loose contact between two parts of a circuit (in which are included a battery and a telephonic receiver) offers greater or less resistance to the flow of the electric current, the degree of intimacy of contact between the conducting pieces being altered by the vibrations of the voice. In Reis's transmitter, and in Edison's transmitter, and other well-known forms of these instruments, the action is indirect, a tympanum of stretched membrane or other equivalent organ, such as a diaphragm of mica, being used to collect or magnify, or concentrate, the vibrations of the voice, and to convey them to the point or points of loose contact that regulate the current. In other forms of transmitters (for example, some of Hughes's microphones), the mode of action is direct, the air-waves beating directly upon the conductors or electrodes which are in loose contact, without the intermediation of a tympanum or diaphragm. Of these two classes of telephone transmitters, viz:—those in which the current-regulator is combined with a tympanum or diaphragm, and those in which the current-regulator is acted upon directly by the air-waves of the voice, the improvements relate to the latter only, as Prof. Thompson dispenses with the membrane tympanum used in Reis's transmitter; and does not employ the tympanic diaphragm of mica used in Edison's transmitter; he does not even employ any diaphragm in the sense of a partition between the current-regulator and the air-waves of the voice, as in Theiler's transmitter. In the improved transmitters, the air-waves act directly upon the current-regulator itself. As a result, the articulation is clearer for some of the consonantal sounds, which are only imperfectly or difficultly transmitted by telephones in which the current-regulator is affected indirectly through a tympanum, diaphragm, or partition. Transmitters of the class to which the improvements relate are ordinarily liable to two defects. Firstly, they do not articulate so loudly as transmitters in which there is a tympanum or diaphragm to collect or magnify the vibrations. Secondly, when, to obviate this difficulty, the speaker speaks with his mouth very close to the current-regulator, the moisture of his breath condenses upon the contact points or adjacent parts of the regulator, interfering with its action and spoiling the articulation. The improvements relate chiefly to means for remedying or obviating these defects. Prof. Thompson proposes to employ mirrors, sound-reflectors or reverberators (one form of which is shown in Fig. 1, in transverse section), consisting of glass, metal, wood, or other material, by which the sound-waves are turned aside from their straight or direct path, and are made to converge upon the current-regulator, precisely as rays of light may be turned aside or converged by a polished mirror. If actual mirrors of polished metal or silvered glass are employed for this purpose, they have the additional advantage of revealing to the speaker the presence of moisture. But in any case the mirror, reflector, or reverberator serves to collect the sound-waves as they come from the speaker's mouth, and to direct them on to the current-regulator while intercepting moisture from the speaker's breath. M is the mouth-piece or tube; C is the current-regulator; R is the reverberator. An adjusting screw and an out-let cock for the water which collects in the mouth-tube are also provided where necessary. The mouth-pieces hitherto used on ordinary transmitters are not intended to serve either as reverberators or as protectors from moisture, and Prof Thompson finds that mouth-pieces for this purpose must, as shown in Fig. 2, be deep and of conical or paraboloidal form. Another part of the invention consists in employing, for the current-regulator, such materials as are at once neither hygroscopic, nor liable, by their properties with respect to heat, to condense films of moisture, while at the same time they are good conductors of electricity.

FIG. 2.

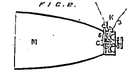


FIG. 3.

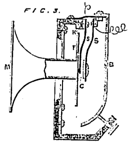


FIG. 1

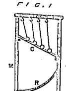


FIG. 5.

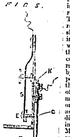
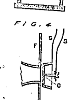


FIG. 4.



Prof. Thompson prefers to use, as materials for the current-regulator, either spongy platinum, carbide of platinum, boron, coke, carbon, or elastic carbon specially prepared, having first deprived such materials of their hygroscopic properties by treatment with petroleum, or with other suitable hydrocarbon, solid or liquid. In some cases, and especially where the contact surfaces of the current-regulator are of platinum or other metal, he finds it convenient to keep their surfaces constantly moistened with petroleum or other hydrocarbon by supplying them through a cotton filament in communication with a small lubricator or oil-vessel. The improvements also partly consist in so arranging the conductors or electrodes, or other parts of the current-regulator, that the points of loose contact can be actuated by the sound-waves, whilst they are protected from the moisture of the breath by some portion of the conductors or electrodes projecting between the contact points and the breath of the speaker. An example of such an arrangement is given in Fig. 4, wherein the contact points C are protected from the breath by making one of the electrodes in the form of a cup, against the concave or hollow face of which the contact point on the other electrode is directed. The improvements relate further to the form of the conductors or electrodes combined to serve as the current-regulator. The current-regulator of Reis, consisting of one piece of platinum resting lightly against another, is imperfect, except when, as in some forms of Reis's instrument, one or both the pieces of metal are fixed upon springs or some equivalent elastic support; otherwise the current is liable to very abrupt interruptions. In Fig. 3 is shown a current-regulator, wherein the two contact pieces are held upon springs S, S; one of these springs is fixed to an adjusting frame B, and the other is fixed to an insulating block K, for it is found that when there are many points of contact instead of but a single pair of such points, there is less liability to such abruptness. Multiple contacts, therefore, are advantageous. One of the improved forms of current regulator consists of a grating or framework of prepared carbon or metal tongues so connected that the current cannot pass from one tongue to the next except through a piece or pieces of good conducting carbon or metal suspended, or resting in loose contact against the tongues. In the instrument shown in Fig. 1, the current-regulator C consists of an inclined grating of carbon strips, against which the voice-waves are reflected by the reverberator R, and upon which rest light balls of carbon or of metal supended from hooks by silken strings. In some cases, where a highly powerful action is desired, the air-waves are caused to act first on a vibrating tongue which then transfers the vibrations indirectly to the current-regulator or

contact points C. Such a vibrating tongue is shown at V. in Fig 5 where it is attached behind a flanged tube T. the contact points or current regulator C being on the same face of the tongue V as that against which the voice-waves impinge. This tongue may be itself an electrode, & serve as a part of the current regulator, in which case it is formed of metal, carbon, or elastic conductor whether anhygroscopic or not.

THE TIMES, WEDNESDAY, MAY 3, 1882.

HIGH COURT OF JUSTICE.

CHANCERY DIVISION.

(*Before* MR. JUSTICE FRY.)

THE UNITED TELEPHONE COMPANY (LIMITED) V. HARRISON, COX-WALKER, AND CO.

The hearing of this remarkable patent action was continued. The cross-examination of Mr. Johnson (the representative of Mr. Edison for the purpose of electric lighting) was continued by Mr. Hemming, Q.C. The evidence of this witness, though he had been preceded by Sir F. Bramwell, Sir W. Thomson, Dr. Hopkinson, and Mr. Imray, was perhaps the clearest and most interesting of any. He had been cross-examined, among other things, upon an invention originally claimed in Edison's patent called the "electro motograph," the instrument that is used in Edison's loud-speaking telephone as the "receiver" part of the whole instrument, which immediately transmits the sound to the receiver of the message sent. In re-examination, one of these instruments was made an exhibit and described. It is, perhaps, the most wonderful of the inventions connected with the subject, but it has been disclaimed. It seems to have been found in the course of litigation between the companies who amalgamated and form the United Company, the plaintiffs in this action, that a report of a scientific communication made by Mr. Edison at a *séance* in America had found its way into an English scientific newspaper previously to the date of the patent. And the patent was avoided in a similar way to that by which the defendants seek to avoid Bell's patent in this action, by the alleged anticipation in the address of Sir W. Thomson to the British Association. In the motograph, Mr. Edison has made use of a discovery of his own, that the intensity of an electric current has an effect as to the quality of roughness on the surface of chalk or other substance in the electric circuit. He uses that discovery in the following way:—A small chalk cylinder, which is made to rotate when a message is sent, is fixed in and forms part of the receiving instrument. Against the chalk cylinder a platinum plate is pressed by a piece of indiarubber. The platinum plate ends in a point, which presses against a mica disc or tympanum. The revolution of the chalk, by means of friction, affects the pressure of the platinum point against the tympanum. The undulatory change of the strength of the electric current effected by the transmitting instrument produces a corresponding undulatory change in the roughness of the chalk, which produces a corresponding undulatory change in the pressure of the point on the tympanum, which causes the tympanum to vibrate in correspondence with the voice undulations of the person speaking into the transmitter; and the mica tympanum in its turn communicates through the air to the ears of the listeners the sounds of articulate speech. We say listeners, for this instrument speaks so loud that it is not necessary to put the ear to it, and many persons can hear at the same time. With some formal evidence, this closed the plaintiffs' case.

Mr. WEBSTER, Q.C., the second counsel for the plaintiffs, said he did not think it necessary to sum up the evidence, but read some passages from the judgment of Lord M'Laren in a Scotch action, in which the plaintiffs had succeeded, as bearing on the case in respect to points not connected with the question of infringement.

Mr. J. PEARSON, Q.C., then opened the case of the defendants. He stated that Mr. Hemmings, whose instrument is said to infringe the Edison transmitter, is a clergyman in Yorkshire, who made his instrument without knowledge of Edison's invention on experiments of his own. He argued that Edison's patent was bad, because the complete specification was in "excess" of the provisional specification, particularly in including the "phonograph," which is entirely a mechanical invention, and not for the purpose of controlling sound by the transmission of electric currents. In the next place, Edison's specification, so far as relates to the material of the "tension regulator," is to be confined to the materials specified, which do not include "gas coke," Hemmings's material. He next said that he would show that Reis's instrument had anticipated the invention—that it had, in fact, a low power of transmitting articulate speech. On the construction of Bell's patent, he argued that the claim, as originally framed, was too wide, being for the principle discovered by Faraday, and could not be made good by subsequent limitation; secondly, that the claim for a tympanum was for a membrane, or metal plate in the alternative. The principle of the membrane had been divulged at Glasgow, and under the circumstances the patent could not be limited to the plate. During the speech of Mr. Pearson, it came out that there was a material error in the stopping of the certified copy of Edison's patent put in evidence, and the original document filed at the Patent Office (of which the Master of the Rolls is chief) was sent for, and it was found that the stopping and use of a capital in that was obscure, and the certified copy was incorrect.

His LORDSHIP said that the printing of the copies was by no means a creditable performance, and that the fact that the certified copy was incorrect called for observation.

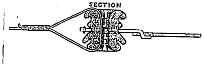
Mr. Aston, Q.C., Mr. Webster, Q.C., Mr. Cozens Hardy, Q.C., and Mr. Moulton are counsel for the plaintiffs; Mr. J. Pearson, Q.C., Mr. Hemming, Q.C., Mr. Goodeve, and Mr. F. L. Muirhead for the defendants.

LEWIS'S PATENT TELEPHONE SHACKLE.

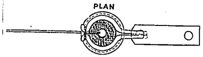
AMONGST the few decided novelties exhibited at the Vienna Exhibition, not the least noticeable is the excellent and ingenious form of binder for insulators, devised by Mr. Slater Lewis, of Birkenhead. A description of this binder was given in the number of the ELECTRICAL REVIEW for Nov. 11th, 1882. Mr. Lewis also exhibits a new form of shackle, which is a very great advance on anything of the kind yet brought out, and is admirably adapted for the purpose for which it is designed. This shackle has been designed with a view to supplying telephone engineers with a cheap, handy, and yet efficient terminal insulator—one that will be found adaptable to all the positions met with in erecting wires in towns and over house tops, and one that will give the least trouble when renewing.

Fig. 1 shews the whole of the shackle and portion of line wire in plan and fig. 2, the same in vertical section.

SECTION



PLAN



It will be seen that, there being only one strap, the shackle can be bolted to a cross arm or to a saddle-top or bracket without any of the complications usually seen where the two straps of the Bright shackle are used; and, should the porcelain be broken and require replacing the change can be effected with the least possible trouble and without having to unscrew any bolts, as in the case of the Bright shackle.

Where a number of wires are arranged round a chimney, a very neat, strong and cheap arrangement can be brought about by the use of this insulator. Four lengths of angle iron are formed into a square frame, and holes are drilled at convenient distances therein, into which the shackle straps can be hooked at any desired point; thus the flat strap and bolt are saved in each shackle used. The shackle is also admirably adapted for terminating on the strand process. The surface taken up by both line-wire and strand are absolutely without any sharp corners, which are so liable to cut the strand wire by the lateral movement of the insulator in windy weather.

One point of importance is that the porcelain portion is suited to the Bright shackle straps, so that, where the invention is adopted, two kinds of insulators need not be carried about.

The porcelain portion is very neatly and well made by Messrs. Doulton & Co., of Burslem.

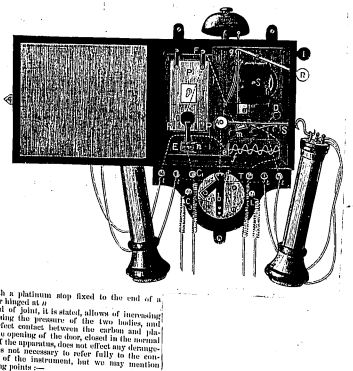
Scientific American Sept. 1, 1888.

M. DE LOCHT-LABYE'S "PANTELEPHONE."

THIS apparatus, which we, in our issue of August 25th, promised to describe, is not by any means new, as it formed one of the principal telephonic attractions at the Paris Exhibition of 1881, and it there achieved great success. It is said that persons speaking to this instrument might retire from it to a distance of 30 metres and yet the speech would be repeated at the receiving end. The instrument is sensitive to all kinds of sounds, loud or feeble, coming from long or short distances, and it is applicable to all kinds of telephonic receivers.

There is combined in the apparatus, shown fully in the drawing, the following parts: the pantelephone, the call button, *a*, *b*, of the bell, *s*, the visual signal, *g*, *h*, *i*, the interrupting switch, *k*, actuated by the weight of the receiver, and the induction coil, *c*, *f*.

The pantelephone is arranged on the left side of the figure, and P, P, P is a cork plate suspended by two small flexible springs, P; the plate bears at its lower extremity a small flat disc of carbon, *o*, which is in



contact with a platinum stop fixed to the end of a metallic bar hinged at *a*

This kind of joint, it is stated, allows of increasing and decreasing the pressure of the two bodies, and insures perfect contact between the carbon and platinum. The opening of the door, closed in the normal condition of the apparatus, does not effect any derangement. It is not necessary to refer fully to the connecting up of the instrument, but we may mention the following points:—

The pressure of the finger upon the call-button in the first station breaks the connection of the spring, *b*, with the contact, *d*, and establishes it with the stop, *c*.

The current traverses in the first station, *c*, *a*, *k*, *l*, passes by the line wire to the second station in the apparatus of which it enters by the terminal, *l*, arrives at the commutator, *A*, and the commutator lever being in contact with the stop, *8*, the current passes into the bobbins of the bell-magnet, *S*, whence by the armature, its spring, and the return wire, it returns to the negative pole of the battery in the first station.

The circuit being closed, the call-bell in the second post is put in action. This disengages the lever, *g*, *B*, which unsevers the disc, *i*. If the correspondent is absent at the time of the call, this permanent signal informs him on his return that some one desires to correspond with him.

This description will enable our readers to understand the mechanism of the apparatus.

All the regulation consists in manipulating the joint at the thumbscrew, so as to produce close contact between the carbon plate and the platinum stop and modifying, by inclination of the plate, the pressure of the plate upon the stop. This regulation is not difficult, since there is a space of more than a centimetre between the extreme positions of the stop.

This is the transmitter which M. De Locht-Labye mses with his "Hammer" telephone.

THE TELEPHONE.

*On the Retardation of Phase of Vibrations transmitted by the Telephone.**

By BENJAMIN P. TRUEMAN, B.A., D. Sc., Professor of Experimental Physics in University College, Bristol.

It was predicted from theoretical considerations by Helmholtz that a difference of phase, amounting to a quarter of a complete vibration, would be found to exist between the displacements of associated bell telephones, the receiving telephone being a quarter of a vibration behind the transmitter. A more complete theory, worked out independently by Helmholtz and Weber, gave a result of what contrariety would, and required only a small difference of phase. Recently Kreiz, in a series of delicate experiments, effected an optical comparison by the method of Lissajous' figures between the vibrations of a pair of telephones, receiving the vibrating impulses of tuning-forks armed with mirrors. The experiment is a difficult one to be performed under conditions not free from objection. The author has proposed the following method of observing. A pair of bell telephones are suspended by wires of about a metre in length, so as to oscillate as pendulums, to frames as disposed of the vibrating bodies the point of rest of each telephone, and at some little distance from it in the plane of swinging, is placed a steel magnet, so that the lengths of the wires have been so adjusted that the telephones shall swing in identical periods, one telephone is not swinging. As it alternately approaches and recedes from the magnet, the induced currents traversing the second telephone set it swinging. In every case the difference of phase observed was a quarter of a vibration.

In the case of Edison's telephones which transmit vibrations by varying the resistance of a circuit traversed by varying electromotive force, there is no such retardation of phase produced in the ordinary electro-magnetic receiver. If, however, the current so transmitted is first passed through an induction coil, a retardation of phase of one quarter is produced, and in the case of several successive inductions the retardation amounts to an additional quarter for each induction. This remark applies only to vibrations of harmonic and quasi-harmonic type. Vowel sounds, which consist of combinations of such vibrations, are unchanged in the perception of the simple ear, which is unable to distinguish differences of phase, or between compound sounds which differ from one another only in the difference of phase of their components. The vibrations of consonantal sounds, on the contrary, depart more and more widely from their original type at each successive induction.

In the case of Edison's undographic or electro-chemical receiver, the velocities, not the displacement of the disc, are proportional to the strength of the currents received. Hence vibrations already retarded one quarter in transmission will be in the with those at the carbon transmitter in conjunction with its induction coil, always send with this instrument vibrations retarded one quarter in phase. The vibrations of this receiver therefore agree in phase with the vibrations of the induction current (which correspond to the first function of flows of the original vibration), but with those corresponding to the function of which the vibrations of the induction current are the derivate; that is to say, they agree in type with the vibrations of the second function of flows. Hence the receiving telephone of Edison electrochemical sounds which depart widely from the purely harmonic type are better rendered than in a telephone, which, like that of Bell, both retards the vibrations in phase, and alters them in type.

* Royal Institution, February 6, 1879.
† Paper read before Section A of the British Association at Sheffield.

SOUTH AFRICAN TELEGRAPHIC.—A line of telegraph from Port Elizabeth to Pretoria is likely to be completed in about two months.

PROGRESS OF THE TELEPHONE.

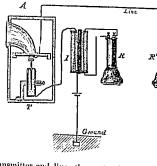
Recalling the recent telephone case, it will be remembered that Mr. Justice Pry held the Edison patent to be invalid because of the phonograph being included in it without connexion with the title of the patent and sufficient notice of it in the provisional specification. The United Telephone Company appealed against this decision, but their request for a hearing in the Court of Appeal could not be granted until after the long vacation. In the mean time the United Telephone Company have applied for a disclaimer and memorandum of alteration. The application will come before the Attorney-General in due course, and any objections to the application must be made within twenty-one days from June 2, the date of the announcement in the Commissioners of Patents' Journal. Almost simultaneously with the announcement of Mr. Fawcett that the Post Office have no intention of taking over the business of the telephone companies in this country, we learn that M. Cochery, the French Minister of Posts and Telegraphs, has asked the Chamber for a grant of 250,000 francs to enable him to establish a State telephone service between certain of the French towns. Absolute secrecy in telephone messages is considered as important in America that a new company with a capital of ten million dollars has been floated there to work the Rogers' secret system for large cities. Secrecy is obtained on this plan by employing two wires wide apart, and the message is sent piecemeal over both by means of a rotating transmitter, so that if either wire be tapped in a clandestine manner, the message will be unintelligible. A telephone circuit of this kind is now in use between the House of Representatives and the Executive Mansion at Washington.

This principle of electro-magnetic induction is one without which the telephone would still be well-nigh, if not entirely, useless—in fact, little more than it was in the days of the now famous Reis—a mere toy for the scientist, an interesting but commercially worthless instrument of the laboratory.

I, therefore, cite below a novelty in the way of telephone connections, touching closely upon this question of induction, in the hope that this account may possibly suggest some ideas to the experimenters of our times; if, indeed, many of them have not already noticed the same thing. I do not claim to have discovered the true remedy for the ailment, but wish to record my plan to reduce extraneous and interfering inductive currents.

I took two Hopkins' transmitters—instruments which, it is claimed, work by intermittent as contradistinguished from the undulatory currents of the Blake and other transmitters, they being the most easily at my disposal, and, withal, I think the best for the trial for various reasons. My line is one-half mile in length, and the instruments were connected as shown in the sketch, in which A and B are the two stations, T and T' the transmitters, I and I' the induction coils, R and R' the receivers. At each end of the line was placed one cell of the ordinary prism batteries.

At station A one element of the battery at that end was connected with the ground, and from the other element for the same battery an attachment was made to the primary of the induction coil, passing through



the latter to the transmitter and line, thence to the transmitter, primary of the coil, battery, and to the ground at station B.

The receivers and secondary windings of the coils, instead of being placed directly in the main line, as in the ordinary method, were connected so as to form with themselves a short or local circuit at each station.

With these connections I have been able to secure very remarkable results, which I shall not detail, except to say that I have succeeded in producing speech and understood by persons standing several feet away from the receivers, the latter hanging down toward the floor by the electric cord through which they were joined to the secondaries of the coils.

The advantages I claim are: first, the substitution for the line of direct currents, instead of the usual induced currents, which latter, as is well known, are of very much higher potential, and consequently more naturally disposed to fly off or leave the line wire at every possible chance; every insulator, therefore, favouring the leakage of current in a much greater ratio than they do the direct or lower potential currents; hence the direct currents started on the line by the transmitter at A are much more likely to reach it with a smaller loss of effective force than is the case with those induced.

In fact a great many telephone experts agree that it is necessary to the accomplishment of a higher utility for the telephone that some other current than the induced be used to traverse the line. Secondly, I claim that the outside induction and disturbance from other lines, telegraph, telephone, and electric light, is greatly reduced in the receivers by this method of connecting them, for the very simple reason that the receivers are not placed in the main line, and therefore an induced current coming from a foreign line must of necessity induce another current before they (the receivers) can be affected thereby, and by the time the receivers are reached by this second induction it has been greatly diminished, in the case of strong, first induction, while in the case of weaker original effects its power is entirely lost.

In the bell plan the receivers are always placed in the main circuit, and consequently respond directly to all induced currents passing on the line, whether from transmitters or from other wires, much to the annoyance of the operator, and frequently, as before stated, entirely nullifying or destroying their usefulness, until the disturbance or the cause of it has ceased.

THE ST. GEORGE TELEPHONE.

MR. A. F. ST. GEORGE has recently patented a telephonic system, which, in some points of detail, differs from those hitherto brought out. The inventor claims for his system that it enables messages to be readily transmitted for long distances, and that the apparatus is very effective and easily worked, whilst the interference of inductive action upon the transmitting wire or wires is reduced or prevented.

The first part of the invention relates to a form of transmitter. The inventor takes a disc of wood or other suitable organic material and carbonizes it between metal plates, so as to obtain a perfectly flat disc of a uniform character, and having great capacity of resonance by vibration and capable of conducting electricity. This carbonized disc is mounted by its edges in a case with an aperture to admit of sound waves impinging upon it. A ball of very hard carbon, hangs by a thin metallic wire or by a flexible non-metallic thread, and this ball is arranged so as to touch lightly against the surface of the carbonized disc. Sounds made to impinge upon the apparatus agitate the disc and the ball touching it so that the ball follows all movements of the disc and always is in contact with it, but whilst the disc vibrates the ball makes small excursions about the surface of the disc, that is to say, any movement of the disc causes the ball to roll more or less, and this rolling action of the ball brings into circuit, from time to time, fresh points of contact in the path of the current of electricity.

The carbon disc and the ball are placed in circuit with a battery and the primary wire of an induction coil in the usual manner.

Fig. 1 shows the arrangement of the transmitter. *a* is the carbonized disc or plate carried in the support, *c*, *c*, between washers, *e*, *e*, and held by the ring, *f*. The ball, *b*, is hung by the wire, *d*, in light contact with the plate, *a*. The electrical current passing through the wire, *d*, the ball, *b*, the plate, *a*, and the conducting

The second part of the invention relates to a form of receiver for receiving and rendering audible electrical vibrations. It consists of two or more discs of mica arranged parallel with, and in close proximity to, each other and suitably mounted by their edges so as to be free to vibrate. One side of each disc of mica is coated by electro-deposition with metal, preferably silver, and the discs are preferably perforated at their centre. The mica discs are arranged so that the metal side of one disc faces the mica side of the next disc, and so on throughout the series. The discs are connected alternately with each other, one set of the series to one conducting wire of the circuit, and the other set of discs to the other wire of the circuit. With these condenser plates so arranged advantage is taken of molecular strains of the mica forming the dielectric of the condenser arrangement of discs, and such molecular agitations produced by polarization of the mica discs in addition to the attractions to each other of the plates serve, it is said, to increase considerably the audible effects of the receiver.

In order that sounds transmitted or produced by the human voice or otherwise, through telephonic wires by means of the transmitting apparatus first described, or other means, may be recorded in such form that they may be at any time subsequently reproduced at any distance, the inventor uses a novel form of apparatus

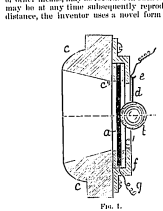


FIG. 1.

consisting of a flat transparent disc of glass or other material, which can readily be lifted up or removed from an axis by which it can be made to revolve in suitable bearings, preferably by means of clockwork or otherwise, by which sufficient uniformity of speed of revolution is obtained. One surface of this glass disc is coated with a film sufficiently sensitive to the action of light of the kind ordinarily known and used in photographic processes, and the disc so prepared is then adjusted upon its axis in a dark chamber. A very small aperture or lens is arranged, through which a beam of light from any convenient source can be directed, so that it falls upon the sensitive surface, and this aperture is made moveable in guides, so that the beam of light can be made to fall upon any point of the sensitive disc between its circumference and its centre, and the moveable aperture is connected to the axis of the disc in such manner that, as the latter revolves the former also travels simultaneously, and the beam of light thus traces a spiral line upon the sensitive surface. The width of the aperture through which the beam of light passes is made variable by means of an elastic or flexible or moveable shutter or diaphragm which is connected to the disc or diaphragm of an ordinary telephonic instrument in such manner that every vibration of the telephonic diaphragm varies to a corresponding degree the width of the aperture, or the electrical current passing through the wire, *d*, the ball, *b*, the plate, *a*, and the conducting wire, *g*, at the edge of the latter.

whilst the apparatus is in motion, a spiral line upon the sensitive surface will be affected by the beam of light falling upon it, and the width of the spiral line so affected will vary in exact proportion with the character and strength of each vibration. The message to be recorded for reproduction having been thus impressed photographically upon the sensitized disc the latter is removed and the impression is developed and fixed in the usual well known way. This disc may then be kept until it is desired to transmit or reproduce the message recorded upon it, and it is then replaced upon its bearings and made to revolve in the way already described, whilst a strong beam of light is made to fall upon and follow the variable spiral line upon its surface, and thence (after traversing the glass) upon a receiver of selenium or other substance having the property of varying in its conductivity of electricity in proportion to the degree of light to which it is exposed. This selenium receiver is arranged to form part of an electrical wire circuit, through which a constant current of electricity can be made to pass, and in any desired part of which one or more telephone receivers are situated; and in this way, as the beam of light falling upon the selenium receiver, varies in proportion to the opacity, thickness and width of the photographically deposited spiral line through which it passes, so will

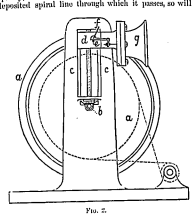


FIG. 2.

corresponding undulations be produced in the electrical current, which undulations will be reproduced in the telephone receivers as audible sounds.

Fig. 2 illustrates this arrangement. *a*, is a transparent glass disc, mounted in bearings at, *b*, and made to revolve at a uniform speed when desired. *c* is a guide in which moves the slide, *d*, having a small aperture at *e*, through which the beam of light is projected upon the plate, *a*. A screw, *f*, regulates the effective size of the aperture, *e*, and is itself regulated by the diaphragm of a telephone instrument at *g*, fixed by the diaphragm of which the sounds to be recorded are produced by the voice or by a transmitting instrument at any distance.

When the telephonic signals or messages have to be transmitted by means of submarine or other cables or wires in the immediate neighbourhood of other wires through which electrical telegraph or other currents are also passing, it is necessary to prevent, as far as possible, the effects of induction from such currents upon the telephone wire in order that the messages transmitted by the latter may be audible and intelligible; this action the inventor proposes to obviate by arranging in a convenient situation near the end of such submarine cable (assuming that a submarine cable is being used), an anti-inductive apparatus, consisting of a sufficient number of fine parallel insulated wires in the neighbourhood of the telegraphic or other wires in the neighbourhood of which upon the telephone wires, the inductive action of which upon the telephone

Patents for Telephones.

"Leetle, leetle boy, you may well ask which is which—there never was two such likenesses;" such was the facetious reply made by an itinerant showman of two life-size equestrian portraits, purporting to represent the Duke of Wellington and Napoleon Buonaparte. This incident of the showman has been forcibly recalled to my mind on viewing the drawings in several patent specifications at the Patent Office.

One of these drawings can be found in the specifications of patent No. 922, dated February 25th, 1882, granted to Arthur French St. George. This drawing, placed side by side with that in Morgan Brown's patent for Bell's telephone, suggests the inquiry "which is which, for there never was two such likenesses."

The description of this *invention*, so called, naturally leads one to attribute to the writer thereof an attempt to use the diplomat's prerogative, namely, that of using language to conceal his intentions. All men are not, however, successful diplomats, and the attempt here is so lame and impotent that, despite of the circuitous verbiage, the intention fails in its object. The disguise is too thin to conceal the Bell receiver under its film. The inventor—I use the word inventor, not to designate a person who has made a discovery, but as a person who has *found* something, the word being derived from the Latin word *invenere*, to find. The inventor writes: "My invention consists in the employment of iron or steel wire in such apparatus, and combining it with the circuit in such manner as to influence the latter by inductive action. . . . I arrange the iron or steel wire in connection with a resonant surface (a vibrating diaphragm of wood), so that any sound, such for instance as the human voice, when made to impinge upon the resonant surface, causes the latter to vibrate in such a manner in rotation to or in combination with the iron or steel inducting wire as to cause corresponding electric currents or variations in the circuit." This description of the "*invention* (?) and the manner in which it is to be performed" are certainly defective, especially about the "variations in the circuit." Failing to draw from this description what is the invention claimed, I turn to the drawings, and what do I find there? simply a resonant plate, made capable of inductive action, held down all round its edges in front of, close to, and not touching the pole of a magnet, upon the end of which, is a bobbin wound with covered wire, the said wire forming part of the line circuit. The specification, or rather one of the claims, is for such an instrument to be used as a transmitter or receiver.

I submit that a correct and true description of this instrument is a correct and true description of Bell's receiver, as concisely set forth in the sixth claim of Morgan-Brown's patent, which is in these words:—

"The combination with an electro-magnet of a plate of iron or steel, or other material capable of inductive action, which can be thrown into vibration by the movement of surrounding air, or by the attraction of a magnet."

I will now ask "was there ever two such likenesses?"

Another patent, No. 6,020, dated 16th December, 1882, granted to George Lee Anders and John Benjamin Henck, when placed side by side with Edison's patent, No. 2,909, dated July 30th, 1877, suggests the inquiry "which is which, for there never was two such likenesses?"

Edison's solitary claim remaining out of his 30 original claims is in these words:—"In an instrument for transmitting electric impulses by sound, the combination with a diaphragm or tympan of electric tension regulates substantially, as herein-before described, for varying the resistance in a closed circuit, substantially as set forth."

The writers of the specification of this *new* (?) invention describes a modification of their invention (?) in the following words:—"This instrument consists of a metallic diaphragm, fixed in a horizontal position, and carrying at its centre a button of hard carbon or other suitable conducting material. Upon this button rests another similar one, mounted as in the Reis transmitter, so as to follow the vibrations of the diaphragm. Thus far this description describes Edison's transmitter, which Mr. Justice Fry decided to be the combination of a diaphragm or tympan with a tension regulator. In addition, however, to the button of carbon, "thin strips of metal are placed over the diaphragm, but not touching it, and a quantity of granulated coke is placed upon the diaphragm so as to come in contact with the metal strips." Can any one think that this addition, or rather increase of contact points of the tension regulator, places the instrument outside of Edison's claim?

The inventors (?) of this instrument have shown great ingenuity indeed, for they have made an instrument, not only like unto one other, but like unto three others.

Does not Hunning's patent claim "the use of finely-powdered carbon or like conductor in a loose and free state, as a means of varying the resistance in a telephonic circuit by the vibrations of a thin metallic or metal-covered diaphragm?"

Another striking likeness to this instrument is presented in Husbands' patent, No. 3008. June 24, 1882. The drawings No. 1 of this patent are identical in construction with the drawing No. 1 of this instrument, with the exception that, in addition to the granulated coke, there are carbon button contacts. Fig. 4 of this invention, showing a divided diaphragm, is marvellously like unto figs. 15 and 16 of Husbands' patent, and fig. 19 of Husbands' patent shows "the combination with the divided disc, of the carbon pieces, the carbon ball, or rod, and the granulated or powdered carbon, as described in claim No. 2.

I dismiss this invention (?) with the words "*par nobile inventorum rem invenerit passim*," specifying, however, that I use the word *invenerit* in its true sense—that is "found."

"The cry is still they come."

Patent No. 676, dated Feb. 7, 1883, granted to H. H. Eldred, is worthy of notice, because of the childlike simplicity of the getter up of the specification, which betrays a total unconsciousness of the existence of Bell's invention, which is the more surprising as the getter up was a defendant in the action for infringement, tried before Mr. Justice Fry, in Jan. 1882, and also on appeal before the late eminent jurist, Sir George Jessel. The claim of Bell and the description of Bell's instrument, by both judges, are too well known to need reciting here. I will merely cite the claims set forth in the specification of Eldred's patent. 1st claim. In an electro-magnetic or magnetic telephone the combination of a membraneous diaphragm carrying a piece of metal capable of inductive or magnetic action, and a disc of thin mica, brass or other material incapable of inductive or magnetic action, or a waterproof equivalent therefor.

3rd claim. "In an electro-magnetic or magnetic telephone the employment of a diaphragm made of mica, brass, or some stiff material not requiring to be strained upon a ring and incapable of inductive action, having at its centre a thin disc or piece of iron or other metal capable of inductive action.

This inventor (?), also says he may use two discs of paper, having a piece of tin-plate or iron placed between them; or the surface of the paper or membraneous diaphragm may be coated with a solution of india-rubber, shellac, or other water-proof varnish, the disc in all cases to be gripped between two rings. Sometimes also he dispenses with the paper, and uses a disc of brass, mica, or equivalent, with a thin piece of iron in the centre.

For these wonderful improvements I cannot give to the inventor (?) any meed of ingenuity, the attempt to disguise a Bell telephone by adding to it something, which not improves but impairs its efficiency, is too glaring.

I will simply remark that a diaphragm of any material which is stiff, or which is rendered stiff by any process, having attached to it any material capable of inductive or magnetic action, placed in front of the pole of a magnet, comes clearly within Bell's patent.

W. C. Barney.

September 3, 1883.

[We would, in reference to the above letter, point out that it must not be forgotten that a modification of a previous patent may be of considerable value. Although the modifier cannot use his patent without an arrangement with the first patentee, this latter cannot use the improved modification without the consent of the inventor thereof.—Eds. Elec. Rev.]

Engineering, Oct. 1882.

The Telephone.

The transmission of music from the Grand Opera at Paris to the Palais de l'Industrie during the International Electrical Exhibition at Paris last year, was a remarkable success, which has never been equalled in any other place. In this case, however, the music could only be heard by keeping the ear close to a pair of telephones. At the Munich Electrical Exhibition now open, steps are being taken to enable a hall full of people to hear the music of a distant band without applying the instruments to their ears at all. An arrangement similar to the Exhibition one of last year has been fitted up at the Electric Exhibition in St. Petersburg with Blake transmitters and Bell receivers. The music of the opera-house is thus transmitted to a saloon in the Exhibition, where twenty persons can hear it. In Paris, too, the music of a band playing at the Hippodrome was recently transmitted to the offices of the International Telephone Company in the Place Vendôme, where forty-eight people were assembled to listen. There were four Ader receivers to each microphone transmitter, and only twenty line wires in all. Some interesting experiments have just been made at the North-East Coast Exhibition, Tynemouth, in the use of the telephone by divers, by Mr. Wake, engineer of the River Wear Commissioners, and Mr. Irish, manager of the Northern District Telephone Company. The length of cable connecting the receiver in the diver's helmet to the transmitter above water was 600 yards, and it was found that the diver could converse with ease, and ask for tools while in any of the usual postures required of him. The efficiency of the microphone as a transmitter was curiously tested recently on an American telephone line running from Gallipolis to Pomeroy through a dense forest in Ohio. One early morning the sound of birds whistling and frogs croaking was distinctly heard on the line, and the explanation is that a loose joint in the wire acted as a microphone at some point of the line where it crossed a stream or pool. The crackle of auroral displays has also been heard recently in the telephone by connecting one terminal of the instrument to the water pipe of a cistern, and the other to a gas-pipe. While upon this subject, we may mention that the new telephone company—the London Globe and Maintenance—which was established during the summer, has been refused a license by the Postmaster-General, for reasons which do not at present appear. To say the least of it this action of Mr. Fawcett and his advisers is a little mysterious, after his announcement in the House last July that an open field of competition would henceforth exist for the telephone, and that licenses would be granted to new companies.

Long Distance Telephoning.

A new company, termed the Long Distance Telephone Company, has issued its prospectus. The company is formed to introduce the American system of telephoning long distances, which we recently mentioned in connexion with a trial made between Chicago and New York over a thousand miles of line. The apparatus used is to be the telephone transmitter and receiver of Mr. George M. Hopkins, who it will be remembered was the first to suggest the use of the induction balance of Professor Hughes as an instrument for localising the bullet in the late President Garfield. Mr. Hopkins's proposal was shelved in favour of Professor Bell's suggestion which came later. The transmitter of Mr. Hopkins consists of a pencil of carbon floating on mercury, and buoyed up against a metal contact on a vibrating plate, without the use of adjusting springs. On speaking to the plate the carbon acts as a microphone. Judging from the way in which the United Telephone Company have disputed any claim to the use of carbon in transmitters, we shall be surprised if they allow this transmitter to pass without question. The receiver of Mr. Hopkins is a modification of Bell's gold-beater's skin receiver, a non-metallic diaphragm of Bristol board soaked in paraffine, having a polarised armature attached to its centre, and attracted by the pole of an electro-magnet in circuit with the line. The patents of Mr. Hopkins, Nos. 687, 688, 689, of 1882, describe these instruments in full, and also a system of *switches* for telephonic work. Illustrated abstracts of these patents appeared on pages 273 and 296 of the last volume of Engineering.

olums. The blackleaf gave a more constant resistance, ranging between 400 and 100 ohms.

Mr. Varley concluded from this that the effect of highly heating charcoal and blackleaf appears to be to make the particles more dense and to bring them closer together, so that they conduct.

It seems highly probable that had Mr. Varley been engaged as a scientific witness in the late trials, some very interesting information concerning the behaviour of carbon in different forms under various conditions might have been elicited, as it is hardly probable that his experiments did not lead him to think of it in connection with matters other than that of his lightning bridge.

A great deal has been said about Clerac's tube of carbon for obtaining variable resistance, and we believe that it was in use before Mr. Varley's invention; still, we think that in justice to the researches of the latter, we should not allow the matter to be unheralded because at the time it formed the subject of no particular praise or called for much remark in scientific journals.

THE TELEPHONE INDUSTRY.

MR. FAWCETT, speaking in the House of Commons last Saturday, said :—"It was desirable also that he should remove all doubt as to the relations of the Government to the telephone companies, as there had been a great deal of speculation on the chance that the Government would purchase them. It was said the truth should be known, for he believed that it was altogether improbable that the Government would do so. Their policy was to encourage free competition. If the thing could be done best by private companies he could only say he should be delighted to see the whole telephonic business of the country conducted by private enterprise. If, on the other hand, it was proved that the business was better done by the Government, the Government would have beaten the companies in the open field of competition, and could sweep the ground without being subject to claims for compensation."

We are pleased at the attitude taken by the Postmaster-General in this most important matter, and if the private companies can only have fair play, we may shortly hope to see an immense development of such a necessary adjunct to our business relations as the telephone. There are, however, several obstacles to be overcome, the chief one being the monopoly at present possessed by the United Telephone Company—at least in their own ideas. Even here the stumbling-block appears to be not so much in the receiving instrument as in the transmitter. A great difference of opinion still exists as to the amount of ground covered by Mr. Edison's single claim, and yet another battle must be fought over this subject. As far as we understand this Edison patent for a transmitter or tension regulator, it is limited in its character; but we believe that the United Telephone Company think it covers any semi-conductor placed in between any two points of a circuit, no matter how connected, or how constructed, as long as the impulses of the voice are directly employed to change the positions of the atoms composing the semi-conductor, and thus to vary the resistance of the circuit. This unsatisfactory state of affairs will, however, it is to be hoped, shortly be placed on a proper footing; for until such is the case, it is almost hopeless to suppose that the telephonic industry can make any great advance, even on the strength of the licences recently granted by the Postal authorities.

The telephone is no longer a novelty, yet we think our readers will be somewhat surprised at the table we now place before them.

We extract from the New York *Review of the Telegraph and Telephone* of July 15th, the following statistics of the progress made in seven countries of Europe. Number of telephonic subscribers in actual operation in Europe :—

IN FRANCE.

Name of Town.	Name of Corporation or Co.	No. of subs.
Paris	Société Générale des Téléphones	1,700
Bordeaux	" "	117
Lille	" "	114
Lyons	" "	70
Lyons	" "	2700
Marseilles	" "	200
Nantes	" "	78

IN ENGLAND.

London	United Telephone Company	1,561
Manchester	Lancashire & Cheshire Telephone Co.	650
Liverpool	" " "	510
Barrow	" " "	19
Preston	" " "	17
Blackburn	" " "	52
Burnley	" " "	31
Wigan	" " "	18
Accrington	" " "	21
Warrington	" " "	12

IN AUSTRIA.

Vienna		331

IN SWITZERLAND.

Zurich	Zurcher-Telephon-Gesellschaft	378
Basle	Gouvernement Fédéral	250
Berne	" "	137

IN BELGIUM.

Brussels	Company Belge du Téléphone Bell	887
Antwerp	" " "	623
Liège	" " "	279
Verviers	" " "	189
Charleroi	" " "	204
Ghent	" " "	194

IN ITALY.

Turin	Società Generale Italienne des Téléphones	319
Genoa	" " "	348
Sampierdarena	" " "	20
Milan	" " "	214
Venice	" " "	68
Florence	" " "	56
Livorno	" " "	54
Bologna	" " "	83
Rome	" " "	209
Naples	" " "	182
Palermo	" " "	30
Messina	" " "	17
Catania	" " "	10

IN GERMANY.

Operated entirely by the Government.*

Berlin	"	"	"	561
Breslau	"	"	"	63
Cologne	"	"	"	81
Elberfeld	"	"	"	17
Frankfort	"	"	"	170
Hamburg	"	"	"	666
Leipzig	"	"	"	142
Mayence	"	"	"	48
Manheim	"	"	"	142
Potsdam	"	"	"	100
Stettin	"	"	"	Don't know
Strassburg	"	"	"	"

As the above statistics stand it would appear that private companies, and not the government, should have the telephonic business; but as yet so little has been done in Europe that the data we have at command is scarcely sufficient to allow of the deduction of any decided opinions.

We will now leave our readers to compare the respective telephonic industries of these countries, and we shall look forward to the time when we are able to state that England holds the leading position in this branch of electrical work, which she does at the present moment in regard to the telegraph.

* Price of each subscription license in every town, viz.: 200 marks (50 dollars), up to 2 kilometres and 50 marks (10 dollars) for each additional kilometre from the Central Bureau. To have a second additional instrument in the same house and on the second line, the price is an extra 50 marks (10 dols.).

An income of 403,853,471 dols. during the year ending with June, 1882, was more than the government has received during any previous year since 1857, and the cost of the government, including pensions, was but 182,630,603 dols., leaving a surplus of 141,001,307 dols. after the payment of 78,268,159 dols. interest on the national debt. Unfortunately, the pension payment will be very heavy this year; but the interest on the debt will be 13,896,220 dols. less than it was last year. The customs receipts, the greatest last year in all the history of the nation, 219,091,223 dols., would be sufficient to maintain the government and nearly reduce the national debt, were the internal revenue and income from miscellaneous sources wholly to cease.

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Engineering, Oct. 26, 1883.

THE LARVE TELEPHONE

In the course of our articles on the Paris Electrical Exhibition of 1881, we referred to an ingenious and very efficient telephone transmitter, shown under the name of the Pantelephone, by the inventor, M. de Locht Labye, Ingenieur des Mines, of Liège. The remarkable feature of this transmitter was its extreme sensitiveness, by which receiver and transmitter could, at the distances usually employed, be used without speaking with the lips to the instrument, as thirty yards from it, and it was thoroughly efficient, at a distance of four yards, in transmitting whispered sentences. The instrument consisted of a single rectangular plate of cork, long freely from two thin brass or steel strips. To the bottom of the sheet of cork was fixed a button of hard carbon, held in light contact by a slight inclination of the plate, with a piece of platinum. This constituted the whole of the transmitter, which has now been supplemented by the an ingenious and efficient receiver which we illustrate on the opposite page. Considerable interest attaches to this latter instrument. Its articulation is at least as clear as that of the Bell telephone, whilst its action differs considerably, and the diaphragm common to other telephones is replaced by a thick, and mechanically rigid aluminium plate. According to M. de Locht Labye the action of this telephone cannot be explained by Bell's theory of undulatory currents. Mr. Bell claims as a point of vital importance, that in order that speech may be transmitted and reproduced, a flexible plate should be employed, and this must be put into undulatory movement corresponding to that of the air waves, in order that such undulations may reproduce the air waves, and that to effect this, it is necessary that the receiving line between the transmitter and receiver should undulate exactly in accordance with the movements of the transmitter, by which produces the vibrations of the diaphragm. On the other hand M. Labye maintains that in his telephone, articulate sounds are reproduced by a series of rapidly succeeding, but absolutely intermittent blows struck on the aluminium plate, the amplitude and rapidity of these blows depending of course on the impulse transmitted through the line, and being rendered audible by an exact reproduction of continuous sounds, the ear not being sufficiently sensitive to mark the intermissions,

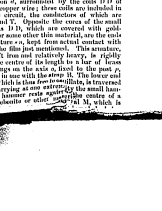

Fig. 2

supposing them to exist. Without dwelling on this theory, we may describe the telephone, which is illustrated by a front view and section, Figs. 1 and 2, and by a perspective view, Fig. 3. To a wooden plate A is secured by brass brackets B, B, a powerful horseshoe magnet N C S. To each pole is attached a small core of soft iron *c*, surrounded by the coils D D of silk insulated copper wire; these coils are included in the telephonic circuit, the conductors of which are shown at L and Y. Opposite the cores of the small electro-magnets D D, which are covered with goldbeater's skin, or some other thin material, are the ends of a brass screw *e e*, kept from actual contact with the cores by the thin pad mentioned. This armature, which is also of soft iron and relatively heavy, is rigidly attached to the centre of its length to a strip of brass *f*, which springs on the top of the pillar P, and is secured by the screw *g*. The lower end of this brass, which is less free to oscillate, is traversed by a screw, carrying at one extremity the small hammer H. This hammer rests against the centre of a thick disc of ebonite or other [illegible]ial M, which is screwed rigidly to a contractor *r*, the whole being secured to the baseplate A, by means of the metal posts B B. By means of the screw V at the end of the hammer, the space between the poles of the magnet and the armature, necessary to give the clearest articulation, can be very accurately adjusted.

Like the Bell telephone the instrument we have described can be used either as a transmitter or a receiver. The form, thickness, and practically the material of the aluminium plate M, are indifferent, although in the circular shape illustrated, is probably the most convenient. The hammer H, striking on the armature gives shortly articulate vibrations, and paper or leather lubbet to as great a thickness as the range of armature lever will allow, may be interposed between the aluminium plate and the hammer, without checking the clearness of the transmitted speech. The two parts—the abutment and the armature—may be made in one piece, and the more rigidly this organ is fixed, the more efficient the telephonic duty appears to be. If, on the other hand, a thin flexible sheet is substituted for the abutment plate—such as the ordinary Bell diaphragm, discs of mica, aluminium, &c., the sounds are very considerably reduced, and if the armature lever be connected to the abutment plate, all audible transmission ceases.

The following table describes the action of the instrument when used as a receiver: "The telephonic currents circulating in the helices cause the armatures to be alternately attracted and repelled. By reason of the reaction of the rigid electrolyte against which the armature lever rests, the repulsion alone is effective in the case of the latter, whilst the attraction of the former is meeting away from the [illegible] momentary rigidity of the electrolyte. The end of the lever from the hammer rises, and the latter falls. This repulsion is succeeded by the attraction of the armature crossed by the following current, and the armature is then pulled back to its original position, and tends to pass beyond this position by reason of the attraction and its own vis viva or momentum, but is stopped in this direction by the rigid piece or obstacle against which the hammer strikes. The intensity of the blow or shock consequently results from the combined effect of these two actions, and is in direct ratio to the electro-magnetic forces which produce the repulsion and attraction of the armature. The number of shocks is equal to the number of electrical charges produced in the telephonic circuit.

MUNRO'S TELEPHONIC EXPERIMENTS.

MR. J. MUNRO, whose name is well known not only as a very clear writer upon electrical subjects, but as an original investigator, has recently, with the assistance of Mr. Benjamin Warwick, been conducting a most interesting experimental investigation of the action of the microphone as a telephonic transmitter with the result of proving that much may advantageously be employed in the place of carbon in a transmitting instrument, a practical development of one of the very earliest of Professor Hughes's microphones, and which we described and figured when we announced for the first time his most important discovery.* The fact that metallic electrodes can practically be employed in microphonic transmitters has been denied of late with no such assurance and in such high quarters, that Mr. Munro's successful application of that portion of Professor Hughes's discovery, possess an especial interest, and must to a considerable extent affect the aspect of litigation in future contests in which the discovery of the microphone and the invention of the carbon transmitter are vital points at issue.

In investigating the properties of metallic contactors employed in the construction of microphones, Mr. Munro's first experiments were made with wires. These, in some cases, were caused by the action of a diaphragm, to rub the one on the other in such a manner as to make the point of contact vary louder the influence of the vibrations of the diaphragm; on one side or other of a position of normal potential, so that by the movement of a wire attached to a vibrating tympan along a fixed wire conveying a current from a battery, and thereby shunting the current at various positions along the length of the fixed wire, the strength of the current in the derived circuit, in which was included a suitable receiver, was varied accordingly. In other experiments mercury was employed, either as a sliding-drop, enclosing the fixed wire, or as an oscillating column; but these experiments, though instructive and interesting, did not for various reasons give encouraging results with a view to the practical application of the principle.

They, however, led Mr. Munro to proceed with compound wire structures, such as gratings resting upon or resting against one another, and a more practical form. In this instrument the very smooth, and led Mr. Munro to the consideration of different diameters, the larger disc D which characteristics and efficient of his practical apparatus, than the smaller disc D.

This instrument consists essentially of two pieces of iron wire gauze, the one fixed in a vertical plane, plumbline, but in reality they rest the one against and the other resting more or less lightly against it, the other; the smaller and movable disc D is held up against D with greater or less pressure by the spiral spring S, the tension of which can be adjusted by a screw or other suitable device at N. This form of the apparatus is more suitable for wall-some in a wall box with or without a mouthpiece, but it does not require the employment of any kind of diaphragm or tympan. Mr. Munro can employ with all his instruments an induction coil for installations where the resistance of the line wire makes it desirable to do so; the microphone and battery being included in the primary circuit and the telephone in the secondary.

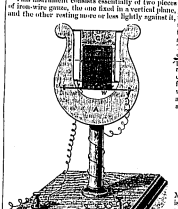

FIG. 1.

Fig. 3 is an ingenious arrangement devised by Mr. Munro, in which the adjusting spring or weight is substituted by a magnet which may be either a permanent or an electro-magnet. The figure shows an arrangement in which the fixed gauze g^1 is perforated as in the apparatus illustrated in FIG. 2, and the movable electrode e is bent or dished so as to press upon g^1 around its edge. E is a soft iron which by the electro-motive influence of a magnet

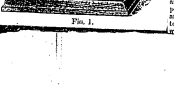

FIG. 3.

the pressure between them being regulated by an adjustable spring or weight. These gauze plates are so connected in a telephonic circuit as to constitute the electrodes of a microphone, for touching one another lightly in several points, they allow the current to be transmitted between them in inverse proportion to the resistance offered to it by its

* See ENGINEERING, vol. xxv., page 369.

passage from one to the other. Under the influence of sonorous vibrations the one plate dances more or less on the other, thus varying the resistance; and very perfect articulation is produced in a telephonic receiver included in the circuit. The gauze transmitter so constructed may be fixed within a wall-box with or without a mouthpiece, but as the sound waves acting directly upon the gauze plates, set them into agitation through their sympathetic vibration or by direct impact, no sort of diaphragm or equivalent device is necessary, and none is employed.

A convenient form of this apparatus is shown in Fig. 4, and to which the name of "The Lyra of Telephone" has been given from its resemblance to that impossible musical instrument. In this apparatus G^1 is a plate of iron wire gauze stretched vertically between two horizontal wires attached to a five-sided framework of mahogany; against the plate rests the smaller plate G^2, the normal pressure between them being regulated by an adjustable spring acting in opposition to a weighted lever W. The two plates are connected respectively with the attachment across X and Y, by which the instrument is placed in circuit with a battery and telephonic circuit.

A modification of this apparatus is shown in the diagram sketch, Fig. 2, which will probably be

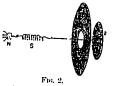

FIG. 2.

up against g^1 with a pressure dependent upon its magnetic intensity and upon its distance from the gauze. By making E an electro-magnet, and including its coil in the telephonic circuit, an instrument may be constructed in which the normal pressure between the electrodes can be automatically adjusted to the strength of the current, and in cases where an induction coil is employed the magnet E may be the core of such a coil.

Fig. 4 illustrates an apparatus devised by Mr. Munro, and to which the name thermo-microphone might be given; as it is a microphone in which thermo-electric currents are employed in the place of voltaic currents, its special feature of interest lying in the fact that the heated junction of the thermo-electric couple is identical with the microphonic contacts of the two electrodes. In this very elegant experiment a piece of iron wire gauze G is supported in a horizontal position by a light metallic support R. To another support A is loosely hinged a fauze, which at its further extremity carries a little coil of German silver wire C, which by its weight rests upon the centre of the gauze plate G^1; and in contact therewith, and to increase the pressure of contact, a little bar weight is laid with the convolutions of the coil. The two electrodes, the gauze and the coil, are connected, as shown, to a receiving telephone T. Upon the application of heat, as from the flame of a spirit

FIG. 4.

lamp placed below, a thermo-electric current is set up throughout the circuit; in this condition the apparatus becomes a very perfect microphone, and when the pressure between the electrodes is properly adjusted it is a very efficient telephonic transmitter, transmitting articulate speech and musical sounds with remarkable clearness and fidelity.

Mr. Munro is, with the aid of Mr. Warwick's manipulative skill, extending this portion of his investigation further by experimenting with gauzes and coils of various metals forming other couples in the thermo-electric series, as well as with iron and other gauze-electrodes tipped with bismuth and other metals, and we hope in due time to lay the results of these experiments before our readers.

Mr. Munro has, moreover, observed that if two pieces of gauze of identical material and in microphonic contact be heated, a peculiar sighing sound is heard in a telephone connected with them and with a battery, and he attributes this phenomenon to the electrical discharge between the gauze plates being facilitated and increased by the action of heat, but we are rather inclined to trace the effect to the mechanical action of the one gauze moving over the other under the influence of expansion and contraction of the metals by the variable temperature of the flame and convection currents of heated air, such movement producing the sounds just as would be produced if one of the electrodes of an ordinary microphone were as delicately moved by the hand or other agent.

Figs. 5 and 6 illustrate another and distinct form

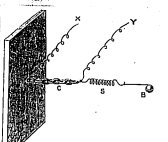

FIG. 5.

of metallic microphone transmitter designed by Mr. Munro and Mr. Warwick, in which a small chain, preferably of iron, forms the microphonic portion of the apparatus. In Fig. 5, A is a plate of sonorous wood forming a diaphragm or collector of the sonorous waves; to the back of this is attached a short length of chain C, the opposite ends of which are by the wires X and Y included in the telephonic circuit. The points of junction of the links with one another constitute the variable microphonic contacts, and the normal pressure between them is adjusted by the spiral spring S, the tension of which may be varied by the cord and winding pin P. Fig. 6 is the section of a transmitter con-

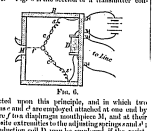

FIG. 6.

structed upon this principle, and in which two chains or of arc employed attached at one end by a wire f to a diaphragm mouthpiece M, and at their opposite extremities to the adjusting springs and s^1; an induction coil D may be employed if the resistance of the line render it advantageous.

Fig. 7 is a form of pencil microphone experi-

FIG. 7.

mented with by Mr. Munro, which differs from some of the Hughes's transmitters adopted by Cromby, Gower, Ader, and many others, only in the material of which it is composed. Mr. Munro's being of coal iron, while the others to which we have referred are of carbon rods such as are used in electric lighting. In Fig. 7 a light coal-iron bar m of the form shown, is supported in holes drilled in two blocks of coal iron r r, and the pressure between the bar and the blocks can be adjusted by a regulating spring s. In connection with the apparatus Mr. Munro has observed that rest has an appreciable effect upon the efficiency of the instrument unless it be to such an extent as to cause the two to adhere, or to be "mutual up" together.

Fig. 8.

Fig. 9.

We now come to another class of metallic transmitters with which Mr. Munro and his associate have been making experiments and to which he has given the name "Grain transmitter," since it consists of a box having metallic sides *e e* to which terminal screws *f f* are attached and filled in between with iron or brass filings, granules of spongy iron, or indeed small metallic particles in any form; one of the most efficient transmitters being a box such as is shown in Fig. 8, filled with a quantity of $\frac{1}{4}$ in. screws. Our readers will probably in connection with this apparatus be reminded of some of the very earliest experiments of Professor Hughes with very similar apparatus,* but in some instances Mr. Munro has immersed the apparatus in liquids such as oil and alcohol with the result of destroying the irregular buzzing sounds without injuring the articulation.

The results of Mr. Munro's experiments have led him to the opinion that the action of the microphone must be attributed to the action of sonorous vibrations upon the air or gaseous medium separating the so-called contact-points of the electrodes, and that across these spaces, or films of gaseous matter, silent electrical discharges take place, the strengths of which being determined by the thickness of the gaseous strata through which they pass, vary with the motion of the electrodes; and so, according to this hypothesis, the distances of

* See ENGINEERING, vol. xxi., 1876.

the electrodes from one another is determined by the sound-waves, the sound in that way controls the current.

We cannot agree with Mr. Munro in this view of the cause of the phenomena, although it would be difficult to disprove. The surface-contact theory which we hold has so firm a foundation of Professor Hughes's discovery is not, in our opinion, shaken by Mr. Munro's very interesting experiments, and, in fact, we think they are more easily explained upon that hypothesis than on his own. There can be little doubt, however, that the action of the microphone is not to be attributed to any one phenomenon to the exclusion of others, but is rather a compound action in which a number of phenomena are going on together, opposing and superposed each upon the others, and perhaps all or nearly all the theories explain some of the causes which enter into and take their share in producing that result which we call by the collective name of the "action" of the microphone. Whether or no Mr. Munro may in further experiments be enabled to prove his theory to be more consistent with observed facts than are other hypotheses, he deserves great credit for his interesting experiments, derived from the microscopic movements of the disc, and for having produced in his gauze transmitter an instrument which is simple to make, readily adjustable, and independent of previous inventions.

TELEPHONES.

The second of the series of six lectures on the application of electricity was delivered at the Institution of Civil Engineers on Thursday evening, the 4th of March, by Sir Frederick Bramwell, F.R.S., V.P. Inst. C.E., the subject being "Telephones." The following is an abstract of the lecture:—

Prior to the invention of the telephone, by making and breaking circuit at the transmitting station sounds had been produced at the receiving station—such as the ticking of a watch, or the vibration of a Morse sounder—but these were independent of sound at the transmitting station, and they could only be made to be intelligible sound at the receiving station, and only by the application of powers of audible telegraphy. Articulate speech was the object of the telephone, it was possible to reproduce at the receiving station, say by a tuning-fork, the vibrations of which break and make contact, the same note produced by a similar tuning-fork at the transmitting station; and if the note-there was a reproduction at the receiving station of the sound at the transmitting station. But the only thing that would be given forth by the note—the note-there was no reproduction of articulate speech. For example, the note might have been produced by a tuning-fork, or by a clarionet at the transmitting station; at the receiving station, however, nothing would be given forth but the note of the tuning-fork, or other vibrating implement, which was the same in every case. All the vibrations transmitted in a given time, whether the modes were due to the variations of the current caused by the human voice in the circuit, and were therefore articulate, or the sound obtained with such an agency was in the medium of breathe, in 1867, reproduced notes, and it would cause words were heard. That machine received no development, the invention of Professor Graham Bell, educated in this country in Germany, and now a citizen of the United States. Professor Bell, F.R.S., Past-President Inst. C.E., turned his attention to the recording of the vibrations of articulate speech. He effected this by means of an instrument called a logograph. This was communicated to the Royal Society, and exhibited in operation there. By its agency what was depicted on a travelling band of paper the mode of vibration of a membrane of any sonorous body under the influence of speech; and he found the results been known, they would probably have enabled the inventor seeking to produce a telephone, as it appeared the vibrations were not always the same for the same syllable, even when spoken with the speaker and from the circumstance. Professor Graham Bell graphically represented the variations in the vibrations of currents, either direct or reversed, caused by loud and weak tones, and showed that these were too abrupt for his purpose of producing by their agency articulate speech. He proposed to attain the object sought by having the circuit always closed, and by causing undulations, or waves, on the one might be, of electricity, which should be made gradually, instead of abruptly, to vary. The telephone made in which he obtained this end is one of the original forms of the Bell transmitter or receiver, and which we have examples of fulfilling the requisite by placing on iron or a steel plate in the neighbourhood of a permanent magnet, surrounded by a coil of insulated wire, so that on the plate being set into vibration by the voice it should induce, in the coil, undulations of electricity which exactly corresponded in character to the vibrations and the plate which had put the first disc into motion, and, in that way, reproduced in the original sound. Professor Bell said a few words that was obtained. Other modes were employed by him, such as the use of a battery in the line wire, and local of all, the use of two local batteries to send the current in a contrary direction round a core, the line wire being connected with each coil, coils acting by induced electricity. As transmitters the whole of the electricity in the current that broke, since the whole of the electricity in the former the three cases mentioned, and what might be called the operative electricity in the other two cases, had to be received from the microscopic movements of the disc, and for having produced in his gauze transmitter under the influence of the sonorous vibrations produced by the voice.

Edison then devised a transmitter, wherein the disc need not be metallic, but might be made of parchment. These were caused to operate on a coil in a local circuit, which carbon was introduced in the circuit of a battery. It was then found that the most unappreciable variation in pressure due to the vibration of the disc was sufficient, for some not very well understood reason, to alter the conducting power of the carbon, and to cause varying currents to be transmitted along the line-wire to the bell receiver at the opposite end. At the present day the transmitter most generally employed in this country appears to be the modified transmitter of Edison, or some modification thereof.

Professor Hughes' microphone was next alluded to, and it was stated how, by its means, the most minute sounds were rendered audible, and how, from the delicacy of the instrument, it was applicable to many scientific purposes. The microphone was, in fact, a modification of the telephone. Prior to Edison's disc it had been known that the friction of certain surfaces varied with the electric current passing through them, notably under such circumstances, the friction of the human tissue. Among other appropriate substances prepared chalk was one, and it was shown how Edison availed himself of this. By attaching a stem to the centre of the disc, and pressing this stem by means of an adjustable pressure upon the periphery of a chalk cylinder, a rotary motion was given to the disc and also to the cylinder through the stem. Upon the cylinder being turned by hand the friction on the stem caused it to move the centre of the disc—its edge being fixed—in a definite position depending on the friction, and on the rigidity of the disc; but, on a variation in the current, the change produced thereby in the friction caused the stem either to advance or recede, and thus the rigidity of the disc was altered, and in effect it to be bent more or less. It is this same vibrations were set up in the disc, corresponding with the vibrations of the transmitter that had sent the varying electrical currents. As in the case of this receiver the power was derived, not from the electricity, but from the hand of the operator turning the chalk cylinder, very considerable loudness was obtained, so that the utterances of the receiver were audible to a large audience.

In 1878, Edison had well having been good enough to lend a microphone, that beautiful invention of Professor Graham Bell was explained. Mr. Blyth showed how, by speaking to a disc, the first being a mirror on which a powerful light was directed, that light could be reflected on to a selenium cell, and as the disc vibrated under the influence of the voice the light played on the selenium cell with varied. Selenium was a metal the resistance of which varied according to the amount of light upon it. It was therefore possible, in this manner to cause a Bell receiver to speak, and reproduce the speech which had been addressed to the mirror disc. It was pointed out that, in this manner, there was no need of a wire connection between the transmitter and the receiver, the passage of a beam of light being all that was required.

Reference was then made to the various purposes to which the telephone might be put, and to the subsidiary apparatus necessary for rendering the telephone of practical use, such as switches for connecting subscribers to the exchange. Amongst special uses, a very interesting one was shown—that of the application of telephony to the diver's helmet. Thanks to the kindness of the Astley Life Saving Co., Mr. Blyth was able to exhibit a helmet with the apparatus in question was Gorman, a helmet with the apparatus in question was Gorman, a helmet with the apparatus in question was Gorman,

INDUCTION IN TELEPHONE CIRCUITS.

THE following is the full text, with the accompanying drawings, of Mr. Edison's specification, filed on March 14th, 1879, and referred to in our article on "Induction on Telegraph Lines" on pages 230 of the present number:

Improvement in Acoustic or Telephonic Telegraphs.—Thomas A. Edison, Menlo Park, N.J., Assignor, to the Western Union Telegraph Company, New York. N.Y. Also, Filed February 27, 1879.

"*To all whom it may Concern.*—Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented an improvement in acoustic or acoustic telegraphs (Case No. 105), of which the following is a specification:

"In telegraphic lines there are very often numerous wires running in the same direction upon the poles, and it has long been known that induction between one wire of one set and wires of another set, and also between the other wires. These ordinarily are harmless in the ordinary systems of telegraphy; but when a wire for a telephone, acoustic or speaking telegraph, runs parallel to or near other wires of the electric influence of another wire, there are faint and confusing sounds at the receiving instrument that greatly interfere with hearing the message sent upon such acoustic lines.

"The object of the present invention is to compensate, neutralize, and destroy the extraneous or induced currents from contiguous circuits, so that the messages will not be in any manner interfered with by false currents.

"The invention is primarily adapted to telephonic circuits, as the induction upon such circuit is the most injurious, but it may be used with advantage where it is desirable to neutralize such extraneous currents.

"The present invention consists in the combination, with the telephonic circuit or other circuit to be freed from external influence, of an induction coil connected with the contiguous circuits in such a manner that a reactionary induction is established in the telephonic line of a power corresponding and similar to the primary inductive action, but opposed to the same, so as to entirely oppose and neutralize the action of the same.

"In the drawing," Fig. 1 is a diagram representing one

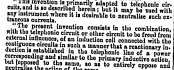

Fig. 1.

of the forms in which the aforesaid compensation is effected. The large coils C C are included in the telephone circuit at each end of the line. In the coils are iron cores surrounded by a primary coil, the coils of which may or may not be of the same number, according to the compensation desired.

Each iron core extends outside of the coils some distance. I have shown the cores passing for two circuits only. These circuits, which I call No. 1 and No. 2, running in close proximity to the telephonic line, may be many miles, as from a commercial center in it every time the circuits are

* For the sake of clearness of detail we have in Figs. 2, 3, and 4 represented on a larger scale from the modification showing the compensating apparatus at one station only of the line; the corresponding apparatus at the other station being identical in form, but reversed in arrangement, so that the same may be completed throughout perfectly symmetrical. It should mention, however, that the three coils both in Figs. 2 and 3 of Fig. 2 ought to have been drawn of equal size as they are in the original drawing.

opened or closed, the strength of which is proportionate to the proximity of the lines to each other, and the number of wires that they run side by side.

"The induced currents are in one direction in closing the circuit and the opposite direction on opening the circuit. To neutralize the induced current from, say, No. 1 circuit, place electro-magnets *a a* at each terminal in the circuit of circuit No. 1.

"These magnets are then adjusted to approach the iron cores *b b'* until the induced current thrown into coils *c c* and telephone line by the action of the magnets *a a* on coil *d*, is of equal opposite, the induced current from the circuit No. 1. Then the telephonic wire by running parallel to it. This is the first compensation is attained.

"If the two lines run parallel for any distance I connect the two coils of the primary coil *a a* in series together, and then retard the magnetism and consequent action of the same by a permanent magnetism the induced current thrown into *c c* and over the telephone line.

"Having the terminals for No. 1 the compensation for No. 2 is exactly similar. If the latter circuit does not affect the telephone circuit the coils *a a* in No. 1, the electro-magnets *f* and *f'* are placed a greater distance from

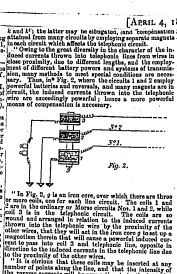

Fig. 2.

"In Figs. 2, *g* is an iron core, over which there are three or more coils, one for each line circuit. The coils 1 and 2 are in the ordinary or Morse circuits Nos. 1 and 2, while coil 3 is in the telephonic circuit. The coils are so wound as to be equal in relation to the induced currents thrown into the telephonic line from the proximity of the other wires, that they will act in the direction of fixed up a magnetism thereto that will cause a powerful current to pass from coil 3 and telephonic line in opposite direction to the induced currents in the telephonic line due to the proximity of the other wires.

"It is evident that these coils may be inserted at any number of points in the circuit, and that the intensity of the reverse currents will be in proportionate to the intensity of the currents exciting the inductive influence, and hence they will always be neutralized.

In cables containing a number of wires there is not only dynamic induction, but static induction. The latter appears sooner than the former, and is of exceedingly short duration. To neutralize this magnetic compensation above the static. Fig. 3 is shown a modification of Fig. 1 to meet this condition, which it is done to a considerable extent, but not entirely. Fig. 3.

"The induction coils 1 and 2 are included in derived circuits from the line circuits 1 and 2 that pass to the condensers C' and C' and to the earth. The object of the condensers is to prevent any leakage of current from the circuits 1 and 2, and at the same time to hasten the magnetizing and de-magnetizing of the cores *g*, so that no induced current of momentary duration is set up in coil 3 to meet and compensate for the static current from the circuits 1 and 2.

"I will here mention that to obtain perfect compensation, both the static and dynamic induced currents must be neutralized. In compensations, so they will circulate in the telephonic wire in opposite directions to those induced in the telephonic wire of the wires used to obtain these conditions, both magnets and condensers are necessary.—The former to set up dynamic induction currents, and the latter statical currents.

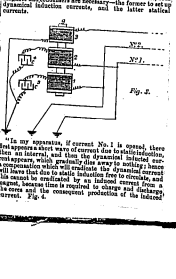

Fig. 3.

"In my apparatus, if current No. 1 is opened, there first appears a short wave of current due to static induction, then an interval, and then the dynamic induced current appears, which gradually dies away by metting; hence a compensation which will eradicate the former current will have that due to static induction four to circuits, and cannot because time is required to charge and discharge the cores, and the consequent production of the induced current. Fig. 4.

Fig. 4.

"Upon short circuits I use a coil with two or more wires wound side by side upon a soft iron bobbin, as shown in Fig. 4. One wire is placed in the telephonic circuit, while the others are placed in the circuits to be compensated for, and so connected therewith that the currents thrown into the telephonic coil are equal, but opposite, to those due to induction resulting from the wires running parallel.

"For long circuits, or long wires, and a large quantity of it, I am enabled to obtain nearly perfect compensation, as the coils act on both Gramme and Siemens cores, or iron cores being used to reduce the appearance of the currents.

"Instead of the coil of several wires wound side by side, several long strips of tinfoil may be placed side by side, but insulated from each other, and the currents passed through the strips in the same manner as if they were wires.

"Another method remains to prevent the telephonic receivers with differential coils, and running near the wire parallel with the telephonic wire and including in it the subsidiary coil.

"I claim as my invention,

"The method herein specified of compensating in one circuit for currents thrown from adjacent circuits, consisting in setting up a reactionary induction, and by an induction coil connected with the adjacent circuit or circuits substantially as set forth.

"Signed by me this 13th day of February, A.D. 1879.

"THOS. A. EDISON."

Witnesses { Geo. T. Pinckney,
Chas. H. Smith.

THE TELEPHONE PATENTS.

ON Monday last commenced the hearing of the action of The United Telephone Company, Limited, *v.* Harrison, Cox-Walker, and Company, in the Chancery Division of the High Court, before Mr. Justice FRY. This action is brought against the defendants in respect of alleged infringements of the telephone patents vested in the plaintiff company for an injunction and damages. The patents alleged to be infringed are Edison, No. 2390, 1877, and Morgan-Brown, No. 4765, 1877. Edison's patent contained originally thirty claims, which have been reduced by declinatures to three only, relative to (1) the use in a telephone of a diaphragm of mica, (2) the use of a semi-conductor as " an electric tension regulator," by means of which the current passing through a mass of carbon is varied by the action of a diaphragm vibrating under the action of sound waves, and causing the resistance of the carbon to be varied by the pressure exerted upon it by the diaphragm, and (3) the phonograph. Morgan-Brown's patent relates to and includes the well-known telephonic receiver and transmitter of Professor Emilius Bell. Practically the transmitter in ordinary use is a carbon transmitter made according to Edison's patent and the receiver is in accordance with Bell's patent. The infringement charged relates both to the transmitter and receiver, and of the substantial similarity of the plaintiff's and defendant's apparatus there seems to be but little question. The main effort of the defence seems to be directed to showing that both patents have been anticipated by the prior publication of the chief elements of the inventions embodied in them. The counsel engaged in the case are, for the plaintiffs, Messrs. Aston, Q.C., Webster, Q.C., Cozens Hardy, Q.C., and J. F. Moulton, and for the defendants Messrs. J. Pearson, Q.C., Hemming, Q.C., Goodeve, and F. L. Mulford. Sir Frederick Bramwell, F.R.S., and Sir William Thomson, F.R.S., have been already examined as witnesses for the plaintiffs, but the case is still continuing, and is likely to last several days.

Original Copy
April 32, 1879

TELEPHONE PROGRESS IN GLASGOW.

IT was recently announced that the monopoly of the Post Office had been recognised by all the existing telephone companies in this country, and that the Post Office had agreed to grant licenses to the various companies, without in any way raising obstacles to hinder the development of the telephone, now that it has proved itself to be such a wonderful aid in our commercial and social relationships. So far as Glasgow is concerned, the settlement of that vexed question has brought about at least one important result, namely, the *rapprochement* of the various contending telephonic companies; and already the National Telephone Company has been registered whose object is to amalgamate all the existing telephone exchanges in Glasgow as well as in the neighbourhood. The exchanges hitherto existing in that city have been the A B C Telegraph Exchange (instituted by Mr. R. S. Symington, and one of the first things of the sort in the kingdom), the Bell Telephone Exchange, the various exchanges of Mr. D. and G. Graham (previously noticed in our columns), and the Edison Telephone Exchange. On the completion of the arrangements which are now in progress and being rapidly developed, every subscriber to any one of these exchanges will be able to hold communication not only with the subscribers on his own exchange but also with those of every other exchange in the city. There is satisfaction in being able to state that the National Telephone Company do not intend to put a "monopoly" charge on the subscribers; on the contrary, the original amount fixed by the Bell Telephone Company (£20, per annum) is to be reduced to, the subscribers having no other charge or expense whatever. Following the example set by Messrs. Graham it is proposed to keep all the exchanges open day and night and all the week through. The number of firms and individuals who will thus be actually put into speaking communication with each other is close upon 500, in addition to many of the public institutions, such as the Central Fire Station, the police stations, theatres, restaurants, newspaper offices, &c. As many of the leading medical men and dispensing chemists of the city and suburbs are also connected with the telephonic exchanges, the loan of telephonic communication can be as readily imagined as described. Glasgow has already been put into telephonic communication with Greenock by means of a private wire—the distance covered by it being about 22 miles—and formal application has been made to the Post Office authorities in London to couple up the exchanges of the National Telephone Company between Greenock and Glasgow, so that members of either exchange can, by payment of a certain fixed sum per annum extra, have the additional facility of talking to every member both on the Glasgow and the Greenock Exchanges.

MAY 26, 1882.]

ENGINEERING.

THE TELEPHONE PATENTS.

During the progress of the trial we referred shortly to the case of the United Telephone Company, Limited, *v.* Harrison Cox-Walker and Co., in which the validity of the telephone patents of Professor Bell and of Edison Bell has come into question. The case after having occupied the attention of the Court for fifteen days, came to an end on Friday last, when judgment was delivered by Mr. Justice Fry. The action was for damages for and an injunction against the alleged infringement by the defendants of the patents of Professor Graham Bell (Morgan-Brown, No. 4703 of 1876) and Mr. Edison (Edison, No. 2903 of 1877), of which patents the United Telephone Company are the owners. These patents have both been amended by disclaimers—Bell's patent once and Edison's twice—by means of which the greater number of claims have been in each case cut out. In fact, out of a large number only the substantial claims having references to the telephone as commercially used have been retained. In Bell's patent the only claims left refer to the "plates" numbered in the specification as the fourth and fifth. The "fourth plate" is the well-known Bell telephone with transmitter and receiver of the same form, in front of an electro-magnet, by acting inductively upon the magnets and the battery currents passing through the solid stump line wire, gives to a voltaic current which is otherwise constant an undulatory character which reproduces upon the diaphragm of the receiver the vibrations of the plate of the transmitter. In the "fifth plate" the core of the electro-magnet is replaced by a permanent magnet and the battery current is dispensed with, the only current passing along the line wire being the undulatory current produced by the motion of the inductive plate of the transmitter in front the permanent magnet.

In Edison's patent, as twice amended, only three claims are left, viz., 1st, "As an instrument for transmitting electric impulses by sound, a diaphragm or tympan of some, substantially as set forth;" 2nd, "As an instrument for transmitting electric impulses by sound the combination with a diaphragm or tympan of electric tension regulators substantially as hereinbefore described for varying the resistance in a closed circuit, substantially as set forth;" and 3rd, "The method herein specified, of recording the undulations of the diaphragm or pickling material, and thus the reproduction of sound by such material acting upon a diaphragm or communicate to the same vibrations similar to the original ones, substantially as set forth."

As is well known, in the telephone as now worked, the electric current is used to continuously vary the Bell receiver, and the infringements complained of by the plaintiffs referred to both these parts. These infringements were the Hunning's transmitter, used by the defendants, which was alleged to infringe Edison's transmitter; and the Cox-Walker and Hedding receivers, as to the identity of which with Bell's there was practically no dispute.

For the plaintiffs the counsel employed were Messrs. Aston, Q.C.; Webster, Q.C.; Cozens-Hardy, Q.C.; and J. F. Moulton, F.S.S.; and for the defendants Messrs. J. Parker, Q.C.; Graham, Q.C.; Chadwick, and A. Maxwell. The principal witnesses examined were, on behalf of the plaintiffs, Sir F. Bramwell, F.R.S.; Sir W. Thomson, F.R.S.; Dr. Hopkinson, F.R.S.; Mr. Varley, and Mr. E. H. Johnson; and for the defendants, the Rev. H. Hunnings, Professor Sylvanus P. Thompson, Dr. Muirhead, Mr. W. Ladd, Professor Dalbear, Dr. Stone, Professor Barrett, and Professor Ayrton, F.R.S.

The defences raised on behalf of the defendant company were very various, and covered a wide area; the defences as to the Bell patent and the Edison patent respectively being of course quite distinct.

As to Bell's patent, the main defence was that the patent was bad by reason of anticipation. Two anticipations were chiefly relied upon. The first was from the description and illustration of Reis's musical telephone published in the *Zeitschrift* of the German and Austrian Telegraph Union, and deposited in the libraries of the Patent Office and of the Institution of Civil Engineers. This periodical is in German, and a preliminary question arose as to whether the invention could be said to have been "published" in the sense necessary for anticipation.* Upon this point, which, in the form in which it was raised, is one of some novelty, Mr. Justice Fry came to the conclusion that, upon the evidence, the publication must be considered to have brought the Reis telephone within the knowledge of scientific persons in this country. But upon the invention thus published the learned judge came to the conclusion that there was nothing in Reis's receiver which could be considered to anticipate Bell's.

The second of the anticipations mainly relied on arose from the address of Sir W. Thomson at the Glasgow meeting of the British Association in 1876, and an instrument there exhibited by him. In that year Sir W. Thomson visited the Philadelphia Exhibition, and Professor Bell there, and hence articulate sounds through a telephone made and exhibited by that inventor. The receiver of this telephone consisted of a tubular electro-magnet about 3in. in diameter enclosing a bar electro-magnet, the top ends of the tubular magnet and the axial bar magnet being of opposite polarity. Over the tubular magnet was placed a disc of thin steel which touched the annular pole throughout its circumference, and was held there by magnetic attraction, when a current was passing, at a small distance from and within the inductive influence of the central magnetic core. The action of the instrument when used as a receiver was thus practically the same as that of the present Bell receiver, but it was contended by the plaintiffs that it differed from it in the fact that it could not be used as a transmitter as well as a receiver. Before Sir W. Thomson left America, Professor Bell presented to him one of his instruments as a present, which was not opened by Sir W. Thomson until he was on board ship on his way back to England. Upon opening it he found that the top disc was screwed by means of a screw at one point of its edge to the top of the annular magnet, and that instead of lying flat it touched the rim of the annular magnet only at this point, and was therefore free to vibrate as a tongue.† Upon this point Sir W. Thomson's evidence to the effect that he thereupon, on saving this instrument and supposing it to be similar to the one he had seen at Philadelphia, thought he must have been mistaken in his view of the *modus operandi* of the Philadelphia instrument, and in the description of the action which he had given in his report upon the Exhibition.

At the meeting of the British Association at Glasgow, Sir W. Thomson exhibited this instrument, which had been given to him by Bell, and in his address gave some account of what he supposed was the theory of its operation. According to the view of the evidence taken by the learned judge, both Sir W. Thomson and those who heard him were under the impression that the screw-down disc was meant to vibrate as a free tongue, and hence the kernel of Bell's invention, which consisted in the use of a stiff vibrating plate, was not made known. It was also shown that Sir W. Thomson had tried to make the Glasgow receiver speak and had failed, and that Dr. Muirhead had tried to construct a similar instrument and had failed to make it work. In addition to this the evidence went to show that the Bell receiver was a much better thing than the Glasgow receiver, and, therefore, upon the case as to what kind of anticipation is necessary, the onus of burden lying on the defendant to show that the anticipation of the Bell receiver by the Glasgow receiver was by an instrument practically as good as the patented one,‡ the learned judge gave his decision on this point in favour of the plaintiffs.

A further objection taken to Bell's patent was that his first claim was a general claim for any means whatever for transmitting electric impulses by sound. The claim was in these words:—"The combination substantially as set forth, and described respectively in the fourth and fifth plate above referred to, but subject always to the disclaiming none, of a permanent magnet (or other body capable of inductive action) with a closed circuit, as that

* The terms cited on this point were: Lang *v.* Gisborne, 31 Beav., 133; Plimpton *v.* Malcolmson, 3 Ch. D., 531; Plimpton *v.* Spiller, 6 Ch. D., 412; Household Co. *v.* Neilson, 1 W.P.C., 73.

† This instrument was illustrated in the number of ENGINEERING for December 22, 1876 (vol. xxvi., page 518).

‡ Hills *v.* Evans, 4 De G. F. and J., 288; Nelson *v.* the Overseers of Hull, one shall occasion electrical undulations in the other or in itself." This claim certainly reads, at first sight, like a claim to the discovery of undulatory currents pure and simple, produced by means of a vibrating magnet, which was known to Faraday. Bell, however, in his specification states that "It has long been known that when a permanent magnet is caused to approach the pole of an electro-magnet a current of electricity is induced in the coils of the latter, and that when it is made to recede a current of opposite polarity to the first appears upon the wire." In view of this statement Mr. Justice Fry, remarking that the patentee has himself shown that he knew what the previous state of knowledge upon the subject was, continues, "I have already expressed my opinion that Mr. Bell was the author of a very remarkable discovery. I think, furthermore, that he has understood honestly to describe that discovery in his specification, and where there two things are found. I think it is the duty of a judge to give, if needful, a benign interpretation to the words of the document." Other points, which were based on these noted above, were raised by the defendants, in opposition to the validity of Bell's patent, but they were all overruled by the judge, and an injunction was granted restraining the defendants from infringing Bell's patent.

Upon the Edison patent the defendants relied on four grounds, every objection to this patent being overruled except one, but that one being held sufficient to destroy the validity of the patent as it stands at present. The Edison transmitter, as is well known, is formed of the fact that a varying conductivity between varying surfaces placed in the circuit." In the Edison transmitter as generally used, a stiff diaphragm vibrating under the influence of the voice, acts upon a button of compressed lamp-black placed between two platinum electrodes, through the medium of a disc of cork placed between the disc and one platinum electrode. The pressure between cork and electrode is regulated by means of an adjusting screw. In Hunning's transmitter no screw adjustment is required. A layer of powdered coke is placed between two platinum foil electrodes which do not act as stiff diaphragms and do not vibrate as a whole like the tympan or stiff diaphragm of the Edison transmitter. The action of the Hunnings transmitter is therefore in this respect different from that of the Edison transmitter, and it was certainly open to argument whether Hunnings's transmitter ceases within the words of Edison's second claim as set out above. Upon this point the decision of the learned judge was in effect that the Edison "tension regulator," substantially as described," was a "tension regulator" made of a substance possessing the qualities of semi-conductivity, resiliency, and compressibility, and that the Hunnings transmitter was like Edison's, a "combination of a diaphragm (that being the platinum foil), vibrating with the voice, and a tension regulator consisting of a semi-conductive, resilient, and compressible substance, and it is therefore within the scope of Edison's specification."

Another point upon which a considerable fight was made by the defendants, was upon the first claim of Edison's patent, as set out above. It was said that this was a claim for making an old thing, viz., a vibrating diaphragm in a telephone, of a particular material, viz., coke, and that upon legal principle,* was a bad claim. Upon this point Mr. Justice Fry says: "Does that claim mean that he claims the mere diaphragm or tympanum in all instruments for transmitting electric impulses by sound? If it did, it appears to me that the claim would be bad, because that would be the claim of the application of an old substance to a particular purpose without the use of any ingenuity or invention in that application; but if it means that the mica diaphragm is claimed in an instrument for transmitting electric impulses by sound, which is described in the specification, and I think that is not in any way bad, and upon the whole I have come to the conclusion that it may be read as relating only to the mica diaphragm in combination

* Hill *v.* Thompson, 1 W.P.C., 222; Cutler *v.* Cutler, 1 Mer. P.C., 137, and 14 Q.B., 972; Tetley *v.* Easton, 1 Car. and K., 708; Crane *v.* Price, 1 Car. and K., 679; Watson *v.* Potter, 1 W.P.C., 205; Routton *v.* Crawley, L.R. 10 Eq., 522; Stockton *v.* Bemis, 2 C.P.C.N.S., 221; Jordan *v.* Moore, L.R. 1 C.P., 623.

† This was one of the instruments." If this be the true reading of the claim we are at a loss to see what it is use.

The one point raised by the defendants upon which they have succeeded is an objection founded on a variance between the complete and the provisional specifications, and upon this objection the learned judge dismissed the action as regarded the Edison patent. We understand that notice of appeal on this point has been given by the plaintiffs, and as in the mean time the law is in a state of uncertainty, but the decision, should it be upheld, will be of great importance. Shortly, the objection is that the subject of Mr. Edison's third claim, viz., the phonograph, is nowhere to be found described in the provisional specification, and that this invalidates the patent.*

The title of Edison's patent is "Controlling by sound the transmission of electric current, and the reproduction of corresponding sounds at a distance," and the provisional specification next includes the phonograph as ordinarily applied. The only words in the provisional specification which can be taken to refer to the phonograph occur in the following sentence: "To carry out the peculiarities of my invention under the varying conditions of use, I have devised several modifications of the transmitting, receiving, and intensifying devices specified in my *second telegraph*; portions of the apparatus are interchangeably available in transmitting or recording; others are adapted to local use; some are only available for transmitting, and others are only for receiving; and some portions of my improvement can be availed of (*sic*) to make a record of the atmospheric sound waves, or of the electric waves, or other disturbances of electrical conditions affecting them." The learned judge took the view that the provisional specification was intended to refer solely to the "sound telegraph" and its adjuncts, and that the claim for the phonograph apart from any application to such one invalidated it. After referring at length to the case of Bailey *v.* Roberton, the learned judge speaking in reference to the words above quoted from Edison's provisional specification, proceeded, "Now, no doubt, some of those words do explain, or might be held to refer to an instrument like the phonograph; but when I ask myself

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whether they in any manner determine the nature of the invention, I am bound to say that they do not; these, as I have already observed, are merely methods for carrying out the peculiarities of the invention; which invention, I repeat, is confined to the transmission of sounds by electrical agency to a distance. Supposing an inventor had during the last six months which preceded the complete specification, both poles of the magnet near the vibrating plate onion invented the phonograph, not as applied to the to the electric telegraph, but operating by itself, and so on, does exercising them with flat bobbins and it be said that the invention would have been protected by the description contained in this provisional specification of that instrument, I agree that the provisional specification need not describe the manner in which an invention is to be carried into effect. I agree that it need not describe the nature of the invention otherwise than roughly; but it ought to do so fairly and honestly, and if Mr. Edison was, at the time at which those letters patent were granted, in possession of that very remarkable mechanical invention by which speech could be reproduced, not necessarily at a distance, but in the same room in which it was uttered, I do not think the provisional specification was an honest statement of the nature of that discovery."

AN IMPROVED TELEPHONE.

M. D'Arsonval has been studying the arrangements of the Bell telephone best calculated to give a maximum effect. The results of his experiments lead to the general conclusion that a telephone should be constructed on the same principles as the dynamo machines. He finds that bringing the vibrating plate between the poles of the magnet near the vibrating plate between the poles of the magnet than in any other position. Supposing an inventor had, very close together as in the Gower-Bell instrument, lies between the poles of the magnet; and this supposition is further proved by the fact that a wire conveying an interrupted current has far greater power over the vibrating plate when placed between the poles of the magnet than in any other position. M. D'Arsonval declares Professor Bell the original inventor of the speaking telegraph, and confirms the American Bell Telephone Company the exclusive right in the United States of talking over a wire by means of electricity. He says: "If the Bell patents were for a mere arrangement or combination of old devices to produce a somewhat better result in a known art, then, no doubt, a person who substituted a new element not known at the date of the patent might escape the charge of infringement. But Bell discovered a new art, that of transmitting speech by electricity, and has a right to hold the broadest claim for it which can be permitted in any case—not to obstruct right of sending sounds by telegraph without any regard to means, but to all means and processes which he has both named and claimed." At first sight this decision appears at variance with that of our own judges, the learned Baron Pollock and Mr. Fitz-James Stephen, in the recent trial between the Post Office and the Bell Telephone Company. They ruled that the telephone was a telegraph, and in that case we may well ask if telephoning can therefore be a new art as the American judge defines it. The English judges were impressed by the counsel for the Post Office with the scientific evolution of the telephone, and evidently regarded the case from an internal point of view; they had been taught to see how Reiss's musical telephone was related to the ordinary "sounder," and how Bell's telephone could be assimilated to Reiss's. The American judge has, however, evidently looked at the case from an external standpoint, and decided on the difference of results effected rather than on the scientific likeness of the means employed; and we question whether his decision is not the clearest and the best. The telephoning of speech is fairly entitled to be ranked as a new art; and though Professor Bell cannot lay claim to the abstract right of sending speech, he is at liberty to claim all the means and processes covered by his patents. The decision will affect the prospects of a great many patentees who have taken out numerous patents for improvements in telephonic apparatus based on Bell's invention; and if it is confirmed by the Supreme Court of the United States it will put a gigantic stop-cock into the hands of the American Bell Telephone Company.

Engineering, Feb. 15. 1884.

THE INVENTION OF THE TELEPHONE.

The American press has long ignored the legitimate claims of Professor Graham Bell to be accounted the first and true inventor of the speaking telephone. That gentleman had the misfortune to be born an Englishman, or, speaking more strictly, a Scotchman; and the lion's share of the invention has always been accredited in the United States to native Americans, such as Mr. Edison and Mr. Elisha Gray. The recent decision of Judge Lowell, of the United States Circuit Court of Boston, Mass., has, therefore, caused considerable surprise and disappointment in America. The judge virtually declares Professor Bell the original inventor of the speaking telegraph, and confirms to the American Bell Telephone Company the exclusive right in the United States of talking over a wire by means of electricity. He says: "If the Bell patents were for a mere arrangement or combination of old devices to produce a somewhat better result in a known art, then, no doubt, a person who substituted a new element not known at the date of the patent might escape the charge of infringement. But Bell discovered a new art, that of transmitting speech by electricity, and has a right to hold the broadest claim for it which can be permitted in any case—not to obstruct right of sending sounds by telegraph without any regard to means, but to all means and processes which he has both named and claimed." At first sight this decision appears at variance with that of our own judges, the learned Baron Pollock and Mr. Fitz-James Stephen, in the recent trial between the Post Office and the Bell Telephone Company. They ruled that the telephone was a telegraph, and in that case we may well ask if telephoning can therefore be a new art as the American judge defines it. The English judges were impressed by the counsel for the Post Office with the scientific evolution of the telephone, and evidently regarded the case from an internal point of view; they had been taught to see how Reiss's musical telephone was related to the ordinary "sounder," and how Bell's telephone could be assimilated to Reiss's. The American judge has, however, evidently looked at the case from an external standpoint, and decided on the difference of results effected rather than on the scientific likeness of the means employed; and we question whether his decision is not the clearest and the best. The telephoning of speech is fairly entitled to be ranked as a new art; and though Professor Bell cannot lay claim to the abstract right of sending speech, he is at liberty to claim all the means and processes covered by his patents. The decision will affect the prospects of a great many patentees who have taken out numerous patents for improvements in telephonic apparatus based on Bell's invention; and if it is confirmed by the Supreme Court of the United States it will put a gigantic stop-cock into the hands of the American Bell Telephone Company.

THE TELEPHONE CASE.

We hear that the appeal on this long-standing dispute will be carried to the Lords. The plaintiffs in the suit are, it will be remembered, the United Telephone Company, the defendants the London, Globe, and Maintenance Company, and the question at issue was the right of the latter company to use Hunnings carbon transmitter and the Bell receiver. By a fault in the Edison (1867) patent, which erroneously included the phonograph, Mr. Justice Fry pronounced that patent invalid and the phonograph had to be disclaimed. In the mean time, while the patent was being reported upon, a considerable number of Hunnings' instruments were made for the Globe Company, and these they now set at liberty to use, and are using in their London exchanges. The Hunnings transmitter is a very fine one; everything considered, it is perhaps the best yet invented, and requires no adjustment, whilst the articulation is remarkably good and loud. Moreover, it is said to have a power of over-riding induction currents possessed by no other transmitter, the grains of carbon in circuit when vibrated by the voice, serving to break up and rub out, as it were, the induction noises, so that the persons talking can distinctly understand each other though there are noises in the wires. The Hunnings instrument will therefore prove valuable should messages have to be underground lines, as will probably be the case in the near future. The receiver employed by the Globe Company consists of an electro-magnet in circuit with the line, and having in front of its pole a non-metallic diaphragm, with a soft iron armature attached. This device was (it is said) disclaimed by Bell from his patent, and was described in England prior to his patent. In the ordinary Bell telephone the diaphragm is of thin iron. The public has heard so much of this case, and its settlement has been so long protracted, that it will be interesting to see the end of it. The London Globe and Maintenance Company have now established themselves in the City, and one peculiar feature of their system is that the workingbatteries are all kept at the exchanges, and are plugged into circuit for speaking, by reversing the exchange switch to connect two subscribers.

THE TELEPHONE CASE.

The appeal of the defendants in the case of the United Telephone Company *v.* Harrison, Cox-Walker and Co., came on for hearing on Wednesday last, in the Court of Appeal, before the Master of the Rolls and Lords Justices Lindley and Bowen. Wonderful that the appeal of the plaintiffs in regard to that portion of Mr. Justice Fry's judgment which pronounced the Edison patent invalid, has been abandoned; the United Telephone Company having preferred to amend the specification by disclaimer, and thus render the patent for the future valid. A novel point has been raised on the appeal which was not fully taken in the court below, viz., that in Bell's receiver, as illustrated in his specification, the attachment of the steel diaphragm or tympan to the rest of the instrument is of such a character as to permit "reed" vibrations. The defendants' contention on this point seems to be not that the nature of the sound vibrations of the armature either in this instrument or in the Reis anticipation, is of a reed character, but that the sound vibrations are of a "tympanic" or molecular character, independently of any special mode of attachment. Possibly this contention as to the meaning of Fig. 10 of Bell's specification, may postpone for some time longer the decision of this appeal, as the Lords Justices have intimated that they may require to read back the case for evidence to be given by experts on to the true intent of this illustration. The appeal stands adjourned to to-day (Friday), when the defendants' arguments will be continued.

* Two cases cited on this point were; Bailey *v.* Bakerite, 7 App. Cas., 1075; Stoner *v.* Todd, L.R., 4 Ch., 58; Cannot *v.* Elliott, 4 C.B.N.S., 320; Penn *v.* Bibby, L.R., 2 Ch., 128.

Engineering, July. 1878

THE TELEPHONE CASE.

The important case of The United Telephone Company v. Harrison, Cox-Walker, and Co., to the course of which we recently referred, has now reached a further, though not necessarily final stage. It will be remembered that the action was brought originally for the infringement of the Bell and Edison patents respectively, both of which are vested in the United Telephone Company. The result of the trial before Mr. Justice Fry* was a judgment for the plaintiffs in reference to the Bell patent, and upon the Edison patent a judgment for the defendants, on the ground that the invention of the phonograph, which was included in Edison's final specification, had not been adverted to in the provisional specification. The defendants appealed from the judgment on the Bell patent and the plaintiffs from that on the Edison patent, but as upon the latter patent every point except that referred to above was given in favour of the plaintiffs, they subsequently resolved to disclaim the phonograph, thus making good their patent for the future and to drop their appeal. The appeal of the defendants has therefore come on to be heard alone, and has now been disposed of, by being dismissed with costs, after a hearing lasting nine days. Upon the appeal, Messrs. Aston, Q.C., Webster, Q.C., and Moulton were counsel for the plaintiffs,

* Reported in ENGINEERING of May 24, 1877 (vol. xxiii., page 524).

and Messrs. Benning, Q.C., and Goodeve for the defendants.

The principal points urged by the defendants in support of their appeal had reference to the questions of anticipation and defective specification. The chief anticipation alleged was the exhibition at the Glasgow meeting of the British Association in September, 1876, of the original Bell receiver and transmitter, brought over in that year from Philadelphia by Sir W. Thomson, to whom they were presented by the inventor himself. It seems probable that at these Bell regarded his invention rather as purely scientific than of great practical importance, and that his anxiety to obtain priority as a discoverer in a field where so many experimenters were engaged, led him to take that opportunity of publishing his invention to the world without regard to commercial considerations. At events the instrument was exhibited at Glasgow, and announced to the world by Sir W. Thomson as one of the most wonderful discoveries of the age, and its modus operandi was explained, though Sir W. Thomson tells us he himself tried to make it work practically and failed. A considerable amount of was shown at this local reed, mounted opposite to the transmitter was shown at Glasgow with the "lid" filled, but it seems pretty clear that this was to the case. In fact, this seems to have been the general impression that the instrument gave, and ordinary pure. In another experiment the vibrator was an "ilk" is clearly shown in our illustration of the instrument exhibited at Glasgow, and which was the receiver, and a tuning-fork mounted opposite to the meeting.* Although the attempts to make the instrument speak failed at the time, it has since been demonstrated by experiments made in the Court of Session that this was due to the transmitter, and that with a good transmitter the original receiver will work with the "lid" either up or down. Hence the receiver, as a receiver, seems a practical working instrument, though it was not in fact practically worked. At the trial this fact being that any vibrator will respond to all that the exhibition of the instrument at Glasgow added nothing to the stock of public knowledge, and was not in law a publication of the invention.

* Reported in ENGINEERING of May 25, 1877 (vol. xxiii., page 524).

The judgment of the Court of Appeal on this point, which, as the result the same, is in detail some of the vibrator, subsides immediately the differed, and has proceeded on other lines. It vexiting cause is removed. As we have indicated, having been shown that the receiver, as such, was this fanciful distinction in principle was not relied a working instrument which could be copied and on in the Court of Appeal, but the case was rested worked with a good transmitter, it has been held on specific differences of construction without that the publication thereof was in law complete, regard to principle involved.

and that no subsequent patent for the instrument A point was raised by the defendants upon the could be good, consequently the validity of the Bell's patent rests only upon the differences which exist between the instrument as patented and as shown at Glasgow, and these, small as they appear, have been held to be sufficient. The only substantial difference seems to be that in the patented receiver the "lid" or tympan is secured to a wooden frame round its edge, and is fixed in position relatively to the magnet, and this difference seems to rest only upon the fact that the "lid" of the Glasgow receiver was "tilted."

The original specification of the patent claimed generally the combination of magnet and tympan for telephonic purposes, and would clearly have included the Glasgow receiver. The specification as amended by disclaimer claimed only the combination as described, thus excluding the Glasgow receiver, but excluding at the same time everything but the form shown in the specification, thus running the risk, that any form not quite the same as the patented form would not be within the scope of the patent and would not be an infringement. In the course of the argument the Court indicated its opinion that nothing but an almost identical receiver would infringe, but it was held that the defendant's receivers are practically identical and are therefore infringements. It will be seen, however, that the field is open, more or less, for other inventors, since what the patent must now be taken to cover is not a principle, but a form of application of a principle, a vast difference, well illustrated by a consequence of this case with that of Otto v. Linford.†

† See ENGINEERING, vol. xxiii., p. 548, † Ibid., vol. xxiii., p. 525.

Of the antiquity of the Bell patent by the Reis telephone we need say but little, the Reis instrument never appears to have been used except as an intermittent, as distinguished from an undulatory current.

In the Court below, the plaintiff's case, as to the difference between the patented receiver and the Glasgow arrangements, was chiefly grounded upon

construction of the specification, which is of little interest in itself, but of considerable moment on one part of the principle involved. Confessedly, the specification was ambiguous and might be read in two ways. According to the more obvious reading, the patentee claimed generally the production of undulatory currents, a thing undoubtedly old. According to the less obvious, but equally possible construction, he claimed only the application of undulatory currents to the purposes of telephony as described. Upon this the Court ruled that where there are two constructions equally open, one of which would support and the other destroy the patent, in the case of a *bond fide* and meritorious invention, the construction most favourable to the patentee should be adopted, and the "benignant interpretation" was accordingly adopted. So one can grudge Bell the legitimate fruits of his invention, but it is open to question how far the adoption of the "benignant" principle, as applied to the construction of specifications, is fair to the public or in the end advantageous to inventors themselves.

On the one hand it has been, over and over again, decided, that the specification should in "particularly describing and ascertaining the nature of the invention," tell the public clearly what they may do and what they may not do without infringing the patent. It would seem that a specification which contains an ambiguity which may upon the face of it claim an old invention can hardly satisfy this requirement. On the other hand the wholesale application of the benignant principle tends to make the administration of the law uncertain, and encourages inventors and patent agents to make their specifications into conundrums which are to be solved in one way or another according to the course of events, and which oftener than not prove snares to the inventors and invaluable to their patents. It may be well doubted whether a strict construction which would condemn unequivocally an uncertainly sounding specification, would not be better for all parties. At all events the present slovenly way in which the majority of specifications are drafted seems to support this view. Unfortunately it is not only on questions of construction, but also of anticipation and infringement that this "benefit of the doubt" is exercised, and the administration of the law becomes uncertain in the highest degree. "Hard cases make bad law" is an old saw, but it would seem better for one deserving inventor to be occasionally sacrificed than for ninety-nine to be left in doubt and uncertainty.

The commercial importance of the present decision was strikingly illustrated by the fluctuations in the market value of the shares of the plaintiff company during the course of the appeal. As the hearing proceeded, and a judgment for the defendant seemed to be a foregone conclusion, the shares went down, but the result announced on Tuesday afternoon sent them up 2½. Barely has there been a case in which the uncertainty of the result from time to time during the hearing afforded a fairer field for speculation.

THE TELEPHONE.

The principal event in connexion with the recent progress of the telephone in this country was the trial at Edinburgh before Lord M'Laren in the High Court of Session of the suit between the United Telephone Company (Limited) and Mr. Alexander Bachem, of Edinburgh. The United Telephone Company wished to restrain Mr. Bachem from using the Sheater or other microphone transmitter and the Bell receiving telephone; and Lord M'Laren gave judgment in their interests. The merits of the microphone as a new invention cannot however rest upon such a decision; that has already been decided by the general sense of the scientific world in favour of Professor Hughes. A Department commissioned the Postal Telegraph officers of the country into their own hands, is also credited by the Postmaster-General; and the public must not regard the fact, for telephonic businesses, as from its private and confidential nature, depending for its success on the satisfaction they give their clients. The exactions of Government officialism are not likely to conduce to that easiness with which a private individual loses in convenience, or to that willing assistance which the attendants of an ordinary company are taught to render. Should the telephone be adapted to long lines connecting town to town the question will take a new phase and require a fresh consideration; but at present the telephone is merely a local convenience for saving people the trouble of going to meet in order to speak with one another. Microphones have been fitted up on the Handel organ at the Crystal Palace and connected by wire to the houses of Major Flood-Page and Colonel Gouraud in the vicinity so as to transmit the music of the organ. It was found that speaking could be carried on whilst the organ tones traversed the wire, and indeed as "new discovery" but it is a discovery which dates back almost to the birth of the telephone itself. With regard to the application of the telephone, we learn that the German Government are now purchasing a new instrument which is stated to be capable of transmitting vocal sounds from Hamburg to Berlin. At home, Messrs. Barraud and Lund, patentees of the time-signalling system now in use in the metropolis, are arranging with the Postal Department to extend the system to telephone subscribers, so that any of these may receive an hourly Greenwich time-current without disturbance of the speaking powers of his instrument.

DRAWBAUGH'S TELEPHONE.

An important suit affecting the "monopoly of the American Bell Telephone Company has just been decided by the Circuit Court of the United States in New York; and a new telephone (dating to be old) has just been unearthed. It strikes us as very remarkable that in a country like America, where journals are largely read, were the telephone was well known, and speakers are as a rule so anxious to publish their claims, that we have not hitherto heard a syllable about the new telephone which has been sprung upon the public; a telephone which not only anticipates Hall's receiver but Edison's and other carbon transmitters, in fact, the telephone which is now worked by the American and English companies. The suit by between the People's Telephone Company and the older American Bell Company, and was decided in favour of the former, Bell's patent being declared void according to the American law; and Hall not the true inventor in the eyes of that law. This result was brought about by the evidence of numerous witnesses who testified to the genuine character of Drawbaugh's telephone. We incline for the present to view the decision with some reserve, notwithstanding the published drawings of Drawbaugh's instruments; but are of course open to conviction; on the matter when it has been thoroughly sifted. Witnesses declared that they had heard Drawbaugh's telephone speak in 1867 and up till 1876, and Mr. F. L. Pope, a well-known electrician declared that his apparatus was a speaking telephone. Drawbaugh's early transmitter (date 1860) was "current regulated" consisting of a vibratory diaphragm or tympan having a stylus projecting from its centre and bearing on a mass of powdered metal (or plumbago) contained between the two metal plates in circuit with the line. Its receiver of this year consisted of an electro-magnet in circuit with the transmitter, and attracting a vibratory armature connected by a string to a membrane stretched across the open bottom of an empty sustenal tin. In 1867-68 Drawbaugh improved these instruments, using carbon powder in the transmitter and suppressing the string in the receiver by attaching the armature direct to the membrane. In 1870 he found that a permanent magnet could be used for the electro-magnet in the receiver. This instrument is the same as Bell's 1877 telephones, and transmits or receives speech without a battery. In 1875, 1874, 1875, and 1876, he added further perfected his apparatus, employing blocks of hard gas carbon, held together by springs in the transmitter, one form closely resembling the well-known Blake transmitter. The series of improvements produced as Drawbaugh's are remarkably complete, and so perfectly anticipate the apparatus now in use, that we cannot help a suspicion as to their genuineness. If proven, it is, if anything, too close, and Drawbaugh's work too obviously forestalls that of recognised inventors. If, however, it should turn out, on due investigation, that Bell's work was forestalled by Drawbaugh will deserve much honour for his great invention.

Engineering March 14 1884

TESTER'S TELEPHONE.

M. Tester, of the French telegraph administration, has invented a magnetic telephone which has given good results. It resembles a watch, with the glass replaced by an ebonite mouthpiece. The iron plate vibrates before a double magnetic ring, having projections like the indented edges of two concentric cogs. The magnetic polarity is different in the two rings, one ring presenting north, and the other south poles. Each ring is provided with a fine coil of wire, and the entire magnetic field is traversed by the current.

Engineering March 14 1884

THE DOLBEAR TELEPHONE.

At the last meeting of the Society of Telegraph Engineers and of Electricians on March 5th, Professor Dolbear, of Tufts College, Massachusetts, U.S., delivered a lecture on the telephonic receiver invented by him, and recently introduced into this country. Professor Dolbear began by tracing the history of the speaking telephone from the first experiments of Page on "galvanic tones" unaided by interrupting the current in a coil having a core of soft iron. Most of his audience were probably unaware of the forgotten researches of Farmr, a resident of the town of Keen, in New Hampshire. Farrar was, perhaps, the first to set himself to transmit actual speech by electricity. He succeeded in transmitting the music of a series of vibrating tuning-forks which were struck by keys; but he gave up his efforts to transmit speech because an eminent American physicist of the time, whose name Professor Dolbear did not give, advised him that the thing was impossible. Farrar employed a receiver which bore an essential resemblance to that of Professor Bell. It consisted of two electro-magnet coils enclosed in a box, and having in front of their poles a vibrating plate of soft iron. According to Professor Dolbear, Farrar also used a receiver consisting of an electro-magnet having a vibrating armature of soft iron before its pole, although the fact is not generally known. We propose shortly to describe and illustrate the Dolbear telephone in detail; for the present we may limit ourselves by saying that it consists of two small round metal plates enclosed in an ebonite case not much larger than a watch, and fitted with an ear-piece. One plate is free to vibrate, and is connected to one pole of the secondary wire of an induction coil; the other pole of the wire being to earth, or to the other plate of the telephone through the coils. The primary wire of the coil is in circuit with the line, and is traversed by the vocal currents from the microphone transmitter. The induced secondary currents electrify the free disc, and the attraction between the two plates, which are placed close together, causes the free disc to vibrate in accordance with the varying potentials of the secondary circuit. The person of the listener so he holds the telephone in his ear is a sufficient connexion between the fixed plate and the ground, so that a wire connection is not absolutely necessary, though the effect is louder with one than without. This fact has already been published, but Professor Dolbear astonished most of his audience by demonstrating that it was not even necessary to have a wire connexion to the earth plate of the telephone and a secondary pole of the coil. In fact, the telephone could be held quite free from any connexions in the hand, and still speech could be heard if the listener did not go too many feet (say over fifty) from the coil. The effect was increased by allowing a connecting wire from the telephone to hang free in the air. The effect here is evidently due to induction acting through the air between the poles of the secondary wire of the induction coil and the telephone plates; but it is surprising to find it so marked. Mr. Willoughby Smith, at the end of the lecture, invited members to see a piece of apparatus which he had been experimenting with, and which seemed to give similar results. This consists of a gossamer web of fine iron wire in contact with the poles of a horseshoe magnet wound with a coil, through which telephonic currents are passed. When those currents pass, a large number of persons in the vicinity holding disconnected telephones to their ears can hear the telephonic messages. It is not, however, clear in this case whether the effect is really due to induction as in the case of Mr. Dolbear's experiment; or simply to vibration in the air, and the enhancing effect of the resonance cavity of the telephone when held to the ear. Some experiments made by Professor Hughes, about two years ago, have a less elaborate bearing on the point. Those experiments were made before Mr. Spottiswoode, Professor Stokes, and others, and consisted in transmitting sounds without the air of a room to a telephone which was not in circuit with the battery and transmitter. The electricity from the battery and transmitter appeared to have thirty or forty feet of the air itself and not on the telephone. As Mr. W. H. Preece explained to the meeting, Professor Hughes did not publish those experiments because Mr. Spottiswoode believed them to be due to *induction*, and Professor Hughes, himself, thought they were due to *conduction*. It is generally, we think, unfortunate that the opinion of one authority should in any way check the labours of another; nor is it at all certain that the effect is simply due to induction. Perhaps if Professor Hughes had continued his researches he might have settled the question, and at any rate would doubtless have thrown fresh light on the nature of induction. Probably we have not yet heard the last of the subject.

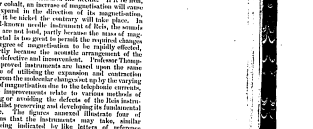
Engineering March 14 1884

THE STATIC TELEPHONE IN RESEARCH.

Thomsquatic-telephone of Graham Bell has proved of great value in research, and Professor S. P. Thompson has now applied the static telephone of Dolbear to the same purpose with considerable success. Professor Thompson has used it for investigating the action of "influence" machines, such as those of Holtz, Toepler, and Winnshurst (see ENGINEERING, vol. xxxiv., page 5). When the coil of the wire from the insulated plate of a Dolbear receiver is held near the revolving discs of those machines, a sound is heard in the telephone by induction. As might have been expected, Professor Thompson finds the discharge from the Holtz class apparently more continuous than that from the Winnshurst or carrier class. The Dolbear instrument has also been used by Professor Thompson to take the place of the galvanometer in a Wheatstone balance of conductivity, if one may use the term, when conductors are compared instead of resistances. The conductors which correspond to the divided coil of the Wheatstone balance have been ingeniously combined by Professor Thompson in the following manner. Two glass tubes are coated with tinfoil and a brass tube slides into both the glass tubes, and forms the common insulated armature of both condensers, while the tinfoils form the earth armatures of the two condensers thus combined. The arrangement allows of the ratio of the capacities of these two condensers being varied by sliding the inner brass tube between them. When the "balance" of condensers is made up in a similar way to Professor G. G. Foster's method of joining up the Wheatstone balance, the results are more delicate than with the ordinary method. This disposition was suggested to Professor Thompson by Mr. Starling, his assistant. Other applications of the Dolbear telephone will suggest themselves to experimenters, now that Professor Thompson has shown its value; and it has the advantage of being a very handy instrument. For example, as Professor Thompson showed, it can be employed to jump out capacities of surfaces round charged bodies; but in this, as in the other cases mentioned, the fluctuating current from an induction coil must be used instead of a continuous charge. Thus when the two terminal wires of the telephone are on the same equipotential surface no sound is heard in the telephone; but a sound is heard if they are not.

TELEPHONIC RECEIVERS.

Professors SILLIMAN and T. Thompson has lately devised a new form of telephonic receiver of the type originally invented by Phillip Reis. In the Reis instrument the telephonic currents are passed through a coil of wire surrounding a needle or rod of iron or steel mounted upon a suitable sounding box or resonator. The variations of the strength of the current produced by the tions in the degree of magnetisation of the needle which in consequence of the molecular changes thus set up, emits sounds. The final result of such molecular changes is, in general, to produce either an expansion or a contraction of the needle. If it be less, steel, or cobalt, an increase of magnetisation will cause it to expand in the direction of its magnetisation, while if it be nickel the contrary will take place. In the well-known needle instrument of Reis, the sounds emitted are not loud, partly because the mass of magnetic metal is too great to permit the required changes in its degree of magnetisation to be rapidly effected, and partly because the acoustic arrangement of the parts is defective and inconvenient. Professor Thompson's improved instruments are based upon the same principles of magnetising the armature and conducting coil, but the character chiefly sought for by the varying degree of magnetisation of the needle is the telephonic currents, and the improvements are due to various methods of obviating or avoiding the defects of the Reis instrument while preserving and developing its fundamental principle. The figures annexed will explain the form of the instrument. The instrument takes, similar parts being indicated by like letters, the form shown in each case. In the example shown in Fig. 1, a thin rod or piece of wire W, of iron, steel, or nickel, is fixed by one end to the centre of a tympanum T of wood, horn, ebonite, sheet metal, or other suitable substance. Its other end is fixed to an adjusting screw or pin S, by means of which the rod can be strained to any degree of tension. C is a coil of wire wound upon a tube of sufficient diameter not to interfere with the vibrations of the central rod. The combined tympanum, wire, and coil are enclosed in a case of convenient form, having an earpiece. The general action of the instrument is as follows: If the current received in the coils C, through the wires from the transmitter, increase in strength, it will change the molecular condition of the central rod, causing it to stretch slightly if of iron, steel, or cobalt, or to contract slightly if of nickel. A decrease in the strength of the currents will be followed by a partial diminution of the central rod, producing an inverse movement. Hence if one end of the rod is tightly screwed up to the case of the instrument, the varying or fluctuating currents will cause corresponding vibrations of the tympanum. This telephonic receiver, when compared with any existing instrument, reproduces sounds much more loudly than the original Reis-needle instrument, and its articulation, especially of the sibilants and of some other consonants, is much clearer and more distinct than that of the common magneto-telephonic receiver.



In the form of instrument shown in Fig. 2 there are two wires W and w attached to the tympanum at different points, but terminating in a common adjusting screw and surrounded by one coil. The wires may both be of iron or steel, but a better effect is obtained if one is of iron and the other of nickel, so that whilst one is expanding the other is contracting. Fig. 3

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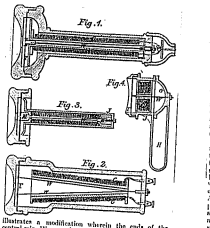

illustrates a modification wherein the ends of the connecting wire W are coiled to receive M of magnetic material in order more effectually to produce the magnetism. One end of the wire is connected to the tympanum and the other to the closed coil of an iron tube H, which serves as the case of the instrument. In Fig. 4 the iron case J is shown wide and short, and provided with a pair of handle which carries an iron cap G, to the centre of which the wire W is screwed, the spring of the band handle being serviceable to keep the wire in the proper condition of tension.

Sonn – Nov. 7, 1884

THE BELL EXHIBITION.

Amongst the Bell telephone exhibits at the Philadelphia Electrical Exhibition is a most interesting apparatus, Professor Bell's audiophone. Its function is to transmit speech by means of a ray of light, and without wire. It consists of a flat mirror, properly suspended, by means of which a ray of light is reflected through a cell containing a slum water, which absorbs the heat rays, to a vibrating diaphragm about 4 feet distant. The diaphragm is itself a mirror, and reflects the ray back through a suitable lens to a parabolic reflector, in the focus of which is a selenium cell, the terminals of which are connected with a magneto receiver. Now, connected with the back of the mirror diaphragm referred to is a flexible tube, fitted with a mouthpiece. On talking into this tube, the mirror diaphragm vibrates, the rays which it reflects through the lens into the parabolic reflector are thereby disturbed, and undergo modifications of intensity; these rays are forced upon the selenium cell, and their changes affect the current in the cell in the same way that a vibrating armature effects the induced current around the poles of a permanent magnet. This current from the selenium cell is carried through the back of the reflector to a hand receiver, and, holding this to the ear, the speech is heard. It is said that Professor Bell has conveyed speech 500 feet in this way by means of a strong ray of light.

SOUND MOTORS.

Mr. Edison's "motophone," in which the vibration of a telephone plate or "tympan" under the action of the voice, is made to work a ratchet wheel round, anticipated the apparatus of Dr. Drouhk, of the University of Agram in Croatia. Through the kindness of Mr. H. Preece, F.R.S., we have seen a set of Dr. Drouhk's apparatus in action. The source of sound is a tuning-fork kept in vibration by electro-magnetism and mounted on a resonance box. The open mouth of this box or chamber is the source of sound, and the sound-mills are placed in front of it. One of these consists of a cluster of light glass balls suspended from a cross-shaped frame which is pivotted on a needle point. Each ball has a little nipple blown on its side, the nipple being pierced with a hole. The holes are on the same line of each ball round the cluster, that is to say, they all point in one way and receive the sound impulses one after another as the group of balls revolves, just like the sails of a windmill. The wall of the balls opposite the nipples is, of course, entire, and the medium is due to the reaction on it. Another mill consists of four little stiff flags or plates of paper-like material pierced with holes, and suspended from four cranks carried by a pivot as before. The holes are no pierced as to make small open nipples as before on a needle point. The holes are .3 centimetres apart. When placed before the resounding cavity, with the smaller ends of the nipple-like holes towards it, the cord is repelled and attracted if the back of the cord presenting the wider openings of the nipple is placed before the resonator. A similar mill is made with plane flags without holes, and the motion is intensified by placing between it and the cavity of the resonator a brass ball, or Helmholtz resonator, with open nipples at opposite diameters. These nipples are placed in line with the resonating cavity and the mill, the larger nipple being next the cavity. When a lighted paper or the hand is held behind the Helmholtz resonator, a distinct puff or wind is felt to issue from the nipple farthest from the resonator; and it is this puff of wind which, impinging on the vanes of the mill, causes it to rotate. A screen pierced with 100 conical holes may also be placed between the ball resonator and the mill in order to distribute the breeze. Another of Dr. Drouhk's rotators, also very interesting, is a fist cylindrical paper box, of glazed paper, having four projections on its sides, each carrying a short open tube of paper. It is a resonator with four openings, and, when suspended by a silk thread from a standard in front of the sounding box, begins to twirl round.

A NEW TELEPHONE.

A PAPER "On the Conversion of Radiant Energy into Sonorous Vibrations," was read before the Royal Society recently by Mr. W. H. Preece, the electrician to the Post Office. The remarkable discovery by Messrs. Graham Bell and Sumner Tainter that the rapid intermittent incidence of vibrations has attracted very much attention and has excited much physical work to refer to the asserted problem. The advocates of the emission theory of light have striven for ten years to obtain such a proof of their theory as Mr. Bell has. Why have Bell and Tainter succeeded, or believed to have succeeded at all? May not their phenomena be due to some other cause than to the instantaneous light? It was suspected by many that it was a heat effect, and not a light one at all. Mr. Mercadier, in Paris (*Comptes rendus*, Dec. 8, 1880), and Professor Tyndall (*Proc. R. S.*, Jan. 3, 1881), have placed this beyond the region of doubt, and now Mr. Preece has completed the chain of evidence by a careful and elaborate inquiry into the cause of the phenomena. In the first part of the paper he has shown that chonite and indiarubber though opaque to the light rays, are remarkably shallow transparent transparent to the heat rays, and therefore that sulphur cells can act though screens of these materials. Indeed, ebonite is shown to be almost perfectly transparent to radiant heat, while it is absolutely impervious to light. He also shows by experiments, which no doubt will be repeated in this country, that the effect of the second can possibly be produced by the direct impact of light waves causing expansion of the mass of the disc, and therefore that the Bell-Tainter effect is not due to the absorption of heat changing the volume of hard substances experimented upon. He next inquires whether the effect observed is due to a molecular pressure similar to that which produces the radiometer or the radiometer, for this being a mere motor action, the element of time is eliminated. Many experiments are described which were made with discs of various kinds in different ways, but the results were so unsatisfactory and uncertain that the opinion was raised whether the disc vibrated at all. By the aid of microphones and specially-constructed chambers, he proved clearly that the sound-waves are those of the air immediately next the disc. In fact, the sounds were produced in the air over the discs. Moreover the effects were materially assisted by cutting the sides of the containing vessel with a calotonic coil of the boldest kind, such as the carbon deposited by barnish on camphor. It is next shown that the effects depend not on the number of heat rays that pass through the discs, and that on these that are incident on them, and that the greater the absorbed number of the air or vapour contained in the case, the more intense the sounds emitted. All these results are repeated and shown with ordinary flicks lamphlacked on their exterior and interior. Finally, it is shown that there is a close element interdicted, and that the loudness of the note emitted depends not only on the rapidity with which the luminous air absorbs the radiant energy, but also on the rapidity with which it gives up its heat to the sides of the case and the cells upon to it. It varies also with the form of the enclosed space and with the character of the contained vapour, and with the substance of the sides. The effect being thus due to radiant heat and its absorption by the surrounding air, Mr. Preece concludes that if a beam can be completely reduced to a lamplblacked case, sounds were emitted when currents of electricity were rapidly and intermittently transmitted through the wire, and, moreover, that when these currents were produced by a proper microphone transmitter articulate speech was produced. Hence these phenomena are simple effects of radiant heat, and they are due to the changes of volume in absorbent gases and vapours produced by the absorption of thermatomic heat in a confined space. All the varied and novel experiments which Dr. Graham Bell performed when he was recently in Europe with solids, liquids and gases, with tubes, flasks and discs are thus brought within our simple explanation, and are due to a remarkable influence of degraded heat rays on absorbent vapours. The final result of this inquiry has been, not only to unravel an exceedingly interesting scientific problem, but to produce another form of telephone based on new principles.

THE TELEPHONE IN GLASGOW.

The telephone exchange system has undergone very great extension in Glasgow within the past couple of years. In the month of March, 1881, the different intercests then existing were amalgamated in the National Telephone Company; and whereas there were at that time 200 exchange subscribers, there are now 650 exchange and 200 private lines. There are now no fewer than six exchanges—one each in Queen-street, St. Vincent-street, Douglas-street, Morrison-street (south side), Hillhead, and Bridgeton; and all of them are connected together by means of trunk wires. The final-named exchange is the principal one, there being in all about 400 subscribers connected with it. There are bright switch-boards in it, each of which affords communication with fifty subscribers, and all the boards are intercommunicated, so that a subscriber in one may be "connected up" with a subscriber in another. At each of the boards there are two operators, and nearly all of them are young ladies. There is no ringing of bells, or anything of that kind; but when a subscriber calls a small disc falls down which at once attracts the attention of the operator. All the exchanges are open night and day, in which respect they are in advance of the telephone exchanges in London; and communication can be had with Edinburgh and Leith, Greenock and Paisley, by means of trunk lines; and with the Ambulance Association, the infirmaries, most of the public buildings, and many warehouses, offices, and public works. It is especially worthy of remark that there are many private lines from Glasgow to places at distances of ten, twenty, or even thirty miles beyond the boundaries. Further, it is interesting to notice that each subscriber on the average calls up another five times a day, and allowing for five replies, each telephone is used ten times a day; but some subscribers make their telephones fifty or sixty times daily. Among 4000 connections are sometimes made in one day. The National Telephone Company have now obtained a concession from the Postmaster-General by which a reduced tariff can be charged for short communication between the large towns and cities and Glasgow.

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Engineering July, 1881

APPLICATION OF THE PHOTOPHONE TO THE STUDY OF THE NOISES TAKING PLACE ON THE SURFACE OF THE SUN.

On visiting the Observatory of Meudon, at the invitation of M. Janssen, Mr. Graham Bell examined with much care the large photographs which are being made there for the study of the solar surface. M. Janssen having informed him that he detected movements of a prodigious rapidity in the photospheric matter, Mr. Bell had the idea of employing the photophone for the reproduction of the sounds which these movements must necessarily produce on the surface of the sun. M. Janssen approved of the idea, and requested Mr. Bell to attempt its realization at Meudon, placing all the instruments of the observatory at his disposal. The weather being very fine on Saturday last (October 30), Mr. Bell came to Meudon to attempt the experiment. A large solar image of 0.65 metre in diameter was examined with the selenium eyepiece. The phenomenon were not sufficiently decided to be regarded as successful, but Mr. Bell does not despair of succeeding on further examination. M. Janssen suggested that the chance of success would be much greater if in place of directly interrogating the solar image where the variations are produced, though responding to considerable changes on the sun's surface, are not sufficiently rapid even in the most powerful instruments to cause the production of sounds in the photophone, a series of solar photographs of one and the same spot, taken at sufficient intervals to obtain well-marked variations in the constitution of the spot, might be passed with a suitable rapidity before an object glass, which would give conjugated images upon the selenium apparatus. This would be a means of condensing into a time as brief as could be desired the variations which in solar images are much too slow to give rise to a sound. M. Janssen has placed himself at Mr. Bell's disposal to provide him with solar photographs suitable for carrying out this idea, and the latter has left M. Janssen the photophonic apparatus requisite. It has appeared to M. Janssen that the idea of reproducing on earth the sounds caused by great phenomena on the surface of the sun was so important that the author's priority should be at once secured.

LECTURE PHOTOPHONE.

A simple form of Photophone, which is sufficient to show the principle of the instrument, and may be used for lecture purposes, has been arranged by Mr. Shelford Bidwell, and exhibited before the Physical Society of London.

The reflector for receiving the light is discarded, and the beam focussed on the selenium by the lens.

The two lenses used cost only about six dollars, and the beam is rest fourteen feet.

The selenium cell was made by spreading melted selenium over sheets of mica, and then crystallized by heat. For mica Professor Bell recommended microscopic glass.

The resistance of the cell was 14000 ohms in the dark and 6500 in the light. Speech was distinctly transmitted by this apparatus.

A PHOSPHORUS MICROPHONE.

In his photophonic experiments, Professor James Blyth, of Edinburgh, was led to construct a useful form of selenium cell by dovetailing two brass screens, having alternate teeth knocked out, and filling up the spaces between the interlocking teeth with the selenium. A modification of this pattern is made by fastening a brass disc on wood and sawing it across until it consists of radial sectors which are afterwards connected by selenium. While trying substances he found the phosphorus evolved a phonic, and the idea occurred to him that a microphone could be made from it, which would not generate its own electricity, but therefore took a shallow wooden box having a brass bottom, and spread a lid covering the box upon it; a thin flexible brass Wires from a telephone were then connected to the metal top and bottom of the box, and on speaking the words were distinctly reproduced. The varying pressure of the sound waves on the phosphorus, established an undulating current which passing through the telephone, caused it to give out the original words. When a battery was included in the circuit the sounds were remarkably clear and loud and free from the grating which disturbs the carbon microphone. Professor Blyth also finds that the cell, which is really a form of loose contact, operates as a receiver as well as a transmitter, and will of itself emit articulate sounds under the influence of the vocal currents.

THE MICROPHONIC ACTION OF THE SELENIUM CELL.

At a recent meeting of the Physical Society, Dr. James Moser read a paper expressing his opinion that the well-known action of the selenium cell in Professor Graham Bell's photophone is not so much a mechanical, physical, or chemical one as it is a microphonic action. The cell is usually composed of metal plates connected together by annealed selenium, and having wire electrodes. Dr. Moser therefore argues that the junction between the metal and the selenium is what electricians term "a bad joint," or in other words a microphonic contact. The varying beam of light from the photophone transmitter falling upon the cell, expands and contracts the metal plates or the electrodes by virtue of the heat rays, and thereby tightens and slackens the microphonic joint. Another effort of modulating the current of electricity which flows through the cell, and causing the modulations of the voice to be audible in the telephone, Dr. Moser showed that with copper plates the selenium cell was really a pile of copper, selenide of copper, and selenium, built up in order, and he compared it to the thermopile of Professor Hughes and Mr. Edison, in which a number of little cubes of carbon are arranged end to end in a glass tube with brass fillings between. When a current is sent through this combination it becomes very sensitive to heat rays falling on it, owing to the expansion of the carbons by heating and the consequent closing of the microphonic joints between them. The idea of Dr. Moser is highly interesting, but it requires to be further supported by experiment.

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TELEGRAPH AND TELEPHONE

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Enemon.

Like some old Titan of majestic bright,
His march has been with grand and solemn tread,
The lands profoundly working, while the head,
Circled by mists, was often hid from sight;
Yet from its cloud, when great thoughts flushed to light,
That mighty brain by the elect was read.
The many saw not, turned away, instead;
His brightness, veiled, to them was only night.
But, as he walked, anon at either side
Fell pregnant seeds of thought, which, taking root
In minds long barren, showed the tender shoot
That later blossomed. Closely might praise hide,
Yet everywhere the great man planted fast
His mark remains, and shall through time abide.

ELIZABETH C. KINNEY.

What is "The Secret Telephone?"

For the last week or two the voracious scientist of the daily press has been serving up to his readers, well-seasoned accounts of a new telephone company recently formed, to carry on a general telephone business. The somewhat mysterious title of the new organization is stated to be "The Secret Telephone Company;" and the instrument by which the achievements of the new company are to be accomplished is denominated the "The Secret Telephone."

The secret of the electricity shrewdly mentioned, says: "It is called the secret telephone, because when two persons are talking, no one else, although he may be on the same line can hear what is said." After describing the secret telephone and its circuit arrangements the scientific chronicler goes on to enumerate its further advantages, as follows: "The secret telephone is about one-half the size of the Bell telephone. A carbon diaphragm is used in the transmitter instead of a metal one, as in the ordinary telephone, and in the receiver a common horse-shoe magnet is used instead of the vibrating armature. The inventor claims great advantage for his instrument, (of course he does—was there ever an inventor who didn't, from Tubal Cain to Rogers), instead of being suspended, the electricities float in mercury, which gives distinctness to the sound and enables the telephone to be operated at long distances. There are many other differences between the 'secret' and the common telephone, but the advantages enjoyed are secrecy and the superiority in transmission. In an experiment in Washington, conversation in a low tone at a distance of 25 feet from the transmitter was heard plainly two and a half miles away." It may be fairly presumed that about two-thirds of the daily and weekly newspapers of the United States, have printed within the last two weeks, some such statement as the above. We are persuaded that this estimate does not overstate the mark; and judging from the number of samples we have received, with the wards to the effect aforesaid, carefully marked in blue pencil on the second page, we should suppose that our estimate is considerably too small. By the way, why does the telephone man always mark such articles in blue pencil, when he wants to attract your attention? Is it indicative of the tum his feelings would take if he thought there was any adequate foundation for a new and opposition telephone company to be started upon, or is it merely a straw which denotes the growth of esthetics among telephonists?

After reading some two thousand extracts of the same general character pertaining to The Secret Telephone, there came a pause, and we had time to breathe, and then we received duly the REVIEW of the TELEGRAPH and TELEPHONE, etc., etc., and we read with lated breath the details of the organization of the "National Secret Telephone Company," with the momentous fact that a Harris Improvement, of New York, took 19,991 shares, leaving to the majority of his fellow stockholders but one share each, and trusting to the dear public to come boldly forward and take the remaining 10,000 shares. Since it appeared that more than ordinary public interest had been excited by the articles which we have generally described, we have thought that a few words explanatory of the real character of the secret telephone would be generally acceptable.

The secret telephone company, claims thus, to be based upon the patents of James H. Rogers, at present out-of-sight in number.

The first and most characteristic patent was issued December, 1881, and is for the secrecy feature, and the method and apparatus whereby it is attained.

The second purports to be for a battery transmitter, consisting of a mouthpiece, a diaphragm, which may carry a suitable electrode, or which may itself be of carbon; a mercury bath in which floats one or more particles or broken fragments of carbon, which are supported by the mercury and caused to touch the under surface of the diaphragm or of the electrode carried thereon.

One of the circuit wires is connected with the diaphragm, and the other with the mercury bath, and a battery is placed in circuit.

This, according to the specification, may be used with or without an induction coil, and the existence of the circuit is of course varied when the diaphragm is spoken to, causing electrical undulations which traverse the line and influence any electro-magnetic receiving instrument which may be there in circuit.

Patent No. 3, is for a receiving telephone, although the patentee states that it will also transmit.

To understand it without a picture — imagine a sheet of metal, iron or steel for example, about six inches long and three inches wide, folded close round a cylinder or core until it acquires the cylindrical arcuate-like form, with the edges very near to each other but not touching; after the form is acquired the core is withdrawn, one edge is then wound round length-ways with insulated wire and forms the core of the magnet, or if desired, the covered wire may be wound over the whole of the cylinder. The covered wire forms part of line circuit.

Patent No. 4, describes and claims different methods of carrying out the secrecy feature mentioned in No. 1, and shows several ways of putting it into practical operation.

Patent No. 5, is for another variety of battery transmitter, in which the electrical undulations, to quote the specifications, are produced by varying the resistance, quantity or bulk of a fluid conductor, and consequently its conductivity.

A word as to the relative value of patents may here be not out of place: Many persons are now fully acquainted with the general rules by which such relative values are governed. Many more, however, are not But the facts of the matter are something like the following:

Any person who first discovers or invents a new art, or process of manufacture, or machine, or any new article, may obtain a patent for it, in all its breadth, no matter how simple and easy his discovery or invention may have been. The very fact that until the date of his invention, it had remained undiscovered, presupposes a certain amount of inventive or discovering talent to have been necessary, and the protection for seventeen years from the date of issuance of the patent, is his reward for the use and benefit which the world will derive from the free and unrestricted employment of the invention after the seventeen years have expired.

Furthermore, any person who may have made a discover any new and useful *improvement* upon any art, process or machine, may obtain a patent for his improvement, and he is entitled to his improvement just as fully as the first inventor was to *his* invention.

The improver may not use the first invention without the permission of the inventor, and the inventor, while having full right to the first invention, may not avail himself of the improvement unless he first agrees with the improver. For example: Mr. Brown may be the first inventor of a button, Mr. Jones subsequently discovers that buttons having four holes through them possess certain advantages, and patents a button having four holes.

Mr. Brown has a full right to button, but he may not use a four-holed button unless such a button was fully shown in his specification. Mr. Jones again, while controlling his four holes, may not make buttons at all unless he gets permission from Mr. Brown. Carrying the matter still further, let us imagine Mr. Cox to have subsequently found that, by making Mr. Jones's four holes square, he obtains certain additional advantages; this is Mr. Cox's invention and he patents it. At this point, to carry on our argument, Mr. Brown still retains his right to button *per se*.

Mr. Jones monopolizes four-holed buttons if he can get permission from Mr. Brown to use buttons at all, and Mr. Cox may enjoy exclusively the right to make buttons with four square holes—with the trifling

ible age of, thirteen, in the year 1805, revealing three eight years; and during the chief part of the time bound books. Now if was in those books, the hours of the day which I found the beginning of my philosophy." There were ten that especially helped me,—the Encyclopedia Britannica, from which I gained my first notions of chemistry, and Mrs. Marcet's "Conversations on Chemistry," which I devoured with unspeakable delight. Does not suppose that I was a very deep thinker, or was marked a precocious person; I was a busy imaginative person, and could believe the Arabian Nights as easily as in the Encyclopedia. But facts were, impressed to me and saved me; I could trust a fact and always cross-examined each assertion. So when I questioned Mrs. Marcet's book about certain experiments as I could find means to perform, and found it true, I was delighted beyond measure; and I felt that I had got hold of an anchor in chemical knowledge. I clung fast to it. Thence my deep veneration for Mrs. Marcet—for any one who had conferred personal good pleasure on me;—and then as one able to convey the truth and principle of those boundless intellectual delights which concern natural things to the young, tastefully and lucidly. Then, you may imagine my delight when I came to know Mrs. Marcet personally, and found that I was my thoughts backward, delighting to connect the past and the present bow often, when sending her a paper as a thank-offering, I thought of my first instruments; and such thoughts will remain with me."

Henry wrote on the inside of the cover of Gregory's work the following words in his book, although by no means a profound work; but, under Providence, was a remarkable influence on my life. It accidentally fell into my hands when I was but seven years old, and was the first book I ever read with utter interest. It opened to me a new world of thought and enjoyment; invested things before almost unnoticed with the highest interest; fixed my mind on the study of nature, and caused me to resolve at the time I was reading it, that I would devote my life, or devote my life to the acquisition of knowledge.—J. H. Each of these philosophers worked with simple instruments, and was dependent on his own hands; and by methods so direct that he appeared to have almost intuitive perception into the workings of nature; and each gave great care to the composition of his writings, sending his discoveries to the world clothed in simple and elegant English, purified and illustrated by occasional humor. Such was Henry's relation ships with other men. There was sympathy between the men; and Henry loved to dwell on the hours that he and Bakewell, Davy, and Faraday—I shall never forget Henry's account of his visit to King's College, London, where Faraday, Wheatstone, Daniell and Sir Charles Bell were exhibiting the electric spark from the thermopile. Each in turn would try and fail. Then came Henry's turn. He succeeded, calling in the aid of a second battery, the effect of a long interpolar wire wrapped round a piece of soft iron. Faraday became as wild as a boy; and, jumping up, shouted, "That's the Yankee electricity." And Faraday and Wheatstone reciprocated the high estimation in which Henry held them. "During a visit to Wheatstone's, in 1837, Wheatstone's uncle, he told me that Faraday and he had, after Henry's classical investigation of the induced currents of different orders, written a joint letter to the Royal Society, claiming that the Copley medal, that laurel wreath of science, should be bestowed on Henry for his further consultation with them; that the award it was decided to give for the honor till it would come with greater *éclat*, when Henry had made his discovery of the electric telegraphy. Henry's reward to Wheatstone, from those former investigations, Wheatstone promised to give me this letter to convey to Henry. Wheatstone's experiments on light agreed with Faraday and he had for Henry's genius, but Wheatstone's untimely death prevented this." Both Faraday and Wheatstone thought in the philosophy of education, and in the mode in which he agreed. I may in this connection be excused for quoting another letter from Wheatstone, addressed to Professor Henry, after he had received the news I had given him of his name. After a playful discussion of the name Joseph, the letter proceeds: "I hope that both his body and mind will be developed by proper training and instruction; that he may become an intelligent, wise and good man; I say efficient and wise, because an efficient man and a wise man are not always united in the same person. Instruction, whether intellectual or moral, is the work of time. Instruction. Wisdom may be taught, but it cannot be done, but it requires the aid of industry to accomplish the desired object. I hope that in the education of your son due attention will be given to the proper development of both these faculties, but also they will be cultivated in the order of nature; that is, doing before knowing, and knowing before reasoning. By inverting this order much injury is frequently done to a child, especially in the case of the only son of a widowed mother; in which case the temptation becomes an inducement to err. The education in such a case, will generally be found that the boy has never been drilled into habits of industry, of order, of punctuality, of arithmetic, or of spelling; of attention, perseverance, or, in other words, of the habits of an active and efficient life."

Henry was a man of extensive reading, and often surprised his friends by the extent and accuracy of his information; and by the original manner in which he brought his knowledge before them. Not only was he well versed in those subjects in which one might naturally expect to become him proficient, but in departments of knowledge entirely distinct from that in which he gained his reputation as an original thinker. Of poetry, especially the descriptive, he had a keen feeling for the movement of a poem; and was fond of drawing from his retentive memory poetic quotations apt; it the occasion. He was a diligent student of mental philosophy, and also took a lively interest in the progress of biological science; especially in following out the generalizations of Darwin; while the astonishing development of modern research in tracking the history of prehistoric man had for him a peculiar attraction. Of all his learning, reputation and influence, I may say, as evident in his last hours. One day, on opening Henry's copy of Young's Lectures on Natural Philosophy—a book which he had studied more than any other work of science—I read on the fly-leaf, written in his own hand, these words:—

> "In Nature's infinite book of secrecy
> A little I can read."—*Shakespeare*.

And did he not read a little "in Nature's infinite book of secrecy ?" And did he not read that little well ? May we all read our little in that book as modestly and as reverently a did Joseph Henry.

THE PHOTOPHONE.

By Alexander Graham Bell.

In bringing before you some discoveries made by Mr. Sumner Tainter and myself, which have resulted in the construction of apparatus for the production and reproduction of sound by means of light; it is necessary to explain the state of knowledge which formed the starting point of our experiments. I shall first describe the remarkable substance selenium, and the manipulations developed by various experiments: but the final result of our researches has evidenced the class of substances sensitive to light-vibrations, until we can propound the fact of such sensitiveness being a property of all matter. We have found this property in gold, silver; platinum, iron, steel, brass, copper, zinc, lead, antimony, German silver, Arabin's metal, Babbitt's metal, ivory, celluloid, gutta percha, hard rubber, soft vulcanized rubber, paper, parchment, wood, mica and silvered glass; and the only substances from which we have not obtained results are carbon and thin microscopic glass. We find that when a vibratory beam of light falls upon these substances they emit sounds,—the pitch of which depends upon the frequency of the vibratory change in the light. We find further that, when we control the form or character of the light-vibration on selenium, and probably on the other substances, we control the quality of the sound and obtain all varieties of articulate speech. We can thus, without a conducting wire as in electric telephony, speak from station to station, wherever we can project a beam of light. We have not had opportunity of testing the limit to which this photophonic influence can be extended, but we have spoken to and from points separated apart; and there seems no reason to doubt that the results will be obtained at whatever distance a beam of light can be flashed from one observatory to another. The necessary privacy of our experiments hitherto has alone prevented any attempts at determining the extreme distance at which this new method of vocal communication will be available. I shall now speak of selenium.

In the year 1817 Berzelius and Gottlieb Gahn made an examination of the method of preparing sulphuric acid, in use at Gripsholm. During the course of this examination they observed in the deposit a sediment of a dusty reddish, purple color brown color, which, on the return of the blow-pipe gave out a peculiar odor, like that attributed to decayed horseradish. They suspected the existence of extreme rarity; but upon subsequent examination from this deposit; but he was unable, after many experiments, to obtain further indications of its presence. He found plentiful signs of sulphur mixed with mercury, copper, zinc, iron, arsenic and lead, but not a trace of tellurium. It was not in the nature of Berzelius to be discouraged by this result. In science every failure advances the knowledge of the investigator. Berzelius reasoned therefore felt that, if the characteristic odor that had been observed did not proceed from tellurium, it might possibly indicate the presence of some substance then unknown to the chemist. He opened on by this hope he resumed with renewed ardor to his work. He collected together a considerable quantity of the material, and submitted the mass to various chemical processes. He succeeded in separating successively the sulphur, the copper, the lead, the arsenic and all other known substances whose presence had been indicated by his tests;—and after all these had been eliminated, thereafter remained

FIG. 1.

FIG. 6.

FIG. 2.

FIG. 7.

FIG. 3.

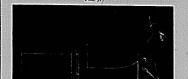


FIG. 8.

FIG. 4.

FIG. 9.

FIG. 5.

FIG. 10.

ILLUSTRATING PAPER ON PHOTOPHONE.

By Alexander Graham Bell.

1—The Interposition of Hard Rubber Plate. 2—The Light passed through openings in rapidly revolving diaphragm and reflected on selenium receiver. 3—Application of figure four. 4—Action of Voice on thin Plate of Silvered Mica. 5—Application of Morse system of Telegraphy to Photophone. 6—Listening directly to Receiving Plate. 7—Another form of Receiver. 8—One of the first forms, Voice passed through Mica. 9—Direct Action of Voice on Gas Flame. Action of Candle Light on selenium receiver.

a residue which proved upon examination to be what he had been in search of—a new elementary substance. The chemical properties of this new element were found to resemble those of tellurium in so remarkable a degree that Berzelius gave to the substance the name of "Selenium," from the Greek word *selene*, the moon—("tellurium," as is well known being derived from *tellus*, the earth.

Although tellurium and selenium are alike in many respects, they differ in their electrical properties; tellurium being a good conductor of electricity, and selenium, as Berzelius showed, a non-conductor. Knox discovered, in 1837, that selenium became a conductor when fused; and Hittorff, in 1852, showed that it conducted, at ordinary temperatures, when in one of its allotropic forms. When selenium is rapidly cooled from a fused condition, it is a non-conductor. In this, its vitreous form, it is of a dark-brown color, almost black by reflected light, having an exceedingly brilliant surface. In thin films it is transparent, and appears of a beautiful ruby red by transmitted light. When selenium is cooled from a fused condition with extreme slowness, it presents an entirely different appearance, being a dull lead color, and having throughout a granulated or crystalline structure, and looking like a metal. In this form it is perfectly opaque to light, even in very thin films. This variety of selenium has long been known as "granular" or "crystalline" selenium, or, as Regnault called it, "metallic" selenium. It was selenium of this kind that Hittorff found to be a conductor of electricity at ordinary temperatures. He also found that its resistance to the passage of an electrical current diminished continuously by heating up to the point of fusion, and that the resistance suddenly increased in passing from the solid to the liquid condition. It was early discovered that exposure to sunlight hastens the change of selenium from one allotropic form to another; and this observation is significant in the light of recent discoveries.

Although selenium has been known for the last sixty years it has not yet been utilized to any extent in the arts, and it is still considered simply as a chemical curiosity. It is usually supplied in the form of cylindrical bars. These bars are sometimes found to be in the metallic condition; but more usually they are in the vitreous or non-conducting form. It occurred to Willoughby Smith that, on account of the high resistance of crystalline selenium, it might be usefully employed at the shore-end of a submarine cable, in his system of testing and signalling during the process of submersion. Upon experiment, the selenium was found to have all the resistance required—some of the bars employed measuring as much as 1400 megohms—a resistance equivalent to that which would be offered by a telegraph wire long enough to reach from the earth to the sun! But the resistance was found to be extremely variable. Experiments were made to ascertain the cause of this variability. Mr. May, Mr. Willoughby Smith's assistant, discovered that the resistance was less when the selenium was exposed to light than when it was in the dark.

In order to be certain that temperature had nothing to do with the effect, selenium was placed in a vessel of water, so that the light had to pass through from one to two inches of water in order to reach the selenium. The approach of a lighted candle was found to be sufficient to cause a marked deflection of the needle of the galvanometer connected with the selenium, and the lighting of a piece of magnesium wire caused the selenium to measure less than half the resistance it did the moment before.

These results were naturally at first received by scientific men with some incredulity, but they were verified by Sale, Draper, Moss and others. When selenium is exposed to the action of the solar spectrum, the maximum effect is produced, according to Sale, just outside the red end of the spectrum, in a point nearly co-incident with the maximum of the heat rays; but, according to Adams, the maximum effect is produced in the greenish-yellow or most luminous part of the spectrum. Lord Rosse exposed selenium to the action of non-luminous radiations from hot bodies, but could produce no effect; whereas a thermopile under similar circumstances gave abundant indications of a current. He also cut off the heat-rays from luminous bodies by the interposition of liquid solutions, such as alum, between the selenium and the source of light, without affecting the power of the light to reduce the resistance of the selenium; whereas the interposition of these same substances almost completely neutralize the effect upon the thermopile. Adams found that selenium was sensitive to the cold light of the moon, and Werner Siemens discovered that, in certain extremely sensitive varieties of selenium, heat and light produced opposite effects. In Siemens's experiments, special arrangements were made for the purpose of reducing the resistance of the selenium employed. Two fine platinum wires were coiled together in the shape of a double flat spiral in the zig-zag shape, and were laid upon a plate of mica so that the discs did not touch one another. A drop of melted selenium was then placed upon the platinum-wire arrangement, and a second sheet of mica was pressed upon the selenium, so as to cause it to spread out and fill the spaces between the wires. Each cell was about the size of a silver dime. The selenium cells were then placed in a paraffine bath, and exposed for some hours to a temperature of 210° C., after which they were allowed to cool with extreme slowness. The results obtained with these cells were very extraordinary; in some cases the resistance of the cells, when exposed to light, was only one-fifteenth of their resistance in the dark.

Without dwelling farther upon the researches of others, I may say that the chief information concerning the effect of light upon the conductivity of selenium will be found under the names of Willoughby Smith, Lieutenant Sale, Draper and Moss, Professor W. G. Adams, Lord Rosse, Day, Sabini, Dr. Werner Siemens and Dr. C. W. Siemens. All observations by these various authors had been made by means of galvanometers; but it occurred to me that the telephone, from its extreme sensitiveness to electrical influences, might be substituted with advantage. Upon consideration of the subject, however, I saw that the experiments could not be conducted in the ordinary way for the following reason: The law of audibility of the telephone is precisely analogous to the law of electric induction. No effect is produced during the passage of a continuous and steady current. It is only at the moment of change from a stronger to a weaker state, or vice versa, that any audible effect is produced, and the amount of effect is exactly proportional to the amount of variation in the current. It was, therefore, evident that the telephone could only respond to the effect produced in selenium at the moment of change from light to darkness, or vice versa; and that it would be advisable to intermit the light with great rapidity, so as to produce a succession of changes in the conductivity of the selenium, corresponding in frequency to musical vibrations within the limits of the sense of hearing. For I had often noticed that currents of electricity, so feeble as to produce scarcely any audible effects from a telephone when the circuit was simply opened or closed, caused very perceptible musical sounds when the circuit was rapidly interrupted, and that the higher the pitch of sound the more audible was the effect. I was much struck by the idea of producing sound by the action of light in this way. Upon farther consideration it appeared to me that all the audible effects obtained from varieties of electricity could also be produced by variations of light acting upon selenium. I saw that the effect could be produced at the extreme distance at which selenium would respond to the action of a luminous body, but that this distance could be indefinitely increased by the use of a parallel beam of light, so that we could telephone from one place to another without the necessity of a conducting wire between the transmitter and receiver. It was evidently necessary, in order to reduce this idea to practice, to devise an apparatus to be operated by the voice of a speaker, by which variations could be produced in a parallel beam of light, corresponding to the variations in the air produced by the voice.

I proposed to pass light through a large number of small orifices, which might be of any convenient shape, but were preferably in the form of slits. Two similarly perforated plates were to be employed. One was to be fixed and the other attached to the centre of a diaphragm actuated by the voice, so that the vibration of the diaphragm would cause the movable plate to slide to and fro over the surface of the fixed plate, thus alternately enlarging and contracting the free orifices for the passage of light. In this way the voice of a speaker could control the amount of light passed through the perforated plates without completely obstructing its passage. This apparatus was to be placed in the path of a parallel beam of light, and the undulatory beam emerging from the apparatus could be received at some distant place upon a lens, or other apparatus, by means of which it could be condensed upon a sensitive piece of selenium placed in a local circuit with a telephone and galvanic battery. The variations in the light produced by the voice of the speaker should cause corresponding variations in the electrical resistance of the selenium employed: and the telephone in circuit with it should reproduce audibly the tones and articulations of the speaker's voice. I obtained some selenium for the purpose of producing the apparatus shown; but found that its resistance was almost infinitely greater than that of any telephone that had been constructed, and I was unable to obtain any audible effects by the action of light. I believed, however, that the obstacle could be overcome by devising mechanical arrangements for reducing the resistance of the selenium, and by constructing special telephones for the purpose. I felt so much confidence in this that, in a lecture delivered before the Royal Institute of Great Britain, upon the 17th of May, 1878, I announced the possibility of hearing a shadow by interrupting the action of light upon selenium. A few days afterwards my ideas upon this subject received a fresh impetus by the announcement made by Mr. Willoughby Smith before the Society of Telegraph Engineers that he had heard the action of a ray of light falling upon a bar of crystalline selenium, by listening to a telephone in circuit with it.

It is not unlikely that the publicity given to the speaking telephone during the last few years may have suggested to many minds in different parts of the world somewhat similar ideas to my own.

Although the idea of producing and reproducing sound by the action of light, as described above, was an entirely original and independent conception of my own, I recognize the fact that the knowledge necessary for its conception has been disseminated throughout the civilized world, and that the idea may therefore have occurred to many other minds. *The fundamental idea, on which rests the possibility of producing speech by the action of light, is the conception of what may be termed an undulatory beam of light in contradistinction to a merely intermittent one.* By an undulatory beam of light, I mean a beam that shines continuously upon the selenium receiver, but the intensity of which upon that receiver is subject to rapid changes, corresponding to the changes in the vibratory movement of a particle of air during the transmission of

a sound of definite quality through the atmosphere. The curve that would graphically represent the changes of light would be similar in shape to that representing the movement of the air. I do not know whether this conception had been clearly realized by "J. F. W.," of Kew, or by Mr. Sargent, of Philadelphia; but to Mr. David Brown, of London, is undoubtedly due the honor of having distinctly and independently formulated the conception, and of having devised apparatus—though of a crude nature—for carrying it into execution. It is greatly due to the genius and perseverance of my friend, Mr. Sumner Tainter, of Watertown, Mass., that the problem of producing and reproducing sound by the agency of light has at last been successfully solved.

The first point to which we devoted our attention was the reduction of the resistance of crystalline selenium within manageable limits. The resistance of selenium cells employed by former experimenters was measured in millions of ohms, and we do not know of any record of a selenium cell measuring less than 250,000 ohms in the dark. *We have succeeded in producing sensitive selenium cells measuring only* 300 *ohms in the dark, and* 155 *ohms in the light.* All former experimenters seemed to have used platinum for the conducting part of their selenium cells, excepting Werner Siemens, who found that iron and copper might be employed. We have also discovered that brass, although chemically acted upon by selenium, forms an excellent and convenient material; indeed, we are inclined to believe that the chemical action between the brass and selenium has contributed to the low resistance of our cells by forming an intimate bond of union between the selenium and brass. We have observed that melted selenium behaves to the other substances as water to a greasy surface, and we are inclined to think that when selenium is used in connection with metals not chemically acted upon by it, the points of contact between selenium and the metal offer a considerable amount of resistance to the passage of a galvanic current. By using brass we have been enabled to construct a large number of selenium cells of different forms. The mode of applying the selenium is as follows: The cell is heated, and, when hot enough, a stick of selenium is rubbed over the surface. In order to acquire conductivity and sensitiveness, the selenium must next undergo a process of annealing.

We simply heat the selenium over a gas stove and observe its appearance. When the selenium attains a certain temperature, the beautiful reflecting surface becomes dimmed. A cloudiness gradually extends over it, somewhat like the film of moisture produced by breathing upon a mirror. This appearance gradually increases, and the whole surface is soon seen to be in the metallic, granular or crystalline condition. The cell may then be taken off the stove, and cooled in any suitable way. When the heating process is carried too far, the crystalline selenium is seen to melt. Our best results have been obtained by heating the selenium until it crystallizes, and continuing the heating until signs of melting appear, when the gas is immediately put out. The portions that had melted instantly re-crystallize, and the selenium is found upon cooling to be a conductor, and to be sensitive to light. The whole operation occupies only a few minutes. This method has not only the advantage of being expeditious, but it proves that many of the accepted theories on this subject are fallacious. Our new method shows that fusion is unnecessary, that conductivity and sensitiveness can be produced without long heating and slow cooling; and that crystalization takes place during the heating process. We have found that on removing the source of heat immediately on the appearance of the cloudiness, distinct and separate crystals can be observed under the microscope, which appear like leaden snow-flakes on a ground of ruby red. Upon removing the heat, when crystalization is further advanced, we perceive under the microscope masses of these crystals arranged like basaltic columns standing detached from one another, and at a still higher point of heating the distinct columns are no longer traceable, but the whole mass resembles metallic pudding-stone, with here and there a separate snow-flake, like a fossil, on the surface. Selenium crystals formed during slow cooling after fusion present an entirely different appearance, showing distinct facets.

We have devised about fifty forms of apparatus for varying a beam of light in the manner required, but only a few typical varieties need be shown. The source of light may be controlled, or a steady beam may be modified at any point in its path. The beam may be controlled in many ways. For instance, it may be polarized, and then affected by electrical or magnetic influences in the manner discovered by Faraday and Dr. Ker. The beam of polarized light, instead of being passed through a liquid, may be reflected from the polished pole of an electro-magnet. Another method of affecting a beam of light is to pass it through a lens of variable focus. I observe that a lens of this kind has been invented in France by Dr. Cusco, and is fully described in a recent paper in "La Nature;" but Mr. Tainter and I have used such a lens in our experiments for months past. The best and simplest form of apparatus for producing the effect remains to be described. This consists of a plain mirror of flexible material—such as silvered mica or microscopic glass. Against the back of this mirror the speaker's voice is directed. The light reflected from this mirror is thus thrown into vibration corresponding to those of the diaphragm itself.

In arranging the apparatus for the purpose of reproducing sound at a distance, any powerful source of light may be used, but we have experimented chiefly with sunlight. For this purpose a large beam is concentrated by means of a lens upon the diaphragm mirror, and, after reflection, is again rendered parallel by means of another lens. The beam is received at a distant station upon a parabolic reflector, in the focus of which is placed a sensitive selenium cell, connected in a local circuit with a battery and telephone. A large number of trials of this apparatus have been made with the transmitting and receiving instruments so far apart that sounds could not be heard directly through the air. In illustration, I shall describe one of the most recent of these experiments. Mr. Tainter operated the transmitting instrument, which was placed on the top of the Franklin schoolhouse in Washington, and the sensitive receiver was arranged in one of the windows of my laboratory, 1325 L street, at a distance of 213 metres. Upon placing the telephone to my ear I heard distinctly from the illuminated receiver the words: "Mr. Bell, if you hear what I say, come to the window and wave your hat." In laboratory experiments the transmitting and receiving instruments are necessarily within ear-shot of one another, and we have therefore been accustomed to pooling the electric circuit connected with the selenium receiver, so as to place the telephones in another room. By such experiments we have found that articulate speech can be reproduced by the oxy-hydrogen light, and even by the light of a kerosene lamp. The loudest effects obtained from light are produced by rapidly interrupting the beam by the perforated disk. The great advantage of this form of apparatus for experimental work is the noiselessness of its rotation, admitting the close approach of the receiver without interfering with the audibility of the effect heard from the latter; for it will be understood that musical tones are emitted from the receiver when no sound is made at the transmitter. A silent motion thus produces a sound. In this way musical tones have been heard even from the light of a candle. When distant effects are sought another apparatus is used. By placing an opaque screen near the rotating disk the beam can be entirely cut off by a slight motion of the hand, and musical signals, like the dots and dashes of the Morse telegraph code, can thus be produced at the distant receiving station.

We have made experiments, with the object of ascertaining the nature of the rays that affect selenium. For this purpose we have placed in the path of an intermittent beam various absorbing substances. Professor Cross has been kind enough to give me his assistance in conducting these experiments. When a solution of alum, or bisulphide of carbon, is employed the loudness of the sound produced by the intermittent beam is very slightly diminished; but a solution of iodine in bisulphide of carbon cuts off most, but not all, of the audible effect. Even an apparently opaque sheet of hard rubber does not entirely do this. When the sheet of hard rubber was held near the disk interrupter the rotation of the disk interrupted what was then an invisible beam, which passed over a space of about twelve feet before it reached the lens which finally concentrated it upon the selenium cell. A faint but perfectly perceptible musical tone was heard from the telephone connected with the selenium. This could be interrupted at will by placing the hand in the path of the invisible beam. It would be premature, without further experiments, to speculate too much concerning the nature of these invisible rays; but it is difficult to believe that they can be bent rays, as the effect is produced through two sheets of hard rubber containing between them a saturated solution of alum. Although effects are produced as above shown by forms of radiant energy which are invisible, we have named the apparatus for the production and reproduction of sound in this way "*The Photophone,*" because an ordinary beam of light contains the rays which are operative.

It is a well-known fact that the molecular disturbance produced in a mass of iron by the magnetizing influence of an intermittent electrical current can be observed as sound by placing the ear in close contact with the iron. It occurred to us that the molecular disturbance produced in crystalline selenium by the action of an intermittent beam of light should be audible in a similar manner without the aid of a telephone or battery. Many experiments were made to verify this theory without definite results. The anomalous behavior of the hard rubber screen suggested the thought of listening to it also. This experiment was tried with extraordinary success. I held the sheet in close contact with my ear, while a beam of intermittent light was focussed upon it by a lens. A distinct musical note was immediately heard. We found the effect intensified by arranging the sheet of hard rubber as a diaphragm, and listening through a hearing-tube. We then tried crystalline selenium in the form of a thin disk, and obtained a similar but less intense effect. The other substances which I enumerated at the beginning of my address were now successively tried in the form of thin disks, and sounds were obtained from all but carbon and thin glass. We found hard rubber to produce a louder sound than any other substance we tried, excepting antimony, and paper and mica to produce the weakest sound. *On the whole, we feel warranted in announcing as our conclusion that sounds can be produced by the action of a variable light from substances of all kinds, when in the form of thin diaphragms.* We have heard from interrupted sunlight very perceptible musical tunes through tubes of ordinary vulcanized rubber, of brass and of wood. These were all the materials at hand in tubular form, and we have had no opportunity since of extending the observations to other substances.

I am extremely glad that I have the opportunity of making the first publication of these researches before a scientific society, for it is from scientific men that my work of the last six years has received the most valuable encouragement. Not only the encouragement which I received from the late Professor Henry at a time when the speaking telephone existed only in theory indeed, it is greatly due to the stimulus of his appreciation that the telephone became an accomplished fact. I cannot state too highly also the advantage I received in preliminary experiments on several occasions in this building from Professor Cross, and from Professor Houston, of the Franklin Institute. The interest of the public were introduced to the possibility of electrical speech the American Academy of Arts and Sciences, the Philosophical Society of Washington and the Essex Institute of Salem recognized the reality of the results and honored me by their congratulations. The public interest, I think, was first awakened by the judgment of the very eminent scientific men before whom the telephone was brought by Professor Thomson, F.R.S., and Professor William Thomson before the British Association for the Advancement of Science.

At a later period, when even practical telegraphers considered the telephone as a mere scientific toy, Professor John Pierce, President of the National Academy, Mr. Cromwell Varley, Mr. Cooke and Mr. Jones, of Freedom, N. H., devoted much time and the service of experiments for the purpose of assisting me in making the telephone a practical utility; and they communicated to me, from time to time, the result of their experiments with a kindness and generosity I can never forget. It is not only pleasant to remember these things and to speak of them, but it is a duty to repeat them, as they give encouragement to scientific men to persevere, and to the kindness of scientific men to unaccustomed novelties, and of their friends of unknown inventors who dare to enter the charmed circle of science. I trust that the scientific favor which was so readily accorded to the telephone may be extended by you to this new claimant—the photophone.

PLAN OF THE CEREBRO-SPINAL NERVOUS SYSTEM.

BY S. V. CLEVENGER, M. D.

[Abstract from the paper (B 41) read before the American Association for Advancement of Science, Boston, August 26th, 1880.]

The great French and German cerebral anatomists Luys and Meynert had endeavored to declare the architecture of the human brain from a multitude of microscopic sections, but no luminous nor relational law of fibres, nerve-cells, arteries, veins, connective tissue, etc., that it was at once seen to be necessary to study lower animal life anatomically and physiologically before the plan could be determined. Luys did nothing in this direction, while Meynert went as far as the brains of small mammals. Spitska has carried the scrutiny still further. The scheme of Meynert started with the upper part of the cerebrum as the seat of consciousness and, working downward, his "projection systems" ended in the periphery.

The nerve fibres composing the cerebrum and cerebellum were mainly considered. The presence of a multitude of nerve-cells and ganglia dispersed throughout this region was unaccounted for, and as these were of undoubted importance and all well known to anatomists, it was seen by pathologists that these schemes were insufficient.

No scheme can be correct which ignores any part of the nervous organization, or excludes any form of life as anomalous. The conclusion I have reached, is that the sympathetic system of vertebrata corresponds to the general nervous distribution of invertebrata above protozoa, presiding over the nutritive functions. The vaso-motor has been differentiated from the sympathetic distribution, whose office is to produce the vermicular motions of the intestines. Differentiation proceeds dorsally because that portion of the animal which is in most constant contact with the changing molecular motion of the environment would be precisely the portion to give origin to the higher series of nerve divisions. The enclosure, alter the gastrula, stage remains under control of the sympathetic system. The so-called cerebral ganglia of Vermes, are homologous with the spinal segments which afterwards become coalesced in the vertebræ. This is the second system to be developed and *Amphioxus* has not acquired the third or cerebral system proper. In *Trigla Adriatica*, the third system series may be seen developed dorsally upon the second or spinal cord. This third system is the intervertebral ganglia. *Fusion of several of the higher intervertebral ganglia produce the cerebellum*, and accounts for the co-ordinating function of that organ. The several cerebral lobes, the tubercula quadrigemina, mammillary eminence, Gasserian ganglion, olfactory lobe, olivary body, etc. are hypertrophied or atrophied (as the case may be) intervertebral ganglia. Projection systems and commissures, as the callosal, make their appearance in exact accordance with laws operative in the lower series.

The three systems develop gradually, and it may be said, commissurally one upon the other, and this scheme appears to account satisfactorily for physiological and pathological phenomena.

In addition to its publication in the proceedings of the Association, the paper will be produced in full, in the *American Journal of Nervous and Mental Disease* for October, 1880.

ANCIENT AGRICULTURAL IMPLEMENTS OF STONE.

BY HON. WILLIAM MCADAMS, OF OTTAWAVILLE, ILLS.

In the rich, alluvial and about the mouths of the Missouri and Illinois rivers are found many of these ancient stone implements used by the Mound-builders in their rude agriculture. Mr. McAdams exhibited a fine collection of these implements.

They are all chipped from flint, or a hard silicious limestone and some of them beautifully made. Some are nearly a foot in length and six inches wide at the broader end.

Some are made to be fastened to handles, like our modern spades. Others resemble our modern hoes, having a deep, lateral notch, to facilitate the fastening to a handle. Some of these stone hoes are made with such ingenuity as to have been effective implements.

Mr. McAdams also exhibited stone implements which evidently were made to fasten to some kind of stock to be pulled through the ground like a plow. As these ancient people had no domestic animals for this purpose, it is probable that manual force was used to perform the work. The broad cutting edge of these stone implements was highly polished from long use by the attrition of the soil.

Mr. McAdams had found these implements of agriculture in the ancient graves associated with pottery, some of which contained carbonized corn. Cobs in a carbonized state were found, and the speaker is of the opinion that these ancient people lived principally on corn and vegetables, which they cultivated to a considerable extent.

The paper elicited much interest in the association.

A very interesting report addressed to the committee of public health in France by M. Wurz, describes a process for retaining the green coloring of vegetables which is generally destroyed by boiling. It consists in the use of an excess of chlorphyl obtained from spinach (spinacia oleracea) which holds in its cells a large amount of coloring matter. A watery solution of this rendered alkaline by soda, is added to the boiling vegetable which is slightly acidulated with hydrochloric acid. The chemical result is common salt and a deposit of coloring matter on the organic tissue. There cannot now be any possible temptation for the unwarrantable dyeing of preserved vegetables by salts of copper, or the employment of adulterants for obtaining that vivid coloring so attractive to the epicure.

Engineering, July 5th, 1878.

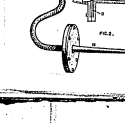
RADIAPHONIC RESEARCHES.

*Upon a Modification of Hunnings's Microphone, and its Application to Radiophonic Researches.**

By ALEXR. GRAHAM BELL.†

In August, 1880, I directed attention to the fact that thin discs or diaphragms of various materials became sources when exposed to the action of an intermittent beam of sunlight, and I stated my belief that the sounds were due to molecular disturbances produced in the substance composing the diaphragm.‡ Shortly afterwards, Professor Tyndall undertook a series of exhaustive investigations, which, however, did not seem to the contrivance that the audible effects were produced by the heating of the plates under unequal heating.§ This explanation has recently been called in question by Mr. Preece,‖ who has expressed the opinion that although vibrations may be produced in the discs by the action of the intermittent beam, such vibrations are not the cause of the sounds heard. According to him the aerial disturbances that are produced are second order spontaneously in the air itself by sudden expansion due to heat communicated from the diaphragm, every increase of heat giving rise to a fresh pulse of air. Mr. Preece was led to demand the theoretical explanation of Lord Rayleigh by the results of a series of experiments undertaken to test the theory.

He was thus forced, by the supposed insufficiency of the explanation, to seek in some other direction the cause of the phenomenon observed, and as a consequence he adopted the impulsive hypothesis alluded to above. But the experiments which he had personally undertaken in the hands of Mr. Preece were unable to succeed when repeated in America under better conditions, and the impulsive theory was necessarily for another hypothesis at once exploited. I have shown in a recent paper read before the National Academy of Science,¶ that audible sounds result from the expansion and contraction of the material exposed to the beam; and that a real loss of vibration of the diaphragms occurs capable of producing sonorous effects. It has occurred to me that the following experiment with a delicate microphone the sonorous vibrations that were so easily observed in our experiments might be carried out. The apparatus has in fact employed the ordinary form of Hughes microphone shown in Fig. 1, and that the vibrating area was confined to the central portion of the disc. Under such circumstances it might easily happen that both the centre (a-b) of the microphone might touch portions of the diaphragm which were practically at rest. It would of course be impossible to determine whether any such localization of the vibration as that would be really occurred, and I have great pleasure in showing to you to-night the apparatus by means of which the point has been investigated (see Fig. 2).



This instrument is a modification of the form of microphone devised in 1877 by the late Mr. Charles Wheatstone, and it consists essentially of a stiff wire A, mounted which is rigidly attached to the centre of a metallic diaphragm B. In Wheatstone's original arrangement the diaphragm was caused directly against the ear and the free extremity of the wire was rested against some sounding body like a watch. In the present arrangement the diaphragm is clamped at the circumference like a telephone diaphragm, and the sounds are conducted to the ear through a rubber hearing tube. The wire A passes through the perforated handle D, and is caused against the diaphragm. When the point A was rested against the centre of a diaphragm, upon which was focussed an intermittent beam of sunlight,

* A paper read before the Philosophical Society of Washington.

† American Association for Advancement of Science, August 27, 1880.

‡ *Nature*, vol. xxiii., page 274.

§ Royal Society, March 10, 1881. ‖ April 21, 1881.

a clear musical tone was perceived by applying the ear to the hearing tube D. The surface of the diaphragm was then rubbed with the point of the microphone and sounds were obtained in all parts of the diaphragm, and in the corresponding senses the other side of the diaphragm. Outside of this area on both sides of the diaphragm the sounds became weaker and weaker, until at a certain distance from the centre they could no longer be perceived.

At the points where the sounds naturally place the apparatus of a Hughes microphone (see Fig. 1) to sound vibrations, it was found possible to detect any audible effects when the point of the microphone was merely applied to the support in which the diaphragm was mounted. The sensitive results announced in Europe by Mr. Preece were, therefore, be reconciled with the positive results obtained in America by Mr. Sumner Tainter and myself. A still more curious demonstration of localization of vibration was obtained in the case of a horse-radish nave. An interrupted beam of sunlight was focussed upon a brass weight (it bluegrammed), and the sounds heard. It was then explored with the microphone shown in Fig. 2, which had distinct sound was heard upon touching the weight within the illuminated area, and for a short distance outside, but not in other parts.

In this experiment, as in the case of the thin discs, absolute contact between the point of the microphone and the vibrating surface is necessary in order to obtain audible effects. Now I do not mean to deny that sound waves may be originated in the manner suggested by Mr. Preece, but I think that our experiments have demonstrated that the kind of action described by Lord Rayleigh actually occurs, and that it is sufficient to account for the audible effects observed.

precise ingredients herein mentioned, as this part of the invention consists essentially in the protective intervention of a substance (alcohol or other) in an solid liquid for the purpose of repelling the fatty ink. Under the term "solid fatty ink" is included not only acids properly so called, but also combinations of those acids with substances which, as they do not neutralise the acids, permit the combinations to act in the same manner as if the acids were free. The paper is thus enabled to use soft acids, by reason of their acid nature repel fatty ink; they are also solid to the compositions which fulfil the double purpose of preserving the paper and of repelling fatty ink, certain substances of a hygroscopic nature, which will retard the evaporation of the composition and keep the material impregnated therewith at a suitable degree of moisture. These substances may be lately named as being either of organic origin, such as gelatine rendered soluble, either hot or in the cold, soluble gluten, starch, dextrine, mucilages, gums, sugars, and glucosides, &c., or of inorganic composition, such as deliquescent salts, &c.; and, in short, all soft-bascule capable of retarding the desiccation of materials impregnated with the composition.

These substances may either be mixed directly with the composition or they may be applied upon the surface of the paper previously to or after application with the composition.

For the production of autographic paper, any kind of paper of medium thickness, glazed or not, or other material may be used. The inks employed are composed of protein substances (albumens, caseine, fibrine, &c.), and of thickenators, peroxides, alums, &c., forming liquid compositions capable when dry of retaining fatty inks. The following is the method of preparation:—dissolve in a quantity of water 2 to 3 times greater than the quantity of albumen (or other protein substance) a mixture of 2 parts of bichromate, prussiate, or alum, &c., to 1 part of ferrocyanide of potassium, by which a liquid brown solution is obtained. Then set apart exactly a certain quantity of albumen and its equivalent of water, which quantity will be necessary in order to obtain sensitive results. Now I do not mean to deny that sound waves may be originated in the manner suggested by Mr. Preece, but I think that our experiments have demonstrated that the kind of action described by Lord Rayleigh actually occurs, and that it is sufficient to account for the audible effects observed.

solution of carbonate of ammonia or of soda. Diluted; 10 to dissolve in pure water 10 to drain upon a plaster slab or blotting paper; 11 to dry it by strong pressure between blotting paper.

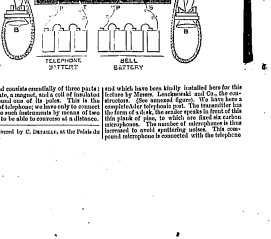
The process of reproducing printed matter is as follows :—The mixture of alcohols and acids is used, before referred to, is applied with a brush either upon the front or back of the printed matter to be reproduced. The paper becomes instantly saturated with the liquid, and the surface is then immediately washed by applying or plunging in pure water. The sheet has been spread very carefully upon a glass plate or has been previously wetted, and a lithographic ink roller is passed over the print, taking care that the roller is passed across from side to side in order to moisten the surface of the paper with the slightly acidified water in reverse of the way adhering to the roller. If the operation, which is very simple, has been performed by a skilled hand, it is only necessary to lightly wash the print to remove the excess of acid; which would otherwise bite the stenotone deeply, then to drain upon a slab of plaster, and when brought to the proper degree of humidity to lay it down upon the stone and pull it through. The transfer is then complete, and the ordinary lithographic operations with the stone will be used. When it is desired to reproduce both sides of a sheet, the sheet is first transferred, and then the other side is damped, inked and transferred. For the reproduction of typographic printed matter it would be made to adhere to the printed sheets, and then bitten in with acid in the ordinary way.

THE APPLICATIONS OF ELECTRICITY.*

(Continued from page 155.)

THE telephone is certainly one of the most important recent applications of electricity. It formed one of the greatest attractions of the Exposition. The telephone was invented by Professor Bell, and consists essentially of three parts: a vibrating plate, a magnet, and a coil of insulated wire wound round one of its poles. This is the transmitter. The receiver is composed of a magnet, the coils of two such instruments by means of two wires, in order to be able to converse at a distance.

* Lectures delivered by C. Decalle, at the Palais de Trocadéro, Paris.



The working of the telephone is easily understood. When we speak near the latter the vibrating plate, we cause it to vibrate in agreement with our voice. The plate vibrating so close to the front of the magnet, causes fluctuations in the strength of its magnetism, and these fluctuations suffice to induce small electrical currents in the coil surrounding the magnet's pole. These currents are transmitted along the line wires, and received in an exactly similar instrument, where they cause the receiving plate to vibrate in unison with the sending plate. In Bell's instrument only one pole of the magnet is utilised, but in Gower's and Ader's telephones both poles are made use of. Besides the telephone we have a microphone, another important class of apparatus, the microphone. Hughes' microphone is certainly one of the simplest electrical apparatus. It merely consists of a pencil of carbon pointed at both ends, and supported by two pieces of carbon, which have each a concave end in which the pencil's points rest. Let us make up a telephonic circuit, and insert in it a battery and a microphone. If we touch the microphone or speak before it, we soon or not to vibration the carbon, which, by pressing more or less on the pencil, causes the resistance more or less of the current to flow through the circuit. We can thus set up important variations in the current, and the two plates of the telephone in the circuit will vibrate in accordance with these variations. Carré, Hughes' microphone, when properly regulated, is an extremely sensitive instrument, and will enable us to hear a fly walk on the ceiling, or a mouse in a corner, when you will easily hear the ticking of my watch, which I have placed upon it; by listening attentively, you will distinguish the noise which the different parts of the watch make in moving. If it works the microphone but very lightly with a feather, you will hear the tickling of the feather. The microphone is also used to make the sensitive for practical purposes, for it converts articulate speech into a continuous current undulating, altogether unintelligible.

Let us now turn our attention to the practical and every-day applications of the telegraph. The most important of these is the clock. In fact I can do no better than to give the interesting account recently compiled for that purpose, on the hour of the *Société générale des Téléphones*,

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ON THE ACTION OF THE MICROPHONE.*

By Professor JAMES HUGHES, M.A., F.R.S.E.

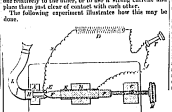
In the Hughes microphone, as usually employed in circuit with a battery and a Bell telephone, we have essentially two pieces of carbon resting lightly against each other through which the current passes. That the instrument may work efficiently two things are requisite; first, that the carbons be always in contact or at least sufficiently near for the current to pass between them, and, secondly, that they may be set exceedingly delicately to the point of any section of the one resting lightly on the other. This state of things is well described by the term "loose contact," first used, I believe, by Professor Stokes.

To understand the action of the microphone we have to find out what effects are taking place at the loose contact when the instrument is acted upon by sonorous waves. These are twofold; first, the effect produced by the sound waves (that is, the variations of density due to the condensations and rarefactions) on the air which surrounds and through it and other they act at the loose contact, and, secondly, the effect produced by tremors set up in the entire instrument, wooden supports and carbons together, by the sound waves which strike against it and are thereby stopped.

For distinction we may call the first of these the air effect and the second the tremor effect.

In my experiments I have endeavoured to arrange the parts so as to get rid of the tremor effect, as far as possible, and to examine carefully the air effect. To reduce the tremor effect as much as possible it is necessary either to fix the sections rigidly in their supports so as to avoid any motion of the one relatively to the other, or to use a strong current and place them just clear of contact with each other.

The following experiment illustrates how this may be done.



A, B, and C are three blocks of lime firmly fixed to a heavy wooden subplank. To the top of A is soldered a piece of brass tube H about 2 in. long and ⅜ in. bore. To the top of B is soldered a piece of similar tube, E, about 4 in. long. Through C passes a fine screw S worked by a milled head M. A piece of carbon rod K is fixed firmly into H and has a hole 1 in. in diameter drilled through its centre. A piece of carbon rod L is fixed firmly into the upper end of the tube E and can be moved backwards and forwards by the screw S. A piece of india-rubber tube J is passed over the left end of the tube H, and to this is attached a mouthpiece M. By means of the wires r and s soldered to the carbon rods, they are put in circuit with the battery (twenty Grove's cells) and the telephone T, which must either have high resistance or be altered in a way not necessary here than containing the battery so as to be kept open inductively.

When the carbon F is forced tightly into the hollow of E the circuit is completely closed and no sound uttered into H is heard at T. But when F is drawn gradually back until small electric arcs are seen to pass between F and G, every sound uttered into M is loudly and distinctly reproduced at the telephone T. Here we have the air effect produced by the small but noisy sparks the small electric arcs passing the carbons.

I have found it as yet, somewhat difficult to get the sounds to last for any length of time in consequence of the arcs distances soon getting too great for the current to pass and requiring re-adjustment. When the arc begins with a sharp click is heard in the telephone; but in the latter case the sound is continuous, and not intermittent.

As far as the tremor effect is concerned, it is obvious that the microphone action must depend, either (1) upon the variation of resistance due to variation of pressure, or (2) to variation in the extent of surface contact due to the elastic yielding of the carbons under pressure.

To test the first of these points, I made about two years ago some experiments on the effect of pressure upon the specific resistance of carbon. For this purpose I took a short length of carbon rod, the ordinary form in which it is sent distance from each end. By means of three wires the resistance of the carbon rod was balanced in the Wheatstone bridge. Pressure was then applied by means of a lever to the carbon in a longitudinal direction. No appreciable variation in the resistance was observed even under considerable pressure; and it only became manifest when the carbon was bent, or when it was crushed by the vulcan. I have recently repeated these experiments with the greatest care, and found the same results. I observed also that similar experiments, with the same result, have quite lately been made by Professor Silvanus Thompson. Hence we can hardly, I think, believe that variation of specific resistance due to pressure can have the slightest effect in producing the microphone action.

To test the second point, the elastic yielding, that is, the variation of resistance due to variation in the extent of surface contact due to elastic yielding under pressure, I experimented as follows: In the apparatus already described, I replaced the tubular carbon by a finely-pointed piece, so as to have two fine points exactly opposite each other. The resistance of the points was balanced in the bridge in the usual way. Pressure was then applied by a known weight to the one point, and the effect on the resistance read in the chord of resistance coils. The screw was then brought back to former position, and the pressure relieved so as to allow the elasticity of the carbon to act and restore the points to their first condition. It is obvious that if the change of resistance were due merely to elastic yielding it should now be the same as before. This I found not to be the case. From the gritty nature of the carbon the points of contact I found were perpetually changing, and the resistance, when the pressure was relieved, was not always the same here. From this irregularity it is impossible, I think, to conclude that this cause could explain the transmission of musical sounds far less articulate speech.

As far as my experiments go, the following appears to be something like the true explanation of the microphone action. When I have heard the sounds in the telephone effects take place at the loose contact. The tremor effect produces a pulse or two of the carbons sufficient to allow momentary minute electric arcs to take place between the points which are just clear of contact with each other. Simultaneously with this the air effect comes in, and, on account of the vanishing of density due to the condensations and rarefactions of the air, acts upon the minute electric arcs so as to vary their resistance. The tremor effect is comparatively powerless in producing sound. The sounds heard in the telephone, whereas it is into the air effect that we must look for the transmission of the quality of the sounds uttered into the microphone transmitter. The microphone is thus so far a delicate make and break analogous to the old Bain transmitter, with the important addition, however, of minute momentary gaps filled with a material which is sensitive to the minute harmonic variations of the atmospheric density which constitute sonorous vibration.

*Read before the Royal Society of Edinburgh.

Dated 1882.

ELECTRICAL DISCOVERY.—It is stated that a new electrical contrivance has been perfected by Mr. A. St. George, the inventor of the telephone which bears his name. This invention is really supplemental to the telephone, and will enable every description of conversation carried on through the instrument to be not only recorded, but reproduced at any future time. The principle of Mr. St. George's invention may be thus described. A circular plate of glass is coated with collodion and made sensitive as a photographic plate. This is placed in a dark box in which is a slit to admit a ray of light. In front of the glass is a telephone diaphragm, which, by its vibrations, opens and closes a small shutter through which a beam of light is constantly passing and imprinting a dark line on the glass. Vibrations of the diaphragm cause the dark line to vary in thickness according to the tones of the voice. The glass plate is moved on by clockwork, and the conversation as it leaves the telephone is recorded on the sensitive plate, the imprinted words spoken being fixed as is done in photography. The plate can be brought forward afterwards, and when replaced in the machine and connected with a distant telephone will, when set in motion, give back the original conversation.

Character of article ...
From the ...
Published at ...
Date ...

—Mr. Edison claims a telephonic invention by which two railroad engineers driving at full speed can communicate with each other when a mile apart. A man capable of such an invention ought to have the skill to get up a contrivance by which a man running at full speed can attract the attention of a car driver a quarter of a square away.

The Am. Sam News - Oct, 15 [illegible]

A SPEAKING CONDENSER.

It is well known that an electric condenser of tinfoil sheets when connected by its terminals to the ends of the secondary circuit of an induction coil will reproduce musical notes when the primary circuit is excited by a battery and a Reis transmitting telephone with intermittent contacts. The notes to be reproduced is sounded near the transmitter, whose vibrating diaphragm makes and breaks the primary circuit in accordance with the vibrations of the note, and the corresponding induced currents setting upon the plates of the condenser set them into sympathetic vibration, which is audible as a humming sound. This is the phenomenon of the "singing condenser" as first discovered, we believe, by Mr. C. F. Varley, and carefully investigated by Count du Monsel and other French savants. An important advance in its application to telephony has just been made by M. Dumand, who has succeeded in making it reproduce articulate speech after the manner of the Bell telephone receiver. M. Dumand found that when a carbon microphone was placed in the primary circuit of the coil instead of a Reis transmitter, the ticking of a clock and the striking of a bell could be imperfectly heard; but speech degenerated into a murmur. Following up this promising step, however, by including a battery in the secondary circuit along with the condenser, M. Dumand found that speech was then delivered with perfect distinctness. The battery is simply included between one end of the secondary circuit and one pole of the condenser. Then the forces of infoil which, under the simple influence of the induced currents of the microphone, only gave out simple sounds, were found to reproduce with fidelity the most delicate articulations when they were already charged with condensed electricity. The best results were obtained from a condenser of six centimetres in the side, and thirty-six leaves of tinfoil. With a seven-centimetre induction coil, one Leclanché cell in the primary circuit gives pure musical tones, and with a twelve-centimetre coil one Leclanché cell employed to give resistance effects. For articulation the battery in the secondary circuit should be at least composed of two or three cells; but in that case the voice is rendered feeble. With ten cells in the secondary, a twelve-centimetre coil and two cells in the primary, the voice is as loud as that of a good Bell telephone; and with fifteen Daniell elements in the secondary the sounds were heightened, and speech could be heard with the ear held a yard away from the condenser. This is a practical result of some importance. M. Dumand has yet further increased the loudness of the voice by inserting three or four bichromate of potash elements in the primary circuit; but the effect is not lasting, for the strong current heats up the contact points of the microphone and enfeebles the sounds. Perhaps, however, this defect will be overcome, and M. Dumand will be able to produce a condenser which will speak as loud as it sings. In commenting on M. Dumand's paper to the Academy, Count du Monsel remarked that he had himself made a similar experiment to that of the author, but with feebler though distinct results; and owing to a lack of battery power he had not pushed his researches further. M. Dumand has shown that the singing condenser, and in fact any electric condenser, can act as a good telephone receiver of atmospheric speech.

LONG-DISTANCE TELEPHONING.

When the telephone was first introduced the public was promised that the name of the instrument would be justified by the transmission of ordinary conversation over the same distances as are covered by the telegraph. The companies now operating, however, have taken no practical steps towards the connection of points more than 15 or 20 miles apart, and a clear field is open to the latest comer, the Long-Distance Telephone Co. The system to be introduced by them was invented by Webster Gillett, of Tuxiland, Md., and has been tested with thorough success between New York and Chicago. The main invention consists of a multiplication of "variable distances"; or, in other words, of points of contact on a single diaphragm, by means of which an unlimited amount of electric force can be applied to send the induced current over the wire, thus giving the power for long-distance talking. In ordinary telephones the force from only one, or at most three cells of a battery, can be used without burning the carbon, rendering the transmitter useless.

The system also includes an arrangement for duplexing or using the same wire at once for telephoning and telegraphing.

The company are said to have been experimenting for more than a year to bring the inventions to a state of perfection, and are now completely satisfied that they have reached a point where they can be put into immediate and successful operation.

Scientific American Aug 22, 1885

THE HAND AS A RECEIVING TELEPHONE.

In order to utilize the hand as a receiving telephone, a primary circuit should be arranged, comprising a microphone, three cells of a Leclanché battery, and the primary wire of an induction coil; a secondary circuit composed of the secondary wire of the same coil, a Leclanché battery of twelve cells, and two metal contact pieces secured for medical purposes. Let two persons each hold a contact piece in one hand, placing their disengaged and gloved hands over the ears of a third person, the latter will hear the words spoken into the microphone as if coming out of the inside. At a recent meeting of the French Physical Society, a piece of paper was successfully substituted for the gloved hand, the two persons holding the contact pieces, placing their heads together, the ears separated by the paper. The words spoken were distinctly heard by both.

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NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Ordinary meeting, Tuesday, March 15, at 8 p.m. Paper to be read, "On Iron Ore Deposits," by William Thomas Doyle. Also, "The Tide-Gauge, Automatic Recorder, Assistant, and Tide-Predictor;" and paper to be read, three persons retiring "On the Compensation Endurance" are not eligible for re-election when proposed to Unfinished Business," by David Phillips. M. Inst. C.E.

THE METEOROLOGICAL SOCIETY.—Wednesday, the 16th instant, at 7 p.m., at the Institution of Civil Engineers, there will be an Ordinary Meeting of the Society, when the following papers will be read:—"Results of Observations of Temperature at Kew, from 1871 to 1880," by Mr. Ellis. "Hail Storms in the British Islands on January 1, 1880. During the evening the President will give a Discussion on the Instruments and Methods of Registration, and will hold conversation such forms as are exhibited.

The Publisher desires to draw the attention of Manufacturers and Inventors to the fact that ENGINEERING is largely circulated among the Engineering Trades and Industries of the new editor of this Journal. In this views are kept for the benefit of Subscribers, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A complete set of the Specifications of Patents published during the current year, and a large collection of those published in previous years, will also be available for reference. Manufacturers or Inventors desirous of introducing their machinery and which will be indexed and placed under the care of an attendant.

ENGINEERING.

FRIDAY, MARCH 11, 1881.

THE PANAMA SHIP CANAL.

THE publicity with which the subscriptions for the construction of the Panama Ship Canal were taken up by the public, has been followed by an almost equally surprising celerity in the commencement of the works, ground having been broken on the first of February. A meeting of shareholders, recently presented to a general meeting of shareholders, combined this announcement, together with much interesting information as to the mode by which he proposes to carry out the work that it is to supersede the continents of North and South America. A similarly sanguine as to the triumphant termination of the great project, M. de Lesseps points out that the problem is not complicated with a number of the difficulties which beset the construction of the Suez Canal, that no ports will have to be formed, that the materials to be dealt with are of a nature far more tractable than the sands of Suez, that the difference in level of the two oceans will present no difficulty, and that extensive workshops and workmen's dwellings will not have to be set up in the midst of a waterless desert. The total length of the canal itself will be about 41 miles, the remainder of the navigable channel being formed by widening, deepening, and straightening the River Chagres. After the Panama Canal Congress of 1879, when an approximate route was decided upon, an International commission was despatched to Panama, and commenced a detailed examination at the beginning of last year. The result of the labours of this commission showed that a considerable reduction might be made in the amount of excavation necessary for the canal works, the originally estimated quantity of nearly 100,000,000 cubic yards being diminished by more than two-and-a-half millions yards, the total amount consisting of 59,381,000 yards of earth, and soft and broken rock, and of 37,353,000 yards of hard rock. The total estimated cost of the whole work is 214,000,000*l.*, of which 27,000,000*l.* will be absorbed in making the canal, the protecting banks for it, and for the Chagres and Rio Grande, and for the transport of material to the site of the works. Chagres river dam, a supplementary but decided upon in consequence of some exceptional floods which occurred upon the Chagres last year. Nearly two millions will be expended in the construction of this dam, its protection works, rising portions of the canal, and in making a pier in the bay of Colon. The improvement of the ports, the formation of docks, and the establishment of lighthouses will cost 4,000,000*l.*, and 7,000,000*l.* more will be occupied in the final location of the route, and the establishment of preliminary works, which will necessarily be of an extensive and very costly nature, but it is expected that by the end of the season 5,000 workmen' dwellings, repairing shops, and machinery will be completed, and a complete railway laid down, the system of transport organized, and a large proportion of the excavation plant on the ground, and it is confidently anticipated that excavations will be vigorously commenced.

That MM. Hersent and Couvreux have undertaken the completion of the canal is one undertaking is a sufficient guarantee that the highest amount of energy, intelligence, and skill will be employed in successfully carrying out so gigantic and somewhat similar works as those which have been successfully carried out in Russia, and which are experiencing peculiarly valuable in this new undertaking. The methods they have already employed to overcome vast quantities of earthwork will be substantially employed at Panama, including the excavation similar to those they used on the Suez Canal, in making the Gaud and Suzweaze canal, and the improvement of the Danube, and also the dredging plant also employed in the latter work. As far the steel plating, MM. Hersent and Couvreux have learnt how to deal with it at Brest and Cherbourg. M. de Lesseps anticipates that excavations in the canal will be opened for traffic in 1883, assuming that 40,000 cubic yards of materials of all kinds can be excavated and dealt with during each month. Within the succeeding years, and that a force of 10,000 men can be kept employed continuously. The remaining and last feature of the work is the utilization of water power from the Chagres, which will be employed for rock cutting. A tunnel 5 miles long is proposed to obtain this by forming the dam, already mentioned as a necessary part of the work, and returning by its fall the air compressors required for the rock drills.

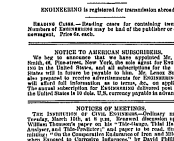
Such is a very general outline of the scheme for carrying out what will be, when completed one of the greatest engineering undertakings that the world will have seen. That it will be carried to a successful issue there is no room for doubt, since the physical obstacles are great only from the magnitude of the materials to be dealt with, so that the contractors have but to repeat what they have done many times before on a smaller scale. The problem of raising the necessary capital has been solved by the 100,000 subscribers, and all the political and financial difficulties appear to have been removed by the energy and diplomacy of M. de Lesseps. In every sense, conditions and opinions have changed since this indefatigable worker astonished the world with his proposal to divide two continents by the Suez Canal. In this country especially this proposal was met with ridicule, and received but little support. It was regarded as impracticable from an engineering point of view, and ridiculous as a financial undertaking. Objections like these have not been urged against the Panama Canal, for the successful completion of the Suez Canal, and, later, of such tremendous undertakings as the Mont Cenis and St. Gothard Tunnels, have silenced all disbelievers in the possibility of great engineering works; while the vast change wrought by the opening of the short canal to the East must convince every one that this new gate to the Pacific will develope (not possibly direct) trade to an incalculable extent, and the army of large and small capitalists who have so readily contributed their money to effect this development, will be benefactors of the world at large, even if they should not themselves reap a sufficient reward for their enterprise.

THE TELEPHOTOGRAPH.

THE apparatus recently exhibited by Mr. Shelford Bidwell to the Physical Society is probably the first detailed step towards the perfect solution of the great electrical problem, how to transmit the image of a natural object along a wire to a distant place.

Mr. Bidwell has for some time past been experimenting with the photophone of Professor Bell, and his letters form of this beautiful instrument is now well known. In this way the capabilities of selenium cells, especially those of high resistance, for transforming the energy of light into an electrical effect, became familiar to him, and this idea suggested itself that by combining a sensitive selenium cell with a modification of Bidwell's sequying telegraph, it would be possible to make an optical image focussed on the cell reproduce itself by delineation at the other end of a line in circuit with the cell.

The theoretical arrangement which he has adopted is shown in Fig. 1, where the positive pole of a battery B is connected, through a set of adjustable resistance coils as R, to a platinum stylus



or pen P, which rests its marking point on a plate of zinc M, covered by a sheet of paper moistened with the solution of iodide of potassium used in Bidwell's electrograph. The circuit of the battery is completed through a galvanometer G by a wire from the plate to the negative pole of the battery B. This is the receiving part of the apparatus; and the transmitting part consists of a second battery B' having its negative pole connected with the platinum stylus P through a sensitive selenium cell S, and the circuit is completed likewise through the zinc plate M and galvanometer. Now, if the selenium cell be exposed to light of equal intensity in other words if a sheet of paper be focussed on it, and the variable resistance R be so adjusted that the opposing currents in the two battery circuits exactly neutralize each other, no current will flow from the stylus P on the paper across the insulated joins, and hence no mark or line will be made with the pen P if the stylus be drawn across it. But if the light be shaded off the selenium, the resistance of the latter will increase and the current from the first battery will therefore, proportionate as so to cause a flow of electricity down the stylus. When the stylus is drawn across the paper it leaves its trace as a brown mark of liberated iodine; and this trace is strong or faint according as the current is strong or faint, that is to say in proportion as the light is bright or more intense. The galvanometer serves to indicate when the balance of currents is zero; and the connecting wires W W, which correspond to the telegraph line between the two stations, where the transmitter and receiver are placed, may of course be of any length.

The actual apparatus constructed by Mr. Bidwell

which are nearest to the surface. A great part of it will, however, be mechanically retained and remain entirely, and when the wax is reduced to fine powder, it will be set free, exactly as the enclosed gas becomes freed by the disintegration of the steel or pig iron.

That this is the case is of the greatest importance to the steelmaker; because he will be enabled to remove the gas from his metal and produce a sound casting free from honeycomb. Dr. Mueller sound casting free from honeycomb. Dr. Mueller has observed, that the castings as at Bochum, are always dense and sound, when the cession of the spiegel is very active in the converter. This rejection can only be explained when the wax is introduced into the metal in a certain quantity of oxygen; the carbon of the spiegel takes this oxygen; the carbon of the spiegel takes this oxygen, blue with this oxygen to form carbonic oxide, which causes a sudden ebullition by which the absorbed gases are driven out, exactly as chlorine and bromine are removed from their respective solutions whenever a current of nitrogenous air is blown through. Dr. Mueller's investigations are therefore of the greatest importance to the practical steel manufacturer, and he deserves the thanks of a large part of the metallurgical profession.

THE BATTEY BOILER EXPLOSION.

As we have already briefly recorded in this journal, there occurred on the 10th ult., at Messrs. Greenhow and Hirst's New Brighton Mills, Carlinghow, near Batley, a boiler explosion of an unusually disastrous kind, this explosion causing sixteen deaths, besides serious injuries. The inquest on those killed by this explosion was twice adjourned, and was only brought to a conclusion on Tuesday last, the 15th inst. During the inquiry, the coroner, Mr. Thomas Taylor, had, we are glad to say, the valuable assistance of Mr. T. W. Hall, of Leeds, as to the cause, and the investigation of the circumstances attending the explosion has been carried out in a thorough manner. We give, on page 200 of the present number, a report by Mr. John Waugh, the chief engineer of the Yorkshire Boiler Insurance and Steam Users Company, which contains a full description of the boiler which exploded, while the illustrations on page 201 will give a fair idea of the havoc which the explosion caused. Under these circumstances it will be unnecessary that we should in the present article enter further into these details, but we may make one conclusion clear to the extent facts brought out in the course of the inquiry.

The history of the boiler which explosion proved by the evidence given at the inquest, is briefly as follows:—The boiler was made in 1858, by Thomas Hill, of Heywood, in 1855, for the Halifax Flour Society, to whom it was delivered in September of that year.

The boiler was at that time one of Mr. Hill's patent screw-fluted boilers, but in 1859 it was altered to a two-fluted Lancashire boiler by Messrs. Crossley and Worthington, of Halifax, at a cost of 80*l*. The Halifax Flour Society worked the boiler until October, 1870, when they sold it for 50*l*. to Messrs. Savage and Norton, by whom it was again sold, in February, 1871, to Mr. Job Terry, trading as *Terry, Sanford, and Co.*, Lastly, Mr. Terry, in his turn, disposed of it, in 1877, to Messrs. Greenhow and Hirst, by taking in exchange 70*l.* and an old boiler, which he subsequently sold for 10*l.* The boiler appears to have been originally made for a working pressure of 50 lbs., and it was being worked at 40 lbs. when the Halifax Flour Society disposed of it, it being stated that they only drove the engine, owing to leakings in the furnace, which was cracked. After the boiler had left Halifax Flour Society no repairs were done to it before it came into the hands of Messrs. Greenhow and Hirst.

As to what was done to the boiler after it came into Messrs. Greenhow and Hirst's hands, information was given at the inquest by Mr. Israel Umpleby, of Cleckheaton. He deposed that he was first asked to look at the boiler in March, 1879, when there was a slight leakage, and he was instructed to put some rivets in the furnace. In October, 1879, some slight repairs were done to the flue, and in December of the same year a piece of angle iron was put in on the left-hand side of the left-hand flue. He also taken out being fractured for a length of about 18 in. In May, 1879, some further repairs were done to the flue and some new rivets put in, while other new rivets were put in the furnace in June of the same year. Again in October, 1879, the engineman, after emptying the boiler for cleaning, attempted to fill it with cold water, and found that a seam in the outside shell was ripped for about 4 ft. This rip was repaired, and in January, 1875, a patch was put in one of the flues, while in March of the same year, some slight repairs were made by putting in rivets. On August 18, 1879, the flues were overheated and partially collapsed, yet notwithstanding they were left in the boiler for 4 days, the boiler not being used until the 17th of September following. The three first plates over the fire in each flue were then renewed. In January or February, 1879, a new safety valve was put on the boiler, the ordinance was offered of any repairs having been done from the time of the new furnaces plates being put in September, 1877, up to the date of the explosion.

So much for the history of the boiler—a history which we think speaks for itself; let us next consider the evidence as to the manner in which it was set and the pressure at which it was worked. Mr. Thomas Bulling, of Batley, deposed that he set the boiler at Messrs. Graham and Hirst's in 1871. It was set on the brickwork of consolidation first passed along the side and then returned underneath. It was carried on two courses of firebrick, and he (Thicke) was not aware of any lime being in contact with the plates. Water accumulated in the centre flue, and six or seven months after the boiler was set a drain was made under this flue. This drain appears to have carried off the soil at the time, but John Oates, a flue cleaner, of Liversedge, deposed that he went into the flues of the boiler four or five months ago, and that in the bottom flue the water then stood half-way up the brickwork. And Charles Smith he (Oates) told Mr. Hirst (who has been for some time the managing partner in the firm) that the flues of the boiler required cleaning out, but Mr. Hirst would not have it done. Mr. Hirst, in his evidence, said that Mr. Oates, formerly for two years engineman to Messrs. Graham and Hirst, that in the time (about four years) that the boiler was about 14 in. out of level, and that he had to carry the water high to keep the water level. A witness, Abraham Jr. Pickles, fireman of Newtown, Leeds, who was engineman to Messrs. Greenhow and Hirst, from May, 1877, to May, 1878, of the boiler, also deposed that at that time the boiler was fastened at the bottom, and he called the attention of Mr. Graham and Mr. Hirst to it. The pressure was not of any great extent, and he believed that it had been caused when running the engine with the safety valve on.

As regards the working pressure we have already stated that the boiler was worked at 40 lbs., when the Halifax Flour Society parted with it in 1870. Previous to that time experiments had been made with the boiler when first started at Messrs. Graham and Hirst's was worked at a pressure of 70 lbs., to 75 lbs., but it was soon reduced and risen to from 40 lb. to 45 lb., and occasionally 45 lb. In 1877 it was worked at a pressure of 50 lbs., but when Messrs. Greenhow and Hirst purchased it in 1877 it was a new boiler was put in for supplying steam to the engine, and the old boiler was reserved for supplying steam for heating purposes, the working pressure being then considered to be about 45 lbs. We say "nominally" because it was proved that this pressure was habitually exceeded. Mr. Inspector Frederick Appleyard, depositing that he was the last inspector of the boiler, and that he had been during the four years; about six months ago he saw it at 75 lb., and that steam was not then blowing off. This witness added that he had never seen the safety valve lifted when he had inspected the boiler. On the Saturday before the explosion he saw the pressure at 70 lb., and in addition to the weight he had seen a steam test to see safety valve. The evidence as to the steam was corroborated by Mr. John Lawrenson, of Batley, and by James Sheard, a plaiter, both of whom had been at the mill in August, 1878, and were soon after removed to the mill. Sheard deposed that he had seen Hirst about having the safety weight on the safety valve, and Hirst had replied that he considered half-a-pound blowing off the engineman was always trying to get more steam than allowed him."

Such is a summary of the main facts elicited in the inquiry. The liability apart from Mr. Waugh's report. The boiler had been subject to no inspection beyond that of the engine tender who cleaned it. A reference to Mr. Waugh's report will show clearly the cause of the explosion. The boiler was extensively and seriously corroded, and it was simply in such a dangerously weak state that it was utterly unfit for work. Mr. Waugh adds that its condition could never have been readily ascertained by proper inspection. In the face of this evidence the Batley jury on Tuesday last returned the following verdict: "The jury are unanimous in returning a verdict that the deceased persons were accidentally killed by the explosion of a boiler at Brighton New Mills, Batley, and that the said explosion was caused by over-pressure. At the same time they desire to express their strong opinion that the proprietor of the premises (Mr. Hirst) is highly censurable in not having the boiler examined by a competent person." We have on page 198 of the present issue, in the course of an article on the Paddock explosion, expressed the opinion of such verdicts as these, and we only add here that it is utterly hopeless to put an end to the recklessness of a certain class of boiler owners so long as explosions are investigated by tribunals which are composed not of men of the class that which occurred at Batley, as "accidental." With the rapid increase which is going on in the number of boilers in use in our cities and towns, the time has arrived for a drastic compulsory legislation on the subject is most urgently, efficient, and those who are promoting such legislation deserve the most earnest public support.

THE ANTECEDENTS OF THE PHOTOPHONE.—No. III.

We have in previous articles referred to the early experiments of Mr. Willoughby Smith upon the action of light upon the electrical resistance of Selenium,* as well as to those of Dr. Werner Siemens and the simultaneous researches of Messrs. W. Grylls Adams, F.R.S.† In the present notice we shall review the continuation of Professor Adams's researches which were brought before the Royal Society in May, 1876, by himself and his pupil, Mr. R. E. Day, and were subsequently published *in extenso* in the Philosophical Transactions.‡ The special objects of those researches were: (1) To determine whether the changes in the resistance of selenium are in direct result of radiation, and if so, whether the dark rays, the luminous rays, or the ultra rays produce the greatest changes. (2) To compare the action of radiation in the selenium in its exposure to light from different sources and also to light which has passed through various absorbing media. (3) To determine whether the action is instantaneous or gradual, and to measure as far as possible the intensity of the action. This was necessary to the character of the electrical conductivity of selenium when kept in the dark and (4) To determine whether light could actually generate an electric current in the selenium, and be of the same nature as the currents Professor Adams adopted a Wheatstone bridge arrangement in which the four sides were respectively the selenium whose variation in resistance was to be measured, a variable resistance box of from 1 to 10,000 ohms, a fixed resistance of 4 ohms, and a coil of 9000 ohms. A reflecting galvanometer was placed in a circuit joining the junction of the selenium and the coil to the junction of the two other resistances, and a battery was included in a circuit which connected the other two junctions. A rough arrangement of circuits is illustrated by the diagram Fig. 7, where B is the battery, G the galvanometer, S the selenium, and

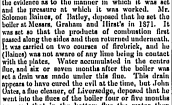


FIG. 7.

O D and E the several resistances. The circuits examined in the earlier experiments was the same specimen which had been first used by Mr. Willoughby Smith, and consisted of a rod about 1·4 millimetres long, 12 millimetres broad, and 3 millimetres in thickness. This was enclosed in a glass tube which was fixed in a box so as to be very similar to the apparatus shown in Fig. 1,* with the exception of being furnished with a sliding bastard of a hinged cover.

In arranging the apparatus for the measurement of resistance according to Fig. 7, the box containing the selenium was placed on its side and close against it was fixed a screen having in it a rectangular aperture which could be closed by a shutter or by pieces of coloured glass or other absorbing media through which the light from a source of illumination could, when required, be allowed to fall upon the selenium bar. The resistance of the latter, when in the dark, was then balanced by the usual process, care being taken that the current was not on for any length of time, which would cause it to increase its resistance. The cover of the box was then removed, light being allowed to fall upon the selenium for about fifteen seconds, by which its resistance was diminished, increasing again the moment that the light was again eclipsed, but Professor Adams found that the heating as well as the polarisation effects of the current are elements in the phenomenon and modify the results; he also found, as Dr. Werner Siemens had done, that the selenium is considerably more sensitive to the influence of light when first exposed after having been kept in the dark for some time than it is after repeated exposures, a fact which renders accurate measurement exceedingly difficult and complicated, for after each experiment the selenium has received a temporary injury to its sensitiveness, to which the name "fatigue" was very aptly applied by Dr. Siemens, and this fatigue renders it extremely difficult, if not impossible, to compare with any degree of accuracy the early experiments in a research with those which follow later on. Professor Adams found that the resistance of Mr. Willoughby Smith's bar of selenium was diminished by the light of an ordinary wax taper at a distance of 200 millimetres by as much as 15½ per cent of its resistance when in the dark, and in a series of experiments with the same bar making a gas jet was the source of radiation, the diminution of resistance amounted to from 10 to 25 per cent of the whole resistance.

In experiments belonging to this stage of the investigation Professor Adams found that the fluorescence fringe presented exceptional conveniences as a source of radiation, for by simply opening or closing a single hole of the burner the fringe can be made non-luminous or luminous at will, the heat remaining while the radiant heat emitted by the non-luminous flame, as measured by a delicate thermo-pile apparatus, was very nearly but not quite as great as that from the luminous flame, the respective values being as 100 were very different upon the resistance of the selenium bar; the non-luminous flame producing but little or no effect, while the comparatively cool luminous flame diminished the resistance in the selenium very considerably, amounting in some cases to as much as 25 per cent of the whole resistance of the bar.

This very interesting result led Professor Adams and Mr. Day to investigate the effect produced upon the electrical resistance of selenium by the dark heat rays of the electric light. For this purpose a screen was placed at such a distance of about two feet from the electric arc, the luminous rays being cut off by Faraday's method, a battery of boron plates of smoked rock-salt and alum, and although the experiment was carried on for hours, no effect could be observed upon the resistance of the selenium bar. As, however, the luminous rays alone in the beam would be to cut off the heating or actinic rays, while that of the smoking of the rock salt would be to eliminate the luminous rays; for clear rock salt, although it absorbs a considerable quantity of the luminous rays, while clear alum is transparent to light but almost perfectly opaque to heat, the interposition of the smoked rock-salt alum produced the same results as that of boron, viz., a perfect blankphilic of carbon of sufficient thickness to be opaque to luminous rays, the luminous rays were repeated in various ways under various conditions and invariably with the same result, leading these authors to the conclusion that "heat rays do not act powerfully in reducing the electrical resistance of selenium."

From this series of experiments it was but natural that Professor Adams and Mr. Day should be induced to take up the investigation of the effects produced upon the resistance of selenium by the chemical or actinic rays of the spectrum, and with this object glass of various colours so as to obtain spectra of such solutions were placed between the source of light and the selenium, but the results were not altogether

* See ENGINEERING, page 1, *ante*.
† *Ibid.*, page 12, *ante*.
‡ Proceedings Royal Society, vol. xxv., page 113.
§ Philosophical Transactions, vol. clxvii., page 313.

diminution of resistance depended rather upon the intensity of illumination than upon the presence or absence of the chemically active rays, the maximum effect on the resistance of the selenium being produced by rays coming from the colours in the spectrum between the yellow and the red, or a little further from the maximum heat region of the spectrum than was estimated by Lieutenant Sale.* After a long series of experiments in which the selenium was exposed to radiation not only proceeding from various regions of the spectrum, but from light emitted by various incandescent metallic vapours, Professor Adams and Mr. Day came to the conclusion that "the luminous rays are the cause of this peculiar behaviour of selenium, and that the dark heat rays and the chemically active rays have very little if any, share in producing it."†

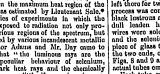


FIG. 8.

By exposing the selenium to the radiative influence of a constant source of illumination placed at different distances, Professor Adams found that the change in the resistance, as measured by the deflection of the galvanometer, is exactly as the square root of the illuminating power. In the following Table the figures represent scale readings of the galvanometer when the source of illumination was placed at the distances from the selenium as are indicated at the top of the columns.

Sources of Illumination.	Distances from Selenium.			
	1 metre.	1 metre.	1 metre.	2 metres
Argand lamp	...	170	82	39
Ditto ...	...	120	58	28
Ditto...	...	85	41	20

In continuation of this investigation, Professor Adams repeated the experiments by a somewhat different method, by varying the illuminating power of the light at its source, and by keeping its distance from the selenium constant, and the results given in the next Table show, as the former, that the change in the resistance is directly proportional to the square root of the intensity of illumination.

Number of Candles Measured by Photometer.	Galvanometer Deflection.
1	90
4	180
9	270
16	360

We may, however, here point out that this conclusion does not necessarily contradict the theory which Dr. Siemens gathering ground, that the ultimate physical action of light upon selenium is an electrolytic one, by heat, thus to light, for the researches of Mr. Crookes seem sufficiently to show that the same conditions of one force than distinct and opposed energies.

All the experiments of Professor Adams and Mr. Day to which we have yet referred have been made with the bar of selenium which had previously been experimented upon by Mr. Willoughby Smith, but in the subsequent researches of those investigators a large number of selenium specimens were tens a large number of selenium specimens were tens a large number of selenium specimens were described by Professor Adams in a paper which he read before the Royal Society. In this paper, which was read on the 15th of December, 1876, Professor Adams described the various methods employed by Mr. Werner Siemens which we figured and described in our last article,‡ and also those which were used for placing them in a test tube which was maintained at a uniform temperature of from 150 deg. to 180 deg. Cent. for several hours in a bath of paraffin, and was allowed to cool down very slowly, but by far the greater number of the experiments were made with the selenium cells of the form shown in Figs. 8 and 9.

Before is throughout this interesting research nothing more remarkable than the great diversity in the resistances of selenium cells prepared in precisely the same way, and apparently under precisely the same conditions. The following Table gives the results of a series of measurements made on a dozen of such cells on two consecutive days in the year 1876. The battery power employed was that of a single cell, and the deflections of the galvanometer are in degrees of the battery being in all cases connected to the marked electrode of the tube.

No. of Cell.	May 8.			May 9.		
	Temperature in Centigrade.	Resistance in Ohms.	Temperature in Centigrade.	Resistance in Ohms.	Temperature in Centigrade.	Resistance in Ohms.
1	19° C.	1,515,000	47° C.	6,87,10	19° C.	1,510,000
2	"	1,510,000	"	6,87,10	"	1,510,000
3	"	7,000,000	"	2,325,000	"	2,300,000
4	"	1,510,000	"	6,87,10	"	1,510,000
5	"	153,000	"	68,000	"	117,000
6	"	153,000	"	68,000	"	117,000
7	"	1,510,000	"	6,87,10	"	1,510
8	"	1,510,000	"	6,87,10	"	1,510,000
9	"	1,000,000	"	1,150,000	"	1,150,000
10	"	55	"	22	"	17
11	"	55	"	22	"	17
12	"	55	"	22	"	17

It is impossible to look at the above Table without being struck with the enormous differences of resistance between cells which are, to all outward effects, differences so great—amounting in some cases to several millions of ohms—and even at ordinary temperatures to over three millions of ohms—that the wonder is not that these differences of electric resistance should have not been met with by all workers with selenium, but that they should have been of very important elements of disturbance as at work investigating the data.

At this point we cannot but draw very special attention to the remarkable selenium cell "No. 10," the last in the above Table, and which is the one illustrated in Fig. 9, because it comprises a very conspicuous position in the history of selenium and among the antecedents of the Photophone. In the very interesting paper in which the invention of the photophone was first announced by Professor Graham Bell and Mr. Sumner Tainter, and which we published *verbatim et literatim* as far back as Sep-

* See ENGINEERING, page 1, *ante*.
† Philosophical Transactions, vol. clxvii., page 328.

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NOTICES OF MEETINGS.

INSTITUTION OF MECHANICAL ENGINEERS.—Thursday, April 21st, and Friday, April 22nd, at 32, Great George-street, Westminster. The chair will be taken for the meeting at 7.30 p.m. on each day. The following papers will be read and discussed: "On Steering Apparatus," by Mr. Thomas Brassey, M.P. "On the Application of Experiments on Riveted Joints," by Mr. John Fernie. "Results of Experiments on Riveted Joints," by Professor A. B. W. Kennedy, F.R.S. "On Steam Jacketting," by Mr. Thomas Wrigley, of London. "On Means for Measuring Small Flows of Water," by Mr. J. J. Taylor, of London. "On the Insane System of Dredging," by Mr. J. S. Langley, of London.

THE MECHANICAL SCIENCE SCHOLARSHIP, the Gold Medal, and Prize of Books, founded by the late Mr. Whitworth, will be awarded in connection with the Institution of Mechanical Engineers. The subjects will be each: "On the Frequency and Duration of Rain," by Mr. Whichert Slingen. "Results of Experiments made at the New Testing Establishment, Elswick," by Mr. Andrew Noble, C.B. "On Wrought Iron," by Professor A. B. W. Kennedy, F.R.S. "Remarks on Mr. Leigh's Table of the Barometric Height at London, with regard to Periodicity," by Mr. E. Whipple, Edin., F.R.A.S., F.M.S.

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INTELLIGENCE AND ADVERTISING COLUMNS OF ENGINEERING. *These columns are read every week by the heads of nearly forty of the principal English and Foreign technical journals, and the circulars and catalogues of the leading firms in every branch of engineering are to be found regularly on the publication. A limited arrangement of the same advertisements can also appear either simultaneously or from time to time in* ENGINEERING *at terms worked out for advertisers. Manufacturers are invited to communicate their catalogues and circulars, which will be inserted and placed in the hands of the trade.*

NGINEERING.

RIDAY, APRIL 15, 1881.

AL EDUCATION OF NAVAL ARCHITECTS.

n of Naval Architects has already to the country and the profession ich it brought to bear on the ifteen years ago, in favour of School of Naval Architecture, arkably good work, a fact orroboration from the eminent position occupied by several of its pupils, and the excellent contributions which they continually render to the Transactions of the Institution. It is in no small degree due to the efforts of the Institution, and the teaching at the school, that naval architecture has ceased to be the empirical art which it was twenty years ago, and has become one of the most exact of the applications of science.

The School of Naval Architecture is, however, essentially a high school, intended only for pupils of somewhat advanced knowledge. It is, moreover, at present not appreciated by the mercantile marine, the great majority of its pupils going into the Government service. The question naturally arises, What facilities exist in the country for the elementary training of naval architects, especially of those whose future career will be in the construction of merchant ships? We fear the answer to this question is not very satisfactory. The present condition of education in naval architecture resembles that of a country possessing excellent universities, but with most inferior elementary, and absolutely no advanced schools. The sole systematic course of elementary instruction to be had in this subject is that obtainable by the classes which prepare for the examinations of the Sciences and Art Department at South Kensington, and it is greatly to be feared that these examinations are of so antiquated a type, and so limited in their scope, that they attogether fail to enlist the sympathy of mercantile shipbuilders, and consequently do not exert the beneficient influence on the training of students which they might do, were they brought more into conformity with the wants of the age.

Mr. W. Denny, of Dumbarton, has brought this question under the notice of the Institution of Naval Architects, by reading a paper at the session just held, "On Local Education in Naval Architecture." Mr. Denny's experience of these examinations is considerable, for in his own town of Dumbarton much advantage has been taken of them, and the local teacher is the chief draughtsman in the employ of his firm. The chief charges brought against the examinations are, that too much attention is devoted to the obsolete subjects of wooden and composite shipbuilding; and that the questions set in the final stage, or honours division, regarding ships' calculations, are not of sufficient difficulty to entitle the student to the distinction of honours; and also, that many of the most important questions relating to naval architecture are totally neglected, such, for instance, as the strength of sections of steamers, involving the calculation of their moments of inertia; the stability of vessels with reference to the metacentric height, and its alterations by reason of changes of draught and alteration of the positions of weights; the speed and power of steamers; Mr. Froude's law of proportional resistances; Mr. Inglis's application of the law to actual results of speed trials; and, lastly, the question of the trim of merchant steamers as affected by the distribution of cargo, the consumption of stores, and the addition or removal of ballast.

Regarding the first of these charges, it is alleged that in the two first stages of the examinations, it is *obligatory* on students to answer questions relating to wooden and composite shipbuilding, while in the third or honours division, although no such questions are obligatory, it is nevertheless the case that in some years all the questions relating to laying off have reference to wooden or composite ships, and consequently unless a student has devoted much time and trouble to acquiring a knowledge of those nearly obsolete arts he cannot pass in any one stage of the subject. It is greatly to be feared that knowledge of this sort, got up merely for the purpose of an examination, must necessarily partake largely of the character of pure "cram," with the additional evil in wrought of taking away the student's attention from other subjects, neglected it is true by the examiners, but which will be of vital necessity to him in his after career.

Mr. Denny does not content himself with criticising, but makes various proposals for the improvement of the examinations, which, we venture to say, if adopted will do much to extend the usefulness of those examinations, and to enlist for them the sympathy of the shipbuilding community. He proposes that they should extend over four years instead of three as at present. The first stage would include questions on the details of iron construction, and on the calculations necessary to produce an ordinary displacement curve, and to find the vertical centre of buoyancy. The second stage would embrace questions relating to the nature of iron and steel, their resistances to tests, and to the calculations for finding the longitudinal and transverse moments. In the third stage, the examination would be on the strength of riveted joints in calculations repeating trial, and the working out of examples showing the use of the longitudinal metacentre. In the fourth or honours year, the questions might relate to the calculation of the moments of inertia of scantling sections, and to calculations of stability showing the use of the transverse metacentre. Mr. Denny is convinced, from his practical knowledge of the progress which drawing-office apprentices are capable of making within a given time, that the above scheme is not too difficult; and on this point, to judge by the tone of the discussion which followed the reading of his paper, the majority of his audience agreed with him. Speaker after speaker arose, and deplored the shortcomings of the present examinations; while, at the same time, they fully endorsed Mr. Denny's views. So unanimous, indeed, was the opinion of the audience, that, if we are rightly informed, the Council of the Institution will again endeavour to influence the Government to give effect to the views expressed. If they would further succeed in obtaining for the best students in each year scholarships of such value as would enable the holders to continue their studies at the Royal Naval College, we have no doubt that they would thereby greatly increase the popularity of the examinations. It is, we believe, no secret, that the scheme for selecting Whitworth scholarships does not work quite satisfactorily, and has not hitherto produced the results which Sir Joseph Whitworth himself sought to attain. We venture to suggest that some of this fund might be wisely spent than in enabling the best competitors in each year to complete their studies, at the only school where it is now possible to obtain a complete education in the subjects of their profession.

ELECTRICAL TORSION.

IT is a surprising fact that we can accomplish so much with electricity, and at the same time have so little of its real nature. We have just conceptions about heat and light, and sound; we can explain to ourselves the modes of motion in air or other which give rise to them; but if we attempt to do the same for electricity, the ideal light is suddenly extinguished and the imagination is left groping in the dark. We cannot even tell whether it be a fluid or not; and yet we can work more wonders with electricity than with either light, heat, or sound.

The principal reason for this want of knowledge is that hitherto we have not been successful in research capable of enlightening us upon the molecular changes which electricity produces in its passage through a body. The electrometer and the galvanometer, sensitive as they are, will only show effects in mass, so to speak; they have no analysing power. In the indirect method of Professor Hughes, however, we have at length found a far more subtle tool of quest, and though the skilful use of it by its inventor, we are likely soon to learn something of the true character of electricity. With its coils and telephone it bears to that mysterious agent a relation similar to that which the microscope with its prisms and telescope bears to the rays of light; and it affords a means of investigating the molecular structure of those materials which, though opaque to light, are permeable by the electric current.

For some time past Professor Hughes has been experimenting with the induction balance on the electrical effect of torsion applied to wires of iron or other magnetic metals, a subject which has been previously studied by Matteucci, Thomson, and others. He was led to this inquiry by the anomalous behaviour of iron in his original tests with the balance. He then found that no two pieces of iron, even though they were cut from the same wire, would accurately balance one another. To discover the cause of this discrepancy he passed a soft iron wire through a hollow coil, as shown in Fig. 1, and connected it in circuit with a telephone. An electric current from a battery B, interrupted in a definite rhythm or cadence by a clock-work fleetone I, was sent through the coil, and he found that when the wire was perfectly free from torsion no current was induced in it by the coil, and no sound was heard in the telephone. The slightest twist

THE TELEPHONE.

The Telephone is now in full operation at Huntington. It is contemplated to extend it to Dewittville and Ormiston, if adequate substantial aid is given by the residents of these two places. The nearest is a distance of 16 miles to Hemmingford.

To be a general benefit however, it must reach Montreal, the market town of that District.

Mr. C. F. Sise, vice-president and managing director of the Bell Telephone Company, and L. H. McFarlane, manager of the eastern division, have recently been spending a few days in the city of St. John, N.B. Their visit there has been of special interest to Mr. J. H. Wagstaff, who has for only a short time been spared for the company, and who by close attention to business, both in the interest of the Company and the subscribers, has so improved the agency as to win the confidence of the managers, and has been rewarded by the appointment of the managers, and has been rewarded by the appointment of the position of district superintendent, which covers the management and inspection of the Maritime Provinces, with the head office at St. John. Mr. Wagstaff will continue to control the affairs of the St. John agency. There seems to have been earned within ten months and without any previous experience in the business, and is, therefore, more to be valued.

The Company will shortly remove to new offices in the Boutwick building, which are being specially fitted up for them, and, when finished, will be very complete and comfortable.

The Bell Telephone Co. are busy stringing in Montreal, a superior new steel No. 12 wire.

The Bell Telephone Co. exchange office at Toronto, which occupies the southern wing of the Mail building, was burned out on the morning of the 24th May. The Bell Telephone Company employ about eighteen young women to answer calls and make telephone connections, six of whom were on duty at the time of the outbreak, their names being Miss Clarke, Miss Mackenzie, Miss Murphy, Miss Leitch, Miss Porter, and Miss McCarthy. Naturally they were very much alarmed at seeing the smoke, and did not care to leave the office. Had they done so and passed by the elevator to the iron doors leading to the composing room which were closed but not locked, they could easily have escaped by the north stairs without going through the experience which they afterwards met with. Mr. Hambly of the Mail editorial staff, re-entering his room, found the telephone girls at the windows at their office, which overlooks his, but one floor higher up. They called to him for help, and he begged of them to keep calm and he would get assistance. Some of them were preparing to take a jump diagonally to the roof of the white building adjoining The Mail building, and knowing the hazardous nature of such a leap, and by clutching at a batch of wires, and sliding along them reached the roof in safety. The other girls then went to the windows overlooking King Street, and screamed for help. Mr. F. Thompson, of The Mail business department got a ladder on the roof of the white building, and resting it against the parapet of The Mail building, the girls were enabled to creep along one by one and passed into safety. The men were only just in time in doing this, as the girls had become terribly excited, and one of them was preparing to jump into King Street, which had she done she would have met with certain destruction. The reaction on her was such that when she was got down in safety she immediately fainted. The Bell Telephone Company suffered the most, and their hundreds of subscribers will be put to some little inconvenience for the next few days. It is expected the two hundred wires are now in working order again, the men working day and night to make the connections under the energetic direction of Supt. Nelson.

The Bell Electric Light Co. were burned out in the Mail building fire, at Toronto on the 24th May.

The Bell Telephone Co. of Toronto have leased new quarters for their Exchange at 116 Bay Street.

ELECTRICAL INDUCTION IN UNDERGROUND AND METALLIC CONDUCTORS.

BY F. S. GISBORNE, C.E., F.R.S., *Supt. of Dom. Government Telegraph Lines*, OTTAWA, 1881.

The Paper read before the Royal Society of Canada at its meeting on Wednesday afternoon, 23rd May, at Ottawa, by Mr. F. S. Gisborne, Superintendent of the Dominion Government Telegraph Service, possesses peculiar interest at the present time in that it deals with the phenomena of induction in electrical circuits to compensate the effect of which, many and various means have been from time to time suggested, but the inefficiency of which to eliminate the evil, has been declared before the Committee appointed to meet at present in session at Albany, N.Y., to consider the question of the practicability of placing electrical conductors under ground. Mr. Gisborne's paper was descriptive of a new system devised by himself, by overcome the difficulties referred to, diagrams were presented which graphically explained the condition obtained in neighboring circuits, and comparisons were made between two or more circuits arranged as heretofore considered best and the same circuits arranged according to his system. Proofs of the efficiency of his system were given in the proposition with respect to any other conductor or pair of conductors in the neighborhood. The philosophy of this device is, that a current passing through any such circuit has necessarily to pass down one wire and up the other, and it is evident that the positions of both with respect to a neighboring circuit, being the same as above stated, the inductive effect of the current passing down one wire is neutralized by the inductive effect of the same current passing up the return wire. It would appear therefore, that Mr. Gisborne's system is in reality one in which the phenomenon of current induction does not obtain rather than one by which the effects are neutralized. Considerable interest in this connection has already been manifested and it is understood that letters patent are about to be issued in Canada and the United States to the gentleman in question.

In connection with the International Electrical Exhibition to be held in September, it may be well to say that the meeting of the American Association for the Advancement of Science, which will be held this year in Philadelphia, and the expected presence of many representatives of the British Association, which will meet this year in Montreal, will attract a numerous and influential scientific gathering in Philadelphia during the time of the holding of the exhibition; and in order that so exceptional an opportunity to promote the interests of science shall not be lost, Congress has been requested to authorize the holding of a National Conference of Electricians, to convene in Philadelphia at this time.

sum he petitions to have repaid him together with a profit of 20 per cent. to cover his profit as contractor, and an allowance of 50 per cent. on the total cost of the works, to repay his failure as an engineer and inventor, bringing up the total amount to £9,137,5, a sum which will be he alleges quite unremunerative, stating that his time could have been better employed elsewhere. But he expresses his willingness to accept 40,000*l.* down rather than incur further delay. If Mr. Emery succeeds in his application he will fare better than English inventors would do on the hands of this Government. It may be interesting to note that the drawings for this machine cost 1200*l.* It will perhaps be remembered that the testing machine was ordered by the United States Government for the proof of the cannon, and was used for all persons who might desire to use it, upon the payment of a suitable fee, the scale of charges being adjusted to cover as nearly as possible the actual costs of the tests. An illustrated report is appended of the Gardner machine gun, the machine of which could not be described without the aid of drawings. Experiments showed that a velocity of 1230 ft. could be obtained, and in a range of 1000 yards 65 per cent. of hits were recorded, the average number of shots fired were 437 per minute. A limited number of these guns were recommended to the service for further trial.

In 1879 a series of trials were conducted by Captain Crozet, U.S.A., on the relative efficiency of the Martini-Henry and the Springfield rifles, especially in reference to initial velocity, range, penetration, accuracy, and flatness of trajectory. The targets used were of white pine. It is claimed that the Springfield gave superior results in all points except that of penetration, but as this rifle has a penetrating power of 9 in. at a safe range, it fully meets all the requirements of the United States service. The long-range firing was at 2000, 2200, and 3200 yards; and some excellent shooting was done by Lieut. H. T. Hare, who hit the 6 ft. pine target repeatedly at the latter range. At 2200 yards the Springfield and Martini both penetrated the 3 in. target, the former with an elevation of 8 deg. 14 min. 2 secs., and the latter 9 deg. 48 min. 57 sec. At 2500 yards the Springfield passed through 5.35 in. pine with an elevation of 10 deg. 33 min. 21 sec., and the Martini through 5 in. with 13 deg. 20 min. 18 sec. Also, at 3200 yards no hit was made out of 300 fires with the Martini, and with the Springfield 55 rounds with the Martini, and with the Springfield 55 per cent. of hits were made, the penetration being about the same as at the 2500 yards' range. The Springfield bullet weighed 500 grs.; the initial velocities were respectively 1951.2 ft. and 1020.8 ft. Four very interesting trials were recorded as to the curve of flight of the bullets at long ranges by means of the telephone. In the experiments two telephones with Blake's transmitter were used, one being placed within a few feet of the gun, and left open to receive the sound of the discharge. The other was in the shelter about 30 ft. in front of the target. A stop-watch beating fourths of a second was employed, and when the discharge was notified by the telephone the watch was started. With a little practice the readings were taken easily and with great accuracy. Four rounds were fired at a 3500 yards' range with the Springfield long range and the Martini. Out of 40 rounds the former hit and penetrated the target once, the latter did not reach far enough. Neither were any hits made with the Springfield service rifle, although a round was occasionally over the target. The concluding appendix in this volume contains a set of Tables and plates showing the principal dimensions and elements of fire of the larger rifle guns existing, proposed, or experimented upon at the beginning of last year, and being constructed in Sweden and Norway and in the also of the various Governments and Companies in European service. This report is illustrated with

BOOKS RECEIVED.

Arranged Four-Figure Logarithms and other Tables, with Examples and Examples. Arranged and compiled by LOWIS D'A. JACKSON. London: W. H. Allen and Co.

The History of Salt; with Observations on its Geographical Distribution, Geological Formation, and Mechanical and Chemical Properties. By JAMES HARGREAVES, F.G.C.S., F.S.S. London: Longmans, Green, and Co.

The Distributing-Gas Station and her Shareholders. Vol. Dresden: Zavisch. Mk. 75 Aktiengesellschaft. Vienna, Pesth, and Leipzig: A. Hartleben.

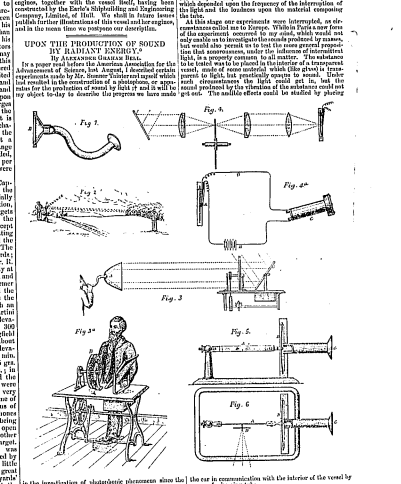
ENGINES OF THE ASSYRIAN MONARCH.

We give this week a two-page illustration and also an engraving on the opposite page, showing general views of the engines of the s.s. *Assyrian Monarch*, these engines, together with the vessel itself, having been constructed by the Barle's Shipbuilding and Engineering Company, Limited, of Hull. We shall in future issues publish further illustrations of this vessel and her engines, and in the mean time we postpone our description.

UPON THE PRODUCTION OF SOUND BY RADIANT ENERGY.*

By ALEXANDER GRAHAM BELL.

In a paper read before the Philosophical Society of Washington for the purpose of describing the experiments recorded certain experiments made by Mr. Sumner Tainter and myself which had resulted in the construction of a photophone, or apparatus for the production of sound by light and it will be my object to-day to describe the progress we have made as successes as this diaphragm. The first experiments made by myself in this direction were undertaken with the hope of obtaining articulate speech, and of course material which (like glass) is transparent to light, but practically opposite to sound. Under such circumstances the light could get in, but the sound produced by the vibration of the substance could not get out. The audible effects could be studied by placing



in the investigation of photophonic phenomena since the date of this communication.

In my Boston paper the discovery was announced that the sonorous vibrations of many different substances could be produced when exposed to the action of a rapidly interrupted beam of sunlight. The great variety of substances on which these experiments led me to believe that sonorous vibrations could be produced would be found to be a general property of matter.

At that time we had failed to obtain audible effects from the vapors of the various substances which were exposed to the rapidly interrupted beam of sunlight, but before the completion of this photophone, let this failure be explained upon the supposition that the sonorous vibrations produced by the light were totally inappreciable by the ear. The subsequent development of the experiments the ear in communication with the interior of the vessel by means of a hearing tube.

Some preliminary experiments were then made with the view of ascertaining if the results were so promising that they were communicated to the Royal Society at London on January 26, 1880, in a note read for me by Mr. Augustus Stroped.†

† Action of an Intermittent Beam of Radiant Heat upon Gaseous Matter," Proceedings of Royal Society, January 26, 1881, vol. xxxi., p. 156.

Sonorous effects were obtained with vapors from the interior of the receiver, but the results were so promising that they were communicated to the Royal Society at London on January 26, 1880, in a note read for me by Mr. Augustus Stroped.†

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† Action of an Intermittent Beam of Radiant Heat upon Gaseous Matter," Proceedings of Royal Society, January 26, 1881, vol. xxxi., p. 156.

* A paper read before the National Academy of Arts and Sciences, April 21, 1880.

† Proceedings of American Association for the Advancement of Science, August 27, 1880; see, also, American Journal of Science, vol. xx., p. 385; Journal of the American Electrical Society, vol. ii., p. 187; Journal of the Society of Telegraph Engineers and Electricians, vol. ix., p. 404; *Annales de Chimie et de Physique*, vol. xxv.

‡ Comptes Rendus, vol. xci., p. 505.

§ "Notes on Radiophony," *Comptes Rendus*, December 6 and 13, 1880; February 21 and 28, 1881. See also *Journal de Physique*, vol. x., p. 57.

|| "On the Conversion of Radiant Energy into Sonorous Vibrations," Proceedings of Royal Society, March 10, 1881, vol. xxxii., p. 366.

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Texas Hail Tel Co

Nov. 1, 1881

TELEPHONIC NOTES.

Mr. Max Ehser, general manager of the Pan-Electric, is fast getting things in shape in this city. The wires are nearly all strung, the switch-board has arrived, and it is expected everything will be in working order within ten days.

The Molecular Telephone company of Texas, is about being organized in Denton. This company uses cork in the place of carbon in the transmitter and hand phone, and claims that articulate speech is transmitted by the "molecular vibration of cork."

Mr. W. T. Bostick, manager for the Erie company in this city was taken very ill about the fifteenth ult., and in consequence, his marriage which was to have taken place at Round Rock on the 18th, was postponed. We are pleased to be able to state that he is now recovering rapidly, and if he receives no backset, will don his swallow-tail and kids in Round Rock on the 10th inst.

The Anniston (Ala.) Blast of the 18th ult., contains a column and a half devoted to a description of the Pan-Electric Telephone Exchange which has lately commenced operations in that city. The notice is very fluttering to the Rogers transmitter, and declares that the Pan-Electric is the coming telephone. The Blast of the 25th ult. contains a challenge from the president of the Alabama Pan-Electric Telephone Company to the Bell Company for an attack through the courts.

The examiners in chief of the Patent Office rendered their decision in the celebrated telephone interference case last week in favor of Alexander Graham Bell. Case G, contained the main point at issue, and practically covers telephonic invention, it being an application for a telephonic receiver, consisting of combination in electric circuit of a magnet and a diaphragm supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality.

The parties were Bell, McDonough, Gray and Edison. After an exhaustive review of a great mass of evidence adduced upon this point, and stating at length the reasons leading to the conclusion, the examiners say, "From the whole McDonough's proofs cannot be held to be sufficient to overcome Bell's record of dates. We have seen that a party contesting right of patentee must show completed and perfected apparatus. That McDonough did not have this, is clear. Had a patent been granted to him for it as described in his application, as experimented with in June, 1875, the public would have been no wiser than before. It still would have been ignorant of the method and apparatus for speech transmission, for no instrument working upon its principle of making and breaking a contract can accomplish that result. In this respect McDonough gave no more to the world than theirs. It is said by Justice Lowell in American Bell Telephone Co. vs. Spencer, a century of McDonough would never have produced a speaking telephone."

Accustics—Telephone and Phonograph.

The beautiful inventions of the telephone and the phonograph, although in the main depending on principles long since established, have imparted a new interest to the study of Acoustics. That former, apart from its uses in every-day life, has already, in the hands of its inventor, Graham Bell, and of Hughes, an instrument of first-class scientific importance, while the latter invention is still in some respects obscure, as is shown by the comparative failure of the many attempts to explain it. In connection with some explanations that have been offered, we do well to remember that molecular changes in solid masses are insensible in themselves; and can only be manifested to our ears by the consequent changes in the motion of the external surface extending over a sensible area. If the surface of a solid remain unaltered, no sound, however tall something of what goes on in the interior.

In theoretical acoustics progress has been steadily maintained, and many phenomena, which were obscure twenty or thirty years ago, have since received a satisfactory explanation. If some important practical questions remain unsolved, one reason is that they have received little attention. Almost everything in connection with the delicacy of our senses presents peculiar difficulties to scientific investigation. Some kinds of information with regard to their surroundings are of such paramount importance to numerous generations of living beings, that they have learned to interpret indications of the most subtle character. Many are of the simplest character, every day we are in the habit of recognizing, without any difficulty, the quarter from which a sound proceeds, but by what steps we attain that end has not yet been satisfactorily explained. It has been proved that when proper precautions are taken we can distinguish perfectly whether a pure tone (as from a vibrating tuning-fork held over a suitable resonator) comes to us from before or behind us. This is what might have been expected from a priori point of view: but what would not have been expected is that with almost any other sort of sound, from a clap of the hands to the clearest musical tone, the discrimination is not only possible but easy and decisive. In these cases it does not appear how the impression on the ear helps us through there is some evidence that it may; and even when sounds come to us from the right or left the explanation of the ready discrimination which is then possible with pure tones, is not so easy as might at first appear. We should be inclined to think that the sound was heard much more loudly with the ear that was turned towards than with the ear that is turned from it; and that in this way the direction was recognized. This, however, is impertinent, we find that, at any rate with notes near the middle of the musical scale, the difference of loudness is by no means so very great. The wave-lengths of such notes are long enough in relation to the dimensions of the head to forbid the formation of anything like a sound shadow in which the averted ear might be sheltered.

Sun — Sept.

THE TELEPHONE IN RUSSIA.—Although the telephone has become an established fact in several of the largest Russian cities, notably, St. Petersburg, Moscow, Odessa, Riga, and Warsaw, it is making but little progress elsewhere in the country. St. Petersburg itself is traversed in every part by at least 1,500 versts of wire on the Bell system. The principal factories in the quarters of Viborg, Peterhof, and Okhta, St. Petersburg are all in connection with the central portion of the city, as are the large government offices with the Admiralty, police courts, and prisons, so that orders from headquarters can be instantaneously communicated and carried out. The wires now extend to the fortresses of Cronstadt and Peterhof, and the large rambling works of Pontilow and Alexandrovsky, some eight or ten versts distant, correspond directly with the Nevsk Perspective and the Monskoi. An office has been opened for the public, who can send a message for 25 copecks.

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The Elec. Era. Phil. Sept. 20, 1884

Telephone Exchanges.

In the issue of August 9th, 1884, the London, Eng., *Electrical Review*, unsolicited, published the following editorial on one of America's leading telephone companies. As it is a Philadelphia organization, born and bred, we take great pleasure in reproducing the article in our columns.

Perhaps no, piece of telegraph apparatus offers more scope for ingenuity than telephone exchange switches. The methods which have been designed for affecting intercommunication between subscribers are very numerous as the records of the Patent Office testify. To a great extent the ingenuity displayed has been thrown away, partly in consequence, no doubt, of the inventors failing to thoroughly understand the actual requirements of the exchange system, but more in consequence of that absence of a competition which would practically compel any telephone company to provide the best system available, or cause it to be superseded by a more energetic and enterprising rival. In London it is generally admitted the room for improvement in the matter of quick intercommunication is very great indeed, and we believe that any energetic rival who would introduce and work a rapid intercommunication system, combined with low rates, would be most welcome to the business community. A very great deal depends upon the personal attention of the switch clerks at the central stations, and systems which are dependent for their quick working almost wholly upon the prompt action of individuals who have practically no incentive for displaying unusual alacrity, are sure to be unsatisfactory. Personal attention cannot be wholly dispensed with, but it can be reduced to a minimum by the use of apparatus which is partially automatic in its action, as, for instance, in the "Clay" system, which we described in the last number of the *Review*. Apparatus which endeavors to affect inter-communication almost wholly automatically cannot, we believe, be included in the range of practical telephony; it is by the judicious combination of automatic with personal action (as in the system referred to) that the best results will be obtained. In connection with the general question of telephone exchanges a somewhat curious point is referred to by the Boston *Transcript*, as regards the expense of working large systems :—"From present appearances (says the journal) the problem can only be met by advancing the local rates of telephone exchange subscribers. It costs to operate an ordinary telephone exchange, including rentals paid the American Bell Telephone Company, about 40 dollars per annum per subscriber, and the annual compensation received is from 42 to 43 dollars, and some additional compensation in the way of charges for extra territorial connections. Now, the greater the business, instead of reducing the expense per subscriber, increases the expense *pro rata*, as the number of the connections and the particular service to every subscriber is increased by a new subscription, this can be well illustrated by the supposition of a telephone exchange attempting to connect all the people in a certain State, say a million. Several hundred dollars a year would not cover the expense of the service that each subscriber might demand of the exchange; but this million of people could be sub-divided into many exchanges, and each person served in his own locality for a comparatively small sum of money. The problem of how to limit the growth of local telephone exchanges, either by sub-division of exchanges or by increased rates is yet to be solved." Even in London, with its small number of subscribers, the necessities for considering the best maximum radius for local exchanges is quite apparent, but before any such town can be telephonically served, as its importance deserves, the present difficulties must be grappled with, and an arrangement which admits of constant extensions adopted.

Jan. — 11, 1885

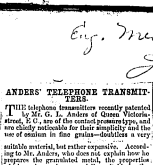
EXTENSION OF THE TELEPHONE.

THERE is always a pulling up of roads and side-walks, as the Americans say, going on in London; but for its last six months unusual energy has been displayed in taking up pavements, both in the City and West-end, by those borrowing destroyers of our duties and tempers. The evil, however, which has been borne, we hope, if not patiently, at least generously, will not be without its compensation in the additional supply of telephonic communication between the various parts of the metropolis. We are informed that at the end of the present month all the West-end exchanges of the United Telephone Company will be kept open all night as well as during the day. The convenience of this to the district subscribers will be very great, as in the event of any need of communication with a doctor, or with the police, or a fire station, or in any other emergency, the requirements can be satisfied by this arrangement with a rapidity and expeditiousness unattainable by any other means. In Paris the public call system, which was permitted by the Ministère des Postes et Télégraphes in the like manner with the concession granted by the English Post Office, has already been fruit. Call stations have been established there, through which, for a small fee, the public can have telephonic communication. These call stations are two at the Bourse, and the others respectively in the Rue des Halles, Rue de Grenelle, Saint-Germain, Place de la Madeleine, and at the Grand Hôtel. The night communication in London at the West-end is a step in the right direction, but it cannot be accepted as a reason why, if Paris can avail itself of the public call system,

Eng. Mech. + World of Science
July 11, 1885.

ANDERS' TELEPHONE TRANSMITTERS.

THE telephone transmitters recently patented by Mr. G. L. Anders of Green Victoria-street, E. C., are of the contact pressure type, and are chiefly noticeable for their simplicity and the use of osmium in fine grains—doubtless a very suitable material, but rather expensive. According to Mr. Anders, who does not explain how he prepares the granulated metal, the properties which render osmium especially suitable for the purpose are great hardness, infusibility, and



sensitiveness to microphonic action. In some instances he employs aluminium for one surface, and osmium for the other, because of its high conductivity for heat and electricity, which prevents overheating, its liability to fusion at the point of contact, &c. Both of the above-named materials, moreover, are free from the defect of producing a non-conducting film easily formed coating by exposure to the air or under the action of the current.

Fig. 1 is a side view, partly in transverse section, of part of a transmitter.

Fig. 2 is also a side view of another form, while Fig. 3 illustrates a modification. A is the diaphragm, which may be made of any suitable material, B B are the electrodes, preferably formed of any metal not easily oxidised or fused. One very advantageous manner of carrying the invention into practice consists in placing granulated osmium between two discs or plates forming the electrodes and inclosed in a tube or sleeve of indiarubber, cork, or other suitable material, as in the instrument shown in Fig. 1. In this instrument one of the electrodes B is attached to the centre of the diaphragm or soundboard by a screw-stud C, or by other suitable means; the electrodes are kept apart by rings or other pieces inclosed in and kept in the case or sleeve apart by the tube or sleeve C. The space D between the discs or bottoms is filled or nearly filled with grains of osmium. The conducting wires E are connected with the electrodes B as shown. The instrument shown in Fig. 2 has the above specified parts in duplicate, the outer ends of the electrodes B being connected by a small bar or plate B'.

Semilious the patentee employs a small quantity of granulated osmium intimately mixed with aluminium leaf or foil by rubbing them together. In this instrument either metal can be used in place of aluminium to form the electrodes B as the principal part of the microphonic action takes place between the mixed grains of osmium and aluminium. In this modification of Fig. 1 one electrode is attached to a diaphragm or sounding board, the other electrode may be prevented towards it by known weights. If desired, the two electrodes may be set firmly in the ends of a glass or other tube with sealing-wax or other cement, and the whole mounted upon a diaphragm or sounding board. According to another modification one electrode is attached to the diaphragm of the transmitter, and about its free end is either or tube of cork or similar material F, Fig. 3, into the end of which the other electrode is screwed. A space is left between the two electrodes in which is placed a short cylinder or disc of aluminium, the surfaces of which are purposely impressed with fine particles of osmium to which they adhere. The electrode should be faced with platinum or other insoluble metal. The cylinder or tube must fit tightly enough on the electrode on the diaphragm to enable the electrode to support the other parts. An adjusting screw-thread into the back of the case serves to vary the pressure upon the electrodes. This form of my

instrument is shown in Fig. 3. G G are pieces of aluminium which have the grains of osmium pressed into them and which are inclosed in the tubes C and between the electrodes B. The inferior or upper electrodes are connected by the wire or rod H. As the aluminium is sufficiently soft to permit particles of osmium to be readily united thereto by pressure, the patentee sometimes uses the osmium at the tip or point of an electrode formed of aluminium, and forms both electrodes of aluminium. Although Mr. Anders' experiments indicate that the best results are obtained by the use of aluminium in the manner described, yet other metals possessing to a greater or less degree the valuable properties mentioned in this specification may be employed in combination with osmium.

Engineering - Feb. 13/85

INDUCTION ON TELEPHONE LINES.

After the first flush at the success of the telephone its application was found to be, like other mundane matters, far from an ideal. Whatever may be the proper limitations to the term induction it is trusted that the same mind which invented the telephone may yet devise some means to annihilate the disturbing influences which limit its application. Mr. W. W. Jaques, one of Professor Hall's coadjutors, has been making investigations upon underground lines, and finds the empirical rule that when the product of the static capacity of the line in microfarads by its resistance in ohms is less than 18,000, it is feasible to use the telephone for commercial purposes, but when this product amounts to between 18,000 and 30,000, then the transmission is imperfect and nothing can be understood except by skilled operators. No telephonic signals can be transmitted when the product exceeds 30,000.

Dron — Jan. 16, 1886

A MECHANICAL TELEPHONE.

ANOTHER telephone, called by its inventor, Mr. A. G. Miller, of Layden, New York, a "mechanical telephone," has been added to the list of talking machines. The mechanical or acoustic telephone is stated to transmit and receive speech with great clearness and naturalness of tone. The mouthpiece has a central aperture for the passage of sound waves to the diaphragm, whose edges are secured within a rabbet of the mouthpiece. The diaphragm is about 7 inches in diameter, and is made of spruce wood, which possesses great sonorousness combined with strength sufficient to sustain the tension of the line wire. The mouthpiece and diaphragm are held to the wall on a bed plate by the tension of the line wire. The bed piece is recessed at both sides, and centrally perforated to the passage of threads connecting the line wire to the diaphragm. The front recess affords a space between the diaphragm and the centre of the bed piece for free action of the diaphragm, promoting clearness of enunciation when the instrument is used as a receiver, and the rear recess secures a small marginal support for the transmitter, thereby avoiding a large contact with the wall, and preventing excessive vibration. Threaded holes, tect articulation and the ringing sounds common to acoustic telephones, the line wire is connected to the diaphragm by silk cords, which are twisted about the end of the wire to obtain a firm connection therewith, and which diverge into three or more strands that are secured to a metal ring, between which and the diaphragm a rubber or leather ring is interposed. The line wire is made of strands twisted together and coated with varnish to bind them, and prevent them rubbing upon one another. This construction of the line wire makes it strong, and protects it from the weather, and, combined with the silk cord connections, is said to aid largely in clear transmission over line wires of considerable length.

Engineering - Feb. 13/86

Dron — Jan. 9, 1885

THE BELL TELEPHONE IN CANADA.

The Minister of Agriculture of the Dominion of Canada sends a decision on January 26, which wrecks the Bell Telephone patent in Canada. The patent laws among other matters require that the subject of a patent must be manufactured within two years, in order to preserve the patent, and it has been the custom to import portions of manufactured articles in such stages as the state of manufactures in the Dominion suggests, and the final construction and assemblage of parts has been regarded as complying with the law. The matter at issue is an attempt to decide how far back from the finished material it is necessary to go in order to constitute manufacturing. Can the sheet brass of an article be rolled and stamped elsewhere, where there are ample facilities, or is it necessary to go back to the ores of zinc and copper and tin? This is no factitious analogy, because a prominent patent has been prosecuted against on the ground of importation of stamped brass portions. Shall a patent requiring the brains of inventors and the persistence of capital be suddenly declared void because it is put together with imported screws? The principle must set forth patents no other interpretation. If such ideas are carried to their farthest extremes the result will work injury to that portion of Canadian business, fostered by patent laws which were drawn in a spirit of liberality and wisdom for the purpose of increasing the prosperity of the Dominion of Canada.

A NEW TELEPHONE.

EXPERIMENTS were made recently on the large wire of the Postal Telegraph Company between New York and Mendeville, Pennsylvania, a distance of 320 miles, with a telephone devised by Professor Webster Gillett, of Ypsilanti, Michigan. Owing to the storm and atmospheric conditions, the magnetic bell was kept ringing by the induction alone, but there was little difficulty in carrying on a conversation. Professor Gillett used what he calls a 10-point instrument. In its transmitter a needle is attached to a rubber disk, coming in contact with granulated carbon, held under compression to increase the conductivity for taking up loss by friction and other causes. Most instruments have solid carbon buttons. Each point is like adding another telephone in power. The feature of the receiver attached to the telephone is the increased magnetic surface presented to the diaphragm. Chicago, a distance of 1,000 miles, including a cable containing twenty-two wires, has been reached satisfactorily with the 10-point instrument. The single-point instrument has been operated for from 75 to 100 miles. The 10-point instrument was during the experiments reduced to six points, and communication was still kept up. The plan is to construct an instrument that will open communication by cable across the ocean as well as covering long land distances. We hear that a 20-point instrument is making for the purpose of ascertaining the distance it will reach. Professor Gillett states that the French cable is 2,430 miles long from end to end, and the resistance is 2·09 ohms. The resistance of the wire used during the tests experienced is 14 ohms, but as satisfactory results have been obtained from the smaller copper wire, the resistance of which is 6 ohms.

A NEW TELEPHONE.—We learn from *Nature* that M. Marcel Deprez, the well-known electrician, is not confining his labours exclusively to the transmission of electrical force to distant places. In conjunction with others, he has patented a new telephone based on a new principle of vibration, and dispensing with the use of voltaic elements. The lease of the Compagnie générale des Téléphones being about to expire, the municipal council of Paris have held a general meeting on the question whether the lease should be renewed or not. In the course of the discussion it was proposed to grant the renewal of the lease provisionally for a month in order to give the new apparatus a fair trial. The further discussion of the question has been postponed.

ON CAUSES OF DISTURBANCE IN TELEPHONIC COMMUNICATIONS.

ACCORDING to the observations made by M. D'Arsonval, it appears that the nerve of the frog, which has always been regarded as the most perfect of all galvanoscopes, is far from the most sensitive than the telephone. But the experiment of M. D'Arsonval proves that the nerve of a frog's leg placed on the platinum terminals of a telephone, in the circuit of the corresponding receiver, and the platinum touching the nerve and muscle forming the loop, we must attribute a considerable portion of the results obtained in telephony to the perfection of the organs of hearing.

Whatever may be the causes of this extreme sensitiveness, it is certain that it does not tend to the solution of the problem, as we shall, on the contrary, find the disturbing effects which diminish or diminish the power of the voice.

The causes of these disturbing actions exist either at the transmitting station, on the line, or at the receiving station, but very often at all three of them at the same time, so that an analysis of the phenomena which occur, says Mr. W. Le Conte Stevens, in *Telegraphic Journal*, becomes absolutely necessary.

Taking into account only the essential parts, a microtelephonic station comprises a microphonic transmitter with battery, a bell box with or without battery and a telephonic receiver, and a purely telephonic station; a call bell with battery and a telephone serving at once as transmitter and as receiver.

Most generally all this apparatus is essential upon one board, which is fixed to one of the walls of a room where the speech is transmitted and received.

In long as we have a perfectly insulated communication, this mode of grouping all the elements of a station has no disadvantage; but when the arrangement is used for a microtelephonic station, inconveniences may result in certain cases, as we shall see directly.

The microphone most generally used for telephony is the Leclanché, with porous cell. It is composed, as we know, of a glass jar containing a solution of chlorhydrate of ammonia, in this is immersed a porous vessel which contains a mixture of carbon and peroxide of manganese, surmounting a piece of carbon. This latter forms the positive pole of the battery, and the amalgamated zinc rod forms the second in the solution of chlorhydrate of ammonia.

Without describing accurately all the reactions which take place during the passage of the current, we may say that there is, on one hand, a formation of oxychloride of zinc, and on the other the production of the peroxide of manganese with disengagement of ammonia. It is easy to see that the many causes that tend to polarize the battery quickly exist to annul its working properly. We must avoid insulating the mixture contained in the porous cell: for a too strong imbibition of the carbon and peroxide of manganese would result in preventing the disengagement of ammoniacal gas and the escaping subsequent of the chemical.

In this case the battery would not work as well, the current strength would be diminished, and consequently the speech in the receiving apparatus would not be so loud. We think that it is best to have the liquid in the glass vessel one-half of the height of the porous cell.

Certain precautions must be taken generally in order to consider the rather numerous cases of batteries which may be found in the circuit of a microtelephonic station, although, for several reasons, it should be specially attended to in installations of this kind.

If we now examine the phenomena which occur in a battery in the normal state of construction and mounting, and which is placed in a position where the temperature is more or less high, we shall soon see that the chemical reactions which take place therein, upon the one hand, and upon the other, are:

Following this examination more attentively, we observe that these crystals are not of the same nature, and whilst the first are formed of chlorhydrate of ammonia, chloride of zinc enters into the composition of the second.

The following experiment, which may be made for this purpose, completely proves the difference of substances of the crystals which are deposited upon the vessel and upon the zinc.

Having thrown chlorhydrate of ammonia into a glass vessel containing water up to one-third of its height, and placed in a room having mean temperature of about 10° C., we may observe, at the end of the third or fourth day, the formation of the crystals of the salt, forming a band above the surface of the liquid. This band increases continually in width, and after about a month reaches the top of the vessel, and then redescends in a progressive manner upon the outside of the receptacle, and reaches the bottom in about two months and a half.

Whilst the band is developing and rising, the deposit of salt which forms it, and which appears at first like a sort of dew, offers successively more abundant and more regular crystals, with considerable fine creeping salts. These crystals, in fact, actually along the surfaces of the cells, and as soon as a slight deposit is produced, by the evaporation of the liquid which has risen by capillary attraction between the walls and the salt already deposited, forms, arranges and regulates them by it, after having prospected in this manner, we combines the experiment by immersing a rod of zinc in the solution of chlorhydrate, we perceive to change in the phenomena which reveals as they were. The chemical action is manifested by any change of color, and sometimes there are any crystals deposited upon the zinc rod.

It results from these facts that the crystallizations which we observe on the vessels are different from those upon the zinc, and that the first, which are produced in a liquid containing only chloride of ammonium, can only be formed from this salt.

Those, on the contrary, which cover the zinc, and which only exist in batteries which have already worked, are formed of the chloride of this metal, or M. Wurtz said, in his dictionary of chemistry.

The last point is key, moreover, explained as follows:—The chloride of zinc which is produced in the battery under ordinary current requires, in order to be dissolved and crystallized, a certain elevation, and as soon as the temperature is sufficient it is deposited in the form of crystals falling to the bottom of the receptacle. The formation of the crossing salt, which impoverishes the chlorocitrical liquid intended to dissolve the salt of zinc, and therefore, the zinc is deposited upon the crystals.

Therefore, in order to have a good representation of the battery, we know that it is important that the battery be in special conditions, which, although not exactly preventing the formation of the crystallized salt, nevertheless retards it.

The presence of these salts, in fact, leads directly to a diminution of the electromotive force, and hence causes during the working of the battery the formation of crystals upon the zinc, which prevents it from being attacked, and increases the resistance of the element.

We have seen that a certain degree of heat usually favours the production of crystals of chloride of ammonium and zinc, and that the cold is necessary for obtaining them in such a manner as possible in placing the battery in a place where the temperature is low. It follows, therefore, that by grouping up in the same box all the apparatus of a microtelephonic station, including the battery, the considerations mentioned above cannot be realized under all circumstances.

We have now to tell us on the subject of disturbances caused by the special conditions of the battery.

We will now study the microphonic transmitter, which forms the second apparatus of a microtelephonic station.

The most important element which enters into a comp osition is certainly the carbon, of which the transmitting disk is composed, and the resistance upon the hardness and cleanness of the speech.

It must not be powdery, for instance, for by the vibrations, which are, so to speak, continual, to which the apparatus is subjected, the molecules of carbon are accumulated between the contacts and produce a disagreeable crackling which accompanies the voice.

Other organic powders dry, like the finest powders, moreover, fit somewhat, and thus the battery is constantly deranged by a few sharp blows given upon the box containing upon the back of the disk, under where these derangements appear.

Very often M. Carbon is pulverizing, compressing, and subjecting to a high temperature, the mixture of carbon very rare also in fine powder, calcined sagebrush, and syrup of sugar.

On examining with a lens a carbon thus prepared we find a certain number of small white pearls, apparently formed of crystals of sugar not entirely carbonized. They emit, laterally regularly, a fine powder of carbon. This factor, in the series with a rigid diaphragm, which by their nature they extract from the microphone, and Edison's is even followed by the disappearance of the cracks and the formation of a band of which is very loud to detect from the ear.

In order not to be obliged to do this too often, it is necessary to avoid, as much as possible, the formation of the said powder, by the use in every case at the white points by perfectly polishing the surface of the carbon, so as to give it the appearance of a metallic body.

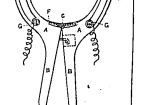
These remarks now only a very little to be said about the bell, the line, and the telephone, which are the last parts to be examined. As regards the bell, we have to the magnetic bell the preference should be given to the polarized bell, on account of that working with or a battery, because of the numerous advantages which it possesses, amongst others, the ensuring of better contact. This is numerous cases of weakness of voice which occur rather frequently in up-to-date when the bell is constantly used in an imperfect manner. The line is also a source of many disturbances, especially when it has a very or badly-soldered joint, for the resistance of the circuit increases, and the intensity of the current is consequently diminished. It may happen, also, that the wire touches a conductor in communication with the earth, and, line, for instance. In this case, the leakage that takes place at the point of contact diminishes greatly the circuit and increases the total resistance, by which is divided at the point of contact in inverse proportion to the resistance of the apparatus used. Consequently, the current which actuates the receiving apparatus is always weaker than when the line is in the regular condition—that is to say, when there are no abnormal leakages. A similar weakening of the current may result from the bad state of the line, from bad connections, as well as from the employment of a bell of communication with earth. As regards the telephone, we may say that the only defect which it can present is an insulation which the ebonite plate taken when the apparatus is kept in a damp place, or when it serves as a transmitter. In these cases, the plate, which is generally covered with a thin coat of wax, no attracts the metal and whatever vapour it may be covered. At the point where moisture is formed—that is to say, at the ends—a leakage is produced to manganese—the plate isn't longer in its normal condition, and, especially, the combined action of this dampness and the attraction of the magnet of the armature results in the production of the apparatus.

The considerations which precedes causes the plate such as the magnet, and protection all speech. It is necessary in this case to heat the apparatus, to

BARRAUD'S TELEPHONE RECEIVERS.

THE telephone receiver shown in the annexed sketches is one of the most powerful of the two-diaphragm type, and is constructed to combine as much as possible the maximum sound, with the minimum amount of battery power. It is patented in this country on behalf of D. G. Barraud, of Ilkley, Caledon, N.Z., and is the result of this adjustable double receiver. Fig. 1 is a transverse section of the receiver, which absorbs the rays emitted therefrom. Fig. 2 is a rear view of the diaphragm with the magnet removed. Fig. 3 is a rear view of the receiver magnet. Similar letters of reference indicate like parts in each figure. In the centre of the receiver between them the bond of the user of the instrument, is a magnet with handles, A, and an adjusted together at the upper ends of the handles by a screw, B. On the two ends of each pole piece, C, is secured two curved metallic arms D, D', which are fixed at their free ends to the rim, E, of the receiver, which pass through the arms D, D' to the diaphragm, forming pivots upon which the coils may swing, and which fix themselves to the ears of the case. The two ends are connected with the terminals of the telephone binding head screws to conduct the telephonic current through the sides of the diaphragm coil, one to each of the arms D, of the opposite sides, one connected with each other by a wire low-spring F, which conforms to the

general curve of the levers A, and draws them towards each other, and, at the same time, serves as an electrical conductor between the bobbins of the diaphragm coils. The ends of the arms D, D', which are connected to the levers A, are prolonged towards the rim, E, and provided at their ends with the adjusting posts G for receiving the usual telephone connections. When the diaphragm coils S are drawn towards each other by the spring F, the handles A are separated, and so limit the movement of the levers A. A book c extends from one handle into a recess in the other, in position to engage a pin or pinning



transversely through the recess when the handles are separated. The diaphragm coils E each contain a A, surrounding the end of a permanent magnet, J, which is curved in a spiral to bring it within the compass of the coil. The magnet J is clamped by screws J' against the fillet K, and lead in the diaphragm coil. The diaphragm coil E contains the usual diaphragm A, which is opposed to the magnet, and is held secured by the aperture cap A. The adjustable telephone receiver is applied to the ear by means of the

diaphragm coils E, by pressing on the handles B, then placing the head between the ears, and relieving the handles B, when the spring F may draw the diaphragm coils against the ears. When thus applied both ears are used, and all extraneous sounds are effectively shut out. By thus counteracting the volume of sound is greatly increased, and faint sounds are rendered more effective. This receiver thus facilitates telephonic communication in noisy places, and permits of receiving telephonic messages in a manner not to operate the ordinary receiver effectively. It is therefore especially adapted to long distance telephony, where the currents arriving at the receiving end of the telephone line are not in a fraction of the current sent out by the transmitter.

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Boston Journal
May 10, 1880.

Character of article: Pop
From the: Tribune
Published at: Minneapolis
Date: July 9 [illegible]

A NEW WRINKLE.

A Mode of Telephoning or Telegraphing Without Batteries.

For three years past T. H. Brown of Fort Worth, Texas, has been at work on an invention on which a patent was allowed last week, but which has not been issued yet at the request of Brown to his lawyers in Washington. The invention is a magnetic telephone and telegraph without batteries, a new system of transmitting and receiving human voice without using batteries of any kind. Brown has had a hard time perfecting his invention, being refused aid by [illegible] to whom he applied. A short time ago Mr. W. P. Masterson, a lawyer of much [illegible] and a man of means, saw Brown's telegraph and telephone one day, saw the instruments tested it and at once wrote to a director of the Western Union Telegraph company and president of the Gresham Telephone company, setting forth the wonderful workings of the invention. The Western Union sent Mr. Norvin Green to see Brown Tinker and asked him to have instructions to some experienced manager in a Texas office as regular Fort Worth to have the instruments tested over the Western Union lines and report to headquarters. Mr. Tinker replied, handed the instructions, and General Superintendent Clowry of the Texas lines. This [illegible] visited Mr. Fraser, Mr. Brown's lawyer, Mr. Masterson, J. H. Murphy and Robert L. Moore, operators, were in the Fort Worth office. Mr. Umsinger, an operator, was in the Dallas office, and Mr. Osborne, words in the Cleghorne office. The batteries on the line were cut off from the wire [illegible] mile long, and the magnetic transmitter and receiver attached at both ends of the line. For two hours the test went on, all parties talking, and all operators, by the telephone system, receiving and sending telegraphic to the Cleghorne office and receiving an answer in the same manner. The voices of the Cleghorne parties were very distinct, and a marked feature was the absence of all ringing or other noises on the line, and of any other apparatus. After the test was completed General Tinker was telegraphed to

Inventor to your letter of June 15, but made over a three-mile-wire circuit worked satisfactorily with the batteries of Brown's invention instead of batteries.

"The instrument used today was composed of, two ounces of wire and a half-pound of steel, and can be made for $6 cents. The transmitter is simply a horseshoe magnet, either pole being covered with fine wire, through which the voice, striking on the steel, agitates which the voice is thrown is transmitted through the magnets to the wire. The receiver is similar, with another magnet. It is claimed by the inventor that he can transmit the voice around the world or across the Atlantic ocean, there being [illegible] to the wire, and the only limit being the increase in the size of magnet. The one used today, weighing half a pound, was capable of transmitting the voice seventy-five miles. The cost of batteries is said to be $1000 yearly, which would be saved by this invention. In telegraphing battery and ordinary instrument is used, but in telephoning very little noise would be made. The receiving operator would have a disk attached to his ear, hung by a hook in a cup or stopped around his head. The noise now incident to the telephone would be done away with. He can send and receive information unlimited to pool-rooms, stock exchanges, etc. The telegraph would be absolutely secret. The inventor says, further, that the instruments could be carried 50 miles, and, in case of breakage, a temporary connection could be made by a telegraph wire and noise given to any station just where the accident had occurred. He says, etc., and this done in a few seconds. He also says a miner or river could take an instrument, attach it to an insulated wire, go into a mine or under the ocean with it, converse with a friend at the other end. Messrs. Brown and Masterson go to New York this week, when Mr. Brown will make arrangements to obtain patents in France, Germany, and England. Those being secured he will return to Texas and visit the country. It is possible the Western Union will buy the patent.—Chicago Tribune.

Character of article: Puff
From the: Sun
Published at: N. Y.
Date: Sept 15 80

TO REVOLUTIONIZE TELEPHONING.

The Wonderful Invention that Came to a Fort Worth Man in the Dead of Night.

From the Fort Worth Democrat.

Over three years ago Fred H. Brown began the work of studying out a telephone on an idea which occurred to him that a telephone and telegraph instrument could be made which would work without a battery. For three years he toiled and thought, encountered no scorn for the goal that was to be attained, until one night in February last, about 2 o'clock in the morning, he awoke suddenly from sleep and found the invention in his mind. Cold as it was, he jumped out of bed, lighted a lamp, and began to work. In a few months he had perfected an instrument and tried it at home. He at once determined to go to Washington, procure a patent, and the right to England to Spence, Gaines J. Frazier and G. H. Shuttler to France and Germany. Mr. Brown's son, who is a wood engraver, accompanied Mr. Brown to Paris.

The electricians of Mr. Gould and Mr. Mackay and the Western Union Telegraph Company and Bell Telephone Company are all interested, and it is learned if the invention could not be patented, but Mr. Brown had provided against all contingencies, and has secured patents in every land. The immense value of the invention was seen by A. J. Rudwig, a capitalist, who brought it to the notice of Mr. Masterson, a lawyer of means, who formed a company, and the multitude, who bought the right of the United States for one hundred dollars, raising $250,000 in 30 days in small dollars. Mr. Brown is secretary of the company of Houston, Mr. Masterson is president, Fort Worth capitalists every one. Several offers were here, and on Thursday night left with his instruments for New York and Washington.

When in 1876 Alexander Graham Bell was negotiating for Canada, which is held by the Dominion Telegraph Company, Mr. Brown offered that a hundred such company instruments was willing to say a dozen sets for it, which will further illustrate Professor Bell's invention. Mr. Brown left Fort Worth three days ago, after their interest in the invention had been sold to Jay Gould, Jersey and Frazier, to run in New York, and will leave in a few days for Europe.

The test in New York and New York a cable test will be made over 3,000 miles of cable, being the distance across the Atlantic. Instruments will be placed in the cable office in London and Paris, and messages will be transmitted over the 6,000 miles of wire and the instruments worked as clear as a bell. In a few days 200 miles of wire will be stretched on Long Island for tests of the instruments.

As soon as possible the company in New York will get to work and organize sub-companies in all the States, and the telephone and telegraph will be superseded. All under control.

This invention is a magnetic telephone and telegraph instrument, by means of a new and peculiar method of using [illegible] for sending without using batteries of any kind. Brown has had a hard time perfecting his invention, being refused aid by those to whom he applied. A short time ago Mr. W. P. Masterson, a lawyer of means, and well-acquainted with prominent Eastern telegraph and telephone men saw the instruments tested, and at once wrote to a director of the Western Union Telegraph Company and President of the Gresham Telephone Company, setting forth the wonderful workings of the invention. The Western Union sent Norvin Green to see Brown. Tinker and asked him to have instructions to some experienced manager in a Texas office as regular Fort Worth to have the instruments tested over the Western Union lines and report to headquarters. Mr. Tinker replied, handed the instructions, and General Superintendent Clowry of the Texas lines. This [illegible] visited Mr. Fraser, Mr. Brown's lawyer, Mr. Masterson, J. H. Murphy and Robert L. Moore, operators, were in the Fort Worth office. Mr. Umsinger, an operator, was in the Dallas office, and Mr. Osborne, words in the Cleghorne office. The batteries on the line were cut off from the wire [illegible] mile long, and the magnetic transmitter and receiver attached at both ends of the line. For two hours the test went on, all parties talking, and all operators, by the telephone system, receiving and sending telegraphic to the Cleghorne office and receiving an answer in the same manner. The voices of the Cleghorne parties were very distinct, and a marked feature was the absence of all ringing or other noises on the line, and of any other apparatus. After the test was completed General Tinker was telegraphed to

Inventor to your letter of June 15, but made over a three-mile-wire circuit worked satisfactorily with the batteries of Brown's invention instead of batteries.

"The instrument used today was composed of, two ounces of wire and a half-pound of steel, and can be made for $6 cents. The transmitter is simply a horseshoe magnet, either pole being covered with fine wire, through which the voice, striking on the steel, agitates which the voice is thrown is transmitted through the magnets to the wire. The receiver is similar, with another magnet. It is claimed by the inventor that he can transmit the voice around the world or across the Atlantic ocean, there being [illegible] to the wire, and the only limit being the increase in the size of magnet. The one used today, weighing half a pound, was capable of transmitting the voice seventy-five miles. The cost of batteries is said to be $1000 yearly, which would be saved by this invention. In telegraphing battery and ordinary instrument is used, but in telephoning very little noise would be made. The receiving operator would have a disk attached to his ear, hung by a hook in a cup or stopped around his head. The noise now incident to the telephone would be done away with. He can send and receive information unlimited to pool-rooms, stock exchanges, etc. The telegraph would be absolutely secret. The Inventor says, further, that the instruments could be carried 50 mi truths, and, in case of breakage, a temporary connection could be made by a telegraph wire and noise given to any station just where the accident had occurred. He says, etc., and this done in a few seconds. He also says a miner or river could take an instrument, attach it to an insulated wire, go into a mine or under the ocean with it, converse with a friend at the other end. Messrs. Brown and Masterson go to New York this week, when Mr. Brown will make arrangements to obtain patents in France, Germany, and England. Those being secured he will return to Texas and visit the country. It is possible the Western Union will buy the patent.—Chicago Tribune.

Menlo Park Scrapbook, Cat. 1035

No. 21A. "Carbon Telephone and Far Sight Machine"

This scrapbook covers the years 1887-1889. The book contains clippings about the telephone, including several articles about conflicting claims over who invented the telephone. There are also some articles about Edison's claims for a "far sight" machine. The book contains 134 numbered pages.

Blank pages not filmed: 18-134.

~~Condensation of Electricity~~ 1035

Carbon Telephone & Far Sight Machine

Book 21st - 2nd vol.

Globe Democrat, St. Louis, Mo

Jany 13. 1888.

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TESTING TELEPHONE WIRES.

Electric Currents Tried, Measured and Corrected by Delicate Instruments.

The Bell Telephone Company is in the midst of experiments looking to the perfection of the system of telephoning in this city. Henry L. Bailey, an electrician from New York, was found by a GLOBE-DEMOCRAT reporter yesterday surrounded by electrical testing machinery in a large front room on the top floor of the Mechanics' Bank Building, and busy making tests. Mr. Bailey said:

"The telephone business in some localities is generally run by a sort of rule-of-thumb method. The people of such places haven't considered it necessary to make any experiments, thinking that their construction is good enough for telephone work. That doesn't seem to be the rule here. The Missouri company's general manager, Mr. Durant, having had a large experience in telegraphy, and knowing the important results of Prof. Varley's visit to America, when he made his test and report about Western Union wires, is alive to business. Varley's work was really the starting point of the successful operating of the Western Union wires, electrically speaking. This company seems to be sparing no pains nor expense in improving its system, and doing all in its power to remedy the troubles of induction, escape, etc., from which all telephone companies' service suffers more or less. It has, in my opinion, by far the finest central office in the world. Its service is better than that of any other company. The subscribers here may have hardships, but they don't know what is suffered in other places. The switchboard and the whole system in the central office as managed there is excellent. I find upon observation that the line construction here is generally strictly first-class.

PATIENT INVESTIGATION.

There are some matters which are developed in telephone business which don't occur in other lines that are exceedingly difficult to treat, and require a long and patient series of tests, which are to be supplemented by changes in the relationship of wires. A gradual improvement will undoubtedly follow the efforts that are being made. A diminution of the effects of noises that are heard on the lines on which a person is talking is an object we are working for. Among the observations that are being made are those which will enable us to distinguish the true effects of induction from those which arise from escapes or leakages from one wire into another. It may interest the general reader to know that it is impossible to insulate the effects of induction in the sense of insulation, as the inductive influence passes freely through the very highest insulators, as also do ordinary magnetic effects through all non-magnetic substances. The interposition of a piece of glass or hard rubber, or any non-magnetic metal, including brass, lead, gold, zinc, silver—most anything except iron, nickel and cobalt—would not affect in the slightest degree the inductive action upon an adjacent magnetic body. The inductive influence can be cut off or screened by the interposition of a conductor, not an insulator; so also the inductive influence of a magnet may be cut off by the interposition of a magnetic body such as a sheet of iron. Of necessity telephone and telegraph wires run in parallel lines through cables or on poles, and there are, naturally, inductive influences of more or less force observed in all such systems. This is especially noticeable with telephone lines, because the receiving instruments or phones themselves, are peculiarly sensitive indicators of these inductive effects, which would be wholly unnoticed and escape observation with the ordinary telegraph instruments. In screening the inductive action in telephone circuits by the interposition of metallic bodies, gives rise to an effect called retardation, something that would be difficult to present in a few words so as to be understood. While it remedies the inductive trouble, it introduces, in a greater or less degree, another difficulty, which is, that there is a lack of distinctness in articulation. While the remedy is a very useful one it must be judiciously applied. The work I am doing is a careful determination of the electrical construction of the lines, their insulation, conductivity and inductive relations, with a view to the diminution of the electrical troubles by equalization of resistances, reconstruction where necessary, employing the best wire with the highest insulation, hunting out and repairing any bad points, and, in fact, a general overhauling, the nature of such work depending wholly on the indications given by the tests.

APPLIANCES USED IN TESTING.

Mr. Bailey made some experiments with a mirror galvanometer, the machine invented by Sir William Thompson. Such instruments are now largely employed in electrical testing. The Bell Company also has in use a standard condenser, similar to those used for determining the relative capacity of the cables. The Wheatstone bridge Mr. Bailey has in use is one of the largest and finest in the country. He has also an Ampere meter used only in charging a storage battery. The most interesting point about the galvanometer is its peculiar sensitiveness. So sensitive is it that a load of iron girders that was driven along Fourth street in the forenoon completely upset the accuracy of the machine until the load was half a block further on. The whole machine is suspended on springs from the ceiling, and its battery table is insulated on glass feet, as is also the sixty cells that Mr. Bailey has in use for his experiments. Sometimes the operator insulates himself, removing from his pockets all keys and knives, and, when experimenting on ocean cables, even cuts the brass or alloy buttons off his clothing. The swinging needle of the galvanometer is mounted on a single filament of silk, so fine that it took Mr. Bailey through several experiments to learn how to tie a knot in it under a strong light, with a crochet-pointed pin. This swings a little mirror that reflects a circle of light on a graduated, transparent, lateral scale, with zero in its center. The instrument is the most sensitive of all measuring instruments. The machine tells the operator what part of the wire is at fault when anything goes wrong with it. Partial faults are hardest to locate. In cables under the sea the toredo, a sea-worm, sometimes bores into the cable, causing a slight defect. These partial faults are sometimes sealed up by sending a heavy current through the wire in one direction or quickly from both ends. Mr. Bailey showed an interesting experiment of sending out 1-1000 of a current through the instrument. That 1-1000 became a multiplier, by the aid of which with the machine's established formulas and presentments he was enabled to determine that one feeble cell, whether large or small, would give 20° deflection through a coil running twenty times around the earth at the equator. The measurement of a line is shown when the light stops at zero.

MEASURING ELECTRICITY.

There were some slight escapes yesterday owing to bad weather. In testing wires there are some little practical difficulties, as the picking up of a little of an electric light current by the wire, etc. A subscriber's wire was found to be 187½ ohms (or units of resistance in length). The light stopped nearly at the right scale line, and the line was pronounced all right by the experimenter. In ocean cabling small fractions of an ohm are taken into consideration, but that is not necessary in making telephone wire experiments. An ordinary telegraph wire, No. 8, measures about 13 ohms to the mile. The human body offers a varying resistance. When the skin is dry there may be between the hands from 20,000 to 40,000 ohms, but if the skin is moist the resistance may be reduced to 3000 or 4000 ohms. The further experiment with the charge and discharge of electricity, and of showing a shock of lightning, and of determining the direction of a current in a wire were shown by the experimenter. The machine showed itself to be so sensitive that when the experimenter touched the two terminals of the galvanometer the spot of light rushed back and forth at his pleasure along the scale. By the machine he was also enabled to tell when the rain stopped falling and when it began again.

Journal, Albany, N.Y. 1888.

TELEPHONE CHARGES.

AN EXHAUSTIVE REPORT BY THE ASSEMBLY COMMITTEE.

No Relief from the Bell Monopoly Except Through a New Invention—A Bill to Reduce the Exorbitant Charges of the Metropolitan Company—Why the Troy Company Escapes Legislation—Over $8,000,000 Already Invested—A Mass of Valuable Information.

Chairman Ainsworth of the telephone investigating committee appointed last year by the assembly presented a report this morning more voluminous than the New Testament. It begins with reciting that on April 27, 1887, the assembly passed a resolution directing the appointment of a committee to ascertain the names of all companies doing telephonic business within the state of New York; the amount of the capital stock of each; the cost of the plant of operation; the amount of the earnings of each, and their dividends. The speaker appointed as such committee Messrs. Ainsworth of Oswego, Hadley of Franklin, Saxton of Wayne, Dickey of Rockland, and Conover of Westchester. Mr. William H. Weed of Mexico, N. Y., was appointed as clerk. The meetings of the committee were held during the summer at Utica, Troy, Saratoga, Buffalo, Rochester and New York. The affairs of all the companies in the state were investigated. The report contains a voluminous and detailed statement of the information sought for. It was compiled from the stenographic report, which cost $1,400, by Chairman Ainsworth, and Charles T. Saxton and F. J. Hadley of the committee. A brief summary of it is as follows:

THE AMERICAN BELL COMPANY.

The American Bell telephone company is a corporation organized under the laws of Massachusetts with a capital of $10,000,000, which, under the present judicial decisions, owns and controls all patents now in use upon telephonic instruments in the United States. It does not sell any of the instruments manufactured under its patent, but leases them to its licensees at an annual royalty of $14 per set of instruments, excepting the Metropolitan company of New York and the Commercial company of Troy, which it charges $10 respectively, reserving the right to increase all these royalties at its pleasure. By the terms of its contract with the local companies these instruments are delivered to the local companies at the company's office in the city of Boston. In addition to these royalties it also exacts from its licensees a further consideration in the form of a donation of 35 per cent of the capital stock of its licensees. It also exacts a commission upon all extra territorial and telegraph business done by the licensees of 15 per cent on the former and 50 per cent of the latter.

THE BELL COMPANY OF BUFFALO.

The Bell telephone company of Buffalo embraces the counties of Erie, Niagara, Orleans, Genesee, Wyoming, Monroe and Livingston, and was organized in March, 1879, and has a capital stock of $600,000, of which the American Bell telephone company of Boston owns $210,000, franchise stock. Its entire capital stock has been issued. The total cost of the construction of its plant is $444,807.15, and its net earnings during the year 1886 were $64,500.25; its percentage of net earnings to cost of construction, excluding franchise stock and watered stock, is 14 per cent. The dividend paid by this company in 1886 was 6 per cent. The rate of charges, being based upon the toll system, cannot be given.

THE CENTRAL NEW YORK.

The Central New York telephone and telegraph company operates the counties in the central portion of this state, with main offices in Utica, and was organized in December,

1883. The capital is $1,000,000, divided into American Bell company's $10,000, issued as franchise stock. Its call certificates during the last fiscal year were $30,681.50.—The actual cost of construction to date is $1,000,000. The amount of outstanding is cost of construction is $1,000,000. This company paid no dividends during the year. Its average dividend has been $.17 per month. It has 1,420 exchange subscribers, at an average annual rental of $36.00. Its net receipts from exchange business during the past fiscal year were $39,276.00, making the total net earnings to cost of construction 3.9 per cent. It has 826 subscribers at an average rental of $48.00.

THE EMPIRE STATE.

The Empire State telephone and telegraph company operates that portion of the line between the Buffalo and Chester New York companies, and has a capital stock of $500,000, divided into 5,000 shares, and of which the American Bell telephone company owns a franchise stock $60,000. The net earnings during the past fiscal year were $17,167.50, of which its city business furnished $1,750.41, while its toll line or country business contributed $15,412.05. Its total cost of construction to date is $25,000. The percentage of net earnings to cost of construction is 67 per cent. It has 826 exchange stations, the average rate being $41.25.

THE TROY COMPANY.

The Commercial telephone company of Troy operates principally the city of Troy and is owned principally by the Western Union telegraph company. It was organized January 1, 1879, and has a capital stock of $100,000, part of which is franchise stock. The nearly remaining evils of the franchises issued under the Edison patent and its franchise ceased expire in 1891, when, by the terms of its contract, the Western Union telegraph company contracts similar to those held by the other companies of the state. Its cost of construction is $90,000. Its net earnings during the past fiscal year were $23,000. Its percentage net earnings to cost of construction is 25.5 per cent. It paid no dividends in 1879, 30 per 'ct. in 1880, 40 per 'ct. in 1881, 50 per 'ct. in 1882, 60 per 'ct. in 1883, the amount of which was derived from its earnings and the district messenger service. It has 1,200 subscribers, at an average annual rental of $60.00 per instrument.

THE UNION COMPANY.

The Union telephone and telegraph company operates the exchanges at Albany, Troy, Saratoga, Cohoes, Warren, Washington and Rensselaer counties. It was organized in 1881 and has a capital stock of $500,000, part of which has been issued and none of which is franchise stock. Its cost of construction is $400,000. Its net earnings for the past fiscal year were $40,000, showing a percentage of net earnings to cost of 10 per cent. It has 1,000 licenses of the Bidden river telephone company, to whom it pays a royalty of $20 per annum each instrument. It has 1,000 exchange subscribers at an average annual rental of $42. Its average annual dividend has been 5.5 per cent.

THE NORTHERN NEW YORK.

The Northern New York telephone and telegraph company operates the northeastern portion of the state. The officers of the company reside in Lowell, Mass., and refused to furnish an interview. The statement was furnished by the manager, Mr. W. W. Wright, of Plattsburgh, from whom it was learned that the cost of construction for the year, 1883, was $75,000. Its capital stock is $50,000, all issued, of which the American Bell company owns $10,000. Its net earnings were $19,000. The dividend for the past fiscal year was 7 per cent. The percentage of net earnings to cost of construction and 25 for business and profession. We are unable to give its cost of construction.

THE NEW YORK AND VERMONT.

The New York and Vermont telephone and telegraph company was organized in 1881, and has a capital stock of $50,000, none of which is issued, for the American Bell telephone company is a subsidiary of the Bidden River company. The cost of construction is $50,000. Its net earnings for the past fiscal year were $5,000, the percentage of net earnings to cost of construction being 10 per cent. It has 200 subscribers, at an average annual rental of $25. It has never paid a dividend.

THE HUDSON RIVER COMPANY.

The Hudson River telephone and telegraph company operates the Hudson river valley, and a portion of Pennsylvania and New Jersey. It has a capital stock of $500,000, $150,000 of which has been actually issued. Its cost of construction is $300,000. Its net earnings for the past fiscal year were $45,000, showing a percentage of net earnings to cost of construction of 15 per cent. The interest company has never paid a dividend on its stock. It has been but a year and a half in operation. It has 2,000 subscribers at an average rental of $22.50.

THE NEW YORK AND PENNSYLVANIA.

The New York and Pennsylvania telephone and telegraph company, operates the southern tier of counties in New York and a portion of Pennsylvania. It was organized in 1882, and has a capital stock of $1,000,000, $250,000 of which has been actually issued. The American Bell company own, as franchise stock, $100,000. The cost of construction is $200,000, and its net earnings for its past fiscal year were $50,291.00, showing a percentage of net earnings to cost of 25 per cent. The annual dividend has been 4.5 per cent upon the issued capital. It has 2,000 subscribers at an average rental of $24.00.

THE WESTCHESTER COMPANY.

The Westchester telephone company operates principally in Westchester county, and has a capital stock of $100,000, all of which has been issued and $10,000 of which is owned by the American Bell company as franchise stock. The cost of construction is $75,000, and its net earnings for the past fiscal years were $18,000, showing a percentage of net earnings to cost of construction of 24 per cent. The capital stock has all been purchased by the Hudden River company. Its average dividend since organization has been 7 per cent. It has 1,000 subscribers.

THE STATEN ISLAND COMPANY.

The Staten Island telephone company operates Staten Island, and is an outgrowth of the Metropolitan company, which operates in New York and Brooklyn, having a capital stock of $125,000, all of which has been issued. Its cost of construction is $80,000, its net earnings for its past fiscal year were $6,474, showing a percentage of net earnings to cost of construction of 8.1 per cent. The Metropolitan company owns $45,000 of its capital stock issued to them as franchise stock. Its annual dividend has been 6 per cent. It has 372 subscribers, paying from $50 to $125 per year, depending upon distance from the central office.

THE NEW YORK AND JERSEY.

The New York and New Jersey telephone and telegraph company operates between Jersey City and various points. It was organized in 1881 with a capital stock of $2,000,000, $400,000 of which is franchise stock of the licensees of the Metropolitan company, which owns $200,000 of the stock. Its cost of construction is $1,000,000, and its net earnings during the past fiscal year were $100,000, showing a percentage of net earnings to cost of 10.5 per cent. It has 2,317 subscribers at an average rental of $75.

INEQUITY OF UNIFORM RATES.

This company has a special class of service furnished to the brokers who are large users, and pays a dividend, in one case of $720 per year. Free service is given by actual count for 70,000 connections with the Jersey City exchange, and from the cost of the instruments and the other items of service furnished the liability of these brokers' business hours, counting from the time the first bell rings in the morning until the last bell rings in the evening, it would appear that these illustrated the inequity of these uniform rates for equal service. These cases point to a loss marked degree throughout the state.

A COMPANY WHICH NEVER EARNED MONEY.

The American Union telegraph company, of Buffalo, was organized in 1865 with a capital of $750,000, and was the pioneer company, especially in the giving of telephonic conversations between different cities. It never earned any money, and was finally wound up under the provisions of the resolution appointing this committee.

THE METROPOLITAN.

The committee review the conflict between the Metropolitan Union telegraph company, owners of the Edison patent, and the Bell company as concerning the Edison Bell patent, and of the settlement of which, gave the Metropolitan company of New York, and the Metropolitan company of Brooklyn, each a franchise of $1,000,000, granted respectively by the Metropolitan telegraph company of New York, and Western Union telegraph company, in the two

DAN-DRAWBAUGH'S HOME

STORY OF THE INVENTOR'S TRIALS

INVENTED THE TELEPHONE AND MACHINE GUN

The Struggle of His Existence Worth and His Sufferings—Handicapped by Poverty and Created by the Press—Millionaire Bell, His Rival Works on His Farm—What His Neighbors Say.

HAMMONTON, Pa., April 12.—I have been over at the Second Valley of the Cumberland in the neighborhood of Dan Drawbaugh's workshop and residence of the Supreme Court of the United States say or think of the claims of this man in the federal courts. The courts have arrived at are that the state has authority, provided by its constitution of legislature, to impose taxes or regulations of doing business in this state; but that the regulations enacted by the full company of Boston *for the right to use its patents* are not subject to state control.

THE ONLY REMEDY IN INVENTED.

The remedy, therefore, for the attempted legislation of the states and the investigations made by their committees, is found in the decisions have been rendered in the New York, Pennsylvania, Ohio, Michigan, Minnesota, Illinois, Iowa, Arkansas and Texas with regard to this question, and review at length the decisions of the supreme position in Indiana and in effect in the states of Minnesota and the people. They treat of the question of the Bell patent that fix the cases. This is brought out in the decision of the American Bell company and the interference between the patent of Dr. Bell and that of Mr. Edison, according at the conclusion that at the option of the Bell company the Edison patent was the company upon telephonic instruments, practical use will extend for a period of 17. years from the date of the settlement of this interference. The only remedy to defeat this patent is to show that the invention of the person of a telephone which shall render communication possible by the use of the Bell apparatus, and that it breaks " sound well, electricians say, is extremely doubtful.

WHEN THE INVENTION MAY INTERFERE.

The committee think there is but one circumstance under which their judgment would justify legislative interference. That circumstance is when the Bell company shall so large that it shall be a burden to the world to use it and which shall produce a revenue disproportionate to the capital upon which it is based. It is not to be supposed that the company will be content to retain its present limits. That circumference is found in the cities of New York and Brooklyn, and in the latter, its franchise expires in 1893, when legislation is recommended for that city.

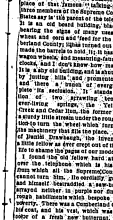
THE METROPOLITAN TELEPHONE CHARGES

The committee believes that the returns of the Metropolitan company are such that they may have a moral right to demand, and will probably get a bill making the charge in the city of New York $1.50 per month, with an additional charge of $1 per month for all points exceeding one half mile from any one of the present central offices.

THE EXPENSE INCURRED BY THE COMMITTEE.

The total expense of this investigation will not exceed $7,000, which appropriation has been paid by the individual members of the committee, owing to the fact that the attorney-general, at the request of the committee of the last session of the legislature refused to act, or sanction, provision for the expenses of a legislative committee of investigation.

The committee employed no counsel, acting themselves in that capacity.



THE OLD HOME.

"In this house, over 20 years ago," said Dan Drawbaugh, as he pointed to the old farm house, "I invented the telephone, and I have the models to prove it." Mr. Dan's wife corroborated the statement. "I remember," she said, "the night he came in from the workshop and told me that he had invented something which would enable people to talk to each other over long distances, so that they could hear the voice of the person at the other end of the line. I remember, too, that I was afraid to go to bed that night, for I thought he would get up and talk to himself all night." Mr. Drawbaugh is a man of about 60 years of age, and has lived on the farm where he now resides for 30 years. He is a man of medium height, with a full beard, and has a pleasant face. He is a man of few words, and modestly, yet firmly, asserts that he is the inventor of the telephone. He says that Drawbaugh did have an interview with Prof. Bell, but that the latter's invention was entirely different from his own. The principle upon which Drawbaugh's telephone operates is a diaphragm, or receiver, which is placed in the mouth of the speaker. This diaphragm is composed of tin, or tar or varnished cambric is concerned. Mr. Drawbaugh has been in the habit of making his own tools, and has a machine shop on the farm, where he has a complete assortment of machinery with which he can make anything he wishes. He

...ical festival, in which a mouth organ, a music-box and a fish horn played the leading rôles.

Drawbaugh's shop is a study for a busy man's work-house. It is full of machinery, turning-lathes for wood and metal, grindstones, saws and I don't know what all. In a like shed outside is a time-worn forge which has seen much service. The signs of electrical research are many. Models of the electrical clock—another invention on which the poor fellow has scored a financial failure—line the walls. The telephone-room, or office, as he calls the little nook in the south end of the old building, is packed and crammed with machines. On the wall is hung a line of transmitters in brass and nickel and receivers and battery-jars, with a tangle of wires running in every direction. Above them shines a very creditable painting of Stephen A. Douglas, made from a photograph, by Drawbaugh, who wields a brush with a great deal of skill. An air-pump adorns one side of the little room; but indeed, if one were to try to catalogue its treasures it would need a volume. Drawbaugh's nephew showed me some of the machinery hand-made by his uncle. It showed him to be what he was testified to be—a thorough mechanic, with a cunning hand, which he could turn to almost anything.

DRAUGHBAUGH'S HOUSE.

The inventor lives in a neat little brown brick house, in which the hand of woman has deftly covered up the visible signs of poverty. All the windows are filled with flowers and the panes are polished so that they shine like plate glass. And this for the edification of a little hamlet of eighty-four souls, the very name of which—Eberly's Mill or Milltown—I found unfamiliar to people living a couple of miles away. When I rang the door-bell of the little manse a plump and pretty maiden, with a smile so dazzling that it sent my aged heart to palpitating, opened it and said her father was in the shop.

"Don't you know where it is? This must be your first visit here. Come to the gate and I will show it to you." And so I did, after taking a peep and noticing that the little house was very neat and cosy within as well as without.

"So Daniel Drawbaugh is not so desperately poor after all," I thought, "for the man who has such a smile as this in his house is rich, and neither Prof. Alexander Graham Bell nor the Chief-Justice of the United States can make him poor."

I will not weary you with a rehearsal of the testimony of neighbors regarding Dan's invention of the telephone. It is summed up in the opinion of Judges Bradley, Field and Harlan, quoted above. No fair-minded man can read the flood of sworn testimony or listen to the talk of neighbors and not agree with this opinion. Nor can one study the subject of Prof. Bell's claims and not indorse the following cap sheaf to the opinion of these learned Judges:

What had he (Bell) when he applied for his patent? On the 10th of June, 1875, they thought they heard something but were not sure; but he knew the principle and he patented it. Up to the time of making his application for a patent they had not succeeded in producing intelligible speech, more than a word or two; perhaps a word or two. If Bell had done at that time as much as Drawbaugh had done according to the evidence, he would have had no hesitation in claiming the greatest discovery that the world has seen in the present century.

HAROLD W. RAYMOND.

News, Newark, N.J. June 22, 1888

CAN GO UNDERGROUND.

What Thomas A. Edison Says About Laying Telephone Wires.

The usual discussion concerning telephone poles and routes took place at the meeting of the South Orange Trustees last night. Mr. Sargeant, the representative of the New York and New Jersey Telephone Company, explained to the Trustees that Prospect street would not be accepted as a route. The underground system of laying wires, he said, was impracticable and absurd so far as the trunk line was concerned.

"Mr. Barrett has something to say about that," remarked Mr. Nugent.

"I took the trouble to write to the most famous electrician of the age," said Mr. Barrett. "I submitted a history of the telephone war, so that he could decide on the merits of the case. He writes as follows:

"I have your letter of the 20th instant in regard to running an underground system of telephone wires through the village of South Orange. This method is entirely feasible. The only question is, Can the telephone company stand the expense and make any money at the present rates? That is the sole question.

"THOMAS A. EDISON."

The board concluded that Edison's was sufficiently good authority to act upon.

The ordinance to designate Prospect street as a route for the telephone line was killed on its third reading. Mr. Sparrow introduced an ordinance naming South Orange avenue as a route, and restricting the telephone poles to one arm. It was passed on its first reading.

Mr. Nugent presented an ordinance requiring hackdrivers and other public carriers to pay licenses. Its consideration was deferred.

N.Y. World, Aug. 23, 1888.

WAS IT BELL OR M'DONOUGH?

6

THE CLAIMS OF THE INVENTOR OF THE TELEPHONE SET FORTH.

An Instrument Made from McDonough's Original Drawings Talks to a "World" Reporter, While Electricians Say Bell's Invention Will Not—Request for a Practical Demonstration Before Commissioner Hall, of the Patent Office—Will It Be Ignored?—Dynamos in Place of Batteries.

Contained in the building at No. 187 Broadway are devices which are likely to have an important bearing on both the telegraph and telephone branches of electrical service, and in which the public generally is deeply interested. They are also matters in which the public is concerned, as they are calculated to improve the two branches of electrical communication and to lessen the tolls. One is a perfected system of using dynamos in place of heavy batteries for transmitting telegraph messages, and the other is a practical demonstration of the fact that a telephone was invented that would actually talk, prior to the first known instance of the Bell telephone having accomplished that feat. A WORLD reporter called on F. W. Jones, Manager and Electrician of the Postal Telegraph Cable Company with a view of ascertaining the facts regarding these matters and also learning the latest news as to this alleged first practical telephone, which was invented by J. W. McDonough, of Chicago, and regarding which recent efforts have been made and are still in progress to obtain a decision of the Commissioner of Patents at Washington. The dynamos were found in the cellar, and their arrangement is a decided improvement over the previous substitution of this class of mechanism for the immense batteries that have been made in this city. They occupy but a small portion of the space required by the batteries, and yet are much more effective and reliable. The arrangement of the dynamos, driven by small engines, is on a plan devised by Mr. Jones and highly commended by other electricians. By a simple process of switching they can readily be connected with any of the wires and a current flashed over any of the company's lines which connect directly with Washington, Boston, Cincinnati, St. Louis, Chicago, Omaha, St. Paul, Denver, San Francisco and other points in this country, and Liverpool, London and other cities in Europe. On entering the operating-room on the upper floor to ascertain how the new process for generating currents worked, the reporter's ears were saluted with a whirl of telegraphic activity, and hundreds of nimble-fingered operators, a large proportion of them ladies, were discovered transmitting the messages to every point of the compass over the multitude of wires radiating from the switch-boards.

FRONT OF RECEIVER.

THE M'DONOUGH TRANSMITTER.

B—Base. C C—Contact Points. D—Diaphragm. V—Vibrator.

On the floor below, in the electrical department, F. W. Jones was found surrounded by numerous costly and delicate electrical apparatus, busily engaged in figuring up ohms, volts and amperes for regulating the electric fluids used in telegraphy. Mr. Jones was asked if there was anything new from the Commissioner of Patents regarding McDonough's application for a rehearing, and also whether, if the request for a practical test were granted, he was prepared to give it.

"We have no recent advices from Washington," he replied, "but we are fully prepared. A short time ago I sent to one of the greatest electricians in the country (a purely disinterested party) an official copy of the drawings and specifications of McDonough as filed in the Patent Office on April 10, 1876, and requested him to make a set of apparatus precisely similar to that described, and here they are, identically the same, as were numerous others we have made, and they talk plain enough."

At the reporter's request Mr. Jones, assisted by Prof. H. C. Buck, who made the instruments, gave a practical illustration of their working, a line being temporarily strung from Mr. Jones's office to a back room for the purpose, a distance of probably one hundred feet, with two partitions and a hallway intervening. First the reporter, who is a practical electrician, assured himself that everything was as represented by comparing the instruments with McDonough's original diagrams and specification. They were found to be constructed literally as described, even the license legally allowable not being taken advantage of. There were the parchment diaphragms even, while the specifications warranted the use of other materials for the purpose, and many better substances are known. First the reporter went into the back room and listened at the receiver, and Prof. Buck told him that he "had been down to Coney Island;" counted, recited poetry, and even announced figures at random, and a large percentage of all he said was distinctly heard. Questions were asked and answered and, in short, the receiver was put to as severe a test as could be conceived, and it unquestionably talked, not as good as the telephones in use, of course, but good enough to demonstrate absolutely that it was in reality a talking instrument.

Returning to Mr. Jones's office, the reporter suggested remarks to Prof. Buck, who repeated them through the McDonough transmitter, and they were heard by Mr. Jones, who was listening, and who stated what they were when he returned. In some instances only an occasional word was heard, but in others entire sentences went over the wire, and one test reproduced a verse of poetry without dropping a word. That McDonough's original application described an instrument that talked is an unquestionable fact, and it is well known that no person has been able to make an instrument, as described by Bell in his original application, that would talk even a little bit. Any intelligent electrician could take McDonough's drawings, which are reproduced herewith, and his specification, and make such instruments as those seen by THE WORLD reporter, as they are exceedingly simple. Prof. Buck said, had he taken advantage of the latitude allowed, he could have made much better talking instruments, but he followed the specifications literally. As to the probabilities and merits of the question at issue, Mr. Jones said:

SECTIONAL VIEW.

C C—Contract points. V—Vibrator.

"The proofs are that Bell never secured a patent for a speaking telephone in 1876, nor at any date prior thereto. Nothing in the patent of March, 1876, indicates any such thing. McDonough, on the other hand, did, and words his application of April 10, 1876, as follows:

"'The object of my invention is to provide a means of transmitting articulate sounds from one place to another through the medium of electricity, so constructed as to vibrate in accord with the vibration of articulate sound and so arranged relative to the magnet and circuit-breaker that the vibrations of the transmitting membrane or apparatus produced by articulate sounds are transmitted by the electrical current to the receiving membrane or apparatus, and so as to cause a like vibration of the receiving membrane or apparatus and to cause it to reproduce the articulate sounds transmitted from and by the transmitting membrane or apparatus.'

"Can anything be clearer than that? On the other hand, where can you find anything about articulate sounds in any of Bell's patents? Not one word. Every one of them is for multiple or harmonic telegraphy, a subject on which both Bell and Elisha Gray were actively engaged at the time. It is a mere pretense to say that Bell describes a speaking telephone, in the patent of March 7, 1876, and the accompanying "figure 7." Certainly such a wonderful and valuable invention, had it been conceived by Bell, would naturally have been made the special subject of the patent and had some definite description, but nothing of the kind appears. It merely says, substantially, as you can read, 'I, Alexander Graham Bell, of Salem, Mass., have invented certain new and useful improvements in telegraphy.' He then alludes to his previous patent and an application for a patent as follows: 'Transmitting two or more telegraphic signals simultaneously along a line wire,' as per specifications. 'My present invention consists in the employment of a vibratory or undulatory current of electricity in contradistinction to a merely intermittent or pulsatory current, and of a method of and apparatus for producing electrical undulations upon the line wire. The advantages I claim to derive from the use of an undulatory current in place of a merely intermittent one are:

"'First—That a very much larger number of signals can be transmitted simultaneously on the same circuit.

"'Second—That a closed circuit and single main battery may be used.

"'Third—That communication in both directions is established without the necessity of special induction coils.

"'Fourth—That cable despatches may be transmitted more rapidly than by means of an intermittent current or by the methods at present in use, for it is unnecessary to discharge the cable before a new signal can be made, and the lagging of cable signals is prevented.

"'Fifth (and last)—And that as the circuit is never broken a spark arrester becomes unnecessary.'

"It is as plain as A, B, C, that there is not the slightest allusion to articulate sounds. If Bell ever had what McDonough's application claims, he never made it known. We still have further proof on this point, and there can be no possible doubt that Bell's claim is a downright steal, a fraud, which only succeeded through a corrupt Patent Office. The evidence clearly shows that when it became known that McDonough was at work upon his speaking telephone then Bell took the cue from McDonough, and hurriedly set about making one and placing it at the Centennial Exposition. By the aid of influential and rich backers he placed himself before the world as the honest inventor, while McDonough, who was poor, was ignored and robbed of his invention. Sir Wm. Thomson and Prof. Joseph Henry were imposed upon by Bell, who led them to believe that there had been no previous worker in the field of speaking telephony. It is proper to say, however, to the honor and credit of Sir Wm. Thomson that, as far as possible, he has made amends for the great wrong done McDonough, but Prof. Henry died too soon after to discover his mistake. In a contest in January, 1882, in Edinburgh, before Lord McLaren in the High Court of Sessions, between the Bell Telephone Company of England and Alexander McLean, Sir William Thomson testified that he felt so very much interested in what Bell told him and showed him at the Centennial Exhibition in Philadelphia in the summer of 1876 that he (Sir William) indorsed Bell further than he was entitled, and upon his testimony and upon that of Sir F. J. Bramwell, Vice-President of the Institution of Civil Engineers of England, and upon other testimony given in behalf of the Bell Company by other eminent electricians and experts, the Court held that Bell never acquired any right to be regarded as the inventor of a speaking telephone, and further, that he had not shown by any act, even in the most remote degree, sufficient to give any one else even a clue to the art of making and using a speaking telephone, and this judgment has been sustained and reaffirmed by the English courts of last resort. I tell you, this Bell telephone is the greatest fraud of this century and a disgrace to our Government."

M—Magnet. D—Diaphragm. F—Frame.

"What was McDonough's position in the Patent Office at the time Bell placed his telephone at the Centennial Exhibition?"

"At that time McDonough stood in the Patent Office as the first man in the world applying for a patent upon a method of transmitting and reporting articulate speech, and in his drawings accompanying his application a diaphragm receiver is shown, also an improved transmitter over that of Philip Reis. This invention of the diaphragm receiver is the key to the whole situation, and the only thing that has ever made a speaking telephone possible. Neither Bell nor all his legal advisers can controvert this statement, and if Commissioner of Patents Benton J. Hall is the man I take him to be, we will prove to the world that James McDonough is the inventor of the telephone. Bell people pooh-pooh all this by saying McDonough's invention won't talk, and if it does talk, then they own it under a contract they made with McDonough. I believe they paid him $10,000 for some privilege, yet they are moving heaven and earth to induce Commissioner Hall to refuse us the chance to prove our assertion, the chance to demonstrate by a practical test in Hall's presence that McDonough's original instrument will talk; we ask nothing more."

"In McDonough's application in April, 1876, do I understand you to say that he describes this diaphragm receiver, which you regard as the key to the telephone?"

"Yes, here is McDonough's application—read it yourself. It sets forth the magnet acting on a thin piece of metal attached to the membrane setting it in motion to throw the air into vibration in harmony with the voice waves thrown upon the transmitter. This was the grand invention that made the telephone, and as I said before, was the missing link, and the key of the situation. The strain on poor McDonough after this invention was very great, and his doctors compelled him to leave the country. Then the Bell people had an easy time and opportunity to practice any amount of fraud. Robbing McDonough when he was sick and absent from the country was cruel, but I believe there is a day of retribution for the Bell people yet, and very near at hand. Here is McDonough's apparatus precisely as described in his original drawings, of which you see I have here an official copy. Two of the most eminent professors in this country tested it last week, and to their entire satisfaction, and I could distinctly hear them talking with it."

"How is it that Mr. McDonough's rights have been so completely ignored in the Patent Office?"

"Mr. McDonough, as I said before, is a victim of duplicity and the most unheard of, unjust and illegal actions of the Patent Office. This whole matter has been handled in the Patent Office in such a way as to stamp with disgrace the whole department. In the first place, the examiner in charge of Bell's cases was a drunkard and a perjurer. The office, instead of doing its duty, took up a club in McDonough's absence to force his timid and uninformed attorney to limit and disclaim everything in his application vital to the invention. After three years' delay in the Patent Office, the application of McDonough went before Examiner Church on a trial of interference between it and Bell's alleged invention and those of Gray and many more inventors who, subsequent to McDonough's application, made many improvements in some features of the telephone. The issue in this interference was 'a telephonic receiver, consisting of the combination in an electric circuit of a magnet and a diaphragm supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality.' Examiner Church, from the evidence, found as follows: 'Taking, therefore, April, 1876, as the date of McDonough's invention of the receiver in issue, it only remains to be considered whether Bell has proved a prior conception, for he does not pretend to have constructed such a receiver prior to July, 1876. Upon the evidence submitted it is impossible to find that he had conceived, much less disclosed, the invention in issue in this case. Upon this count, as defined and explained, J. W. McDonough is awarded priority of invention.' Here is an honest decision so straight and honest as to make the Bell people sick. They had gone ahead enlisting capital and floating immense blocks of stock and the situation was serious and critical—life or death. An appeal was taken to the Examiners-in-Chief who were amazingly accommodating to the Bell syndicate, and decided off-hand that, whereas, McDonough did not have, as they stated, a good transmitter he should not be confirmed in the priority of invention for any diaphragm receiver, and whereas Bell had a magnetic transmitter in perfect order it entitled him to precedence as the sole inventor. From this decision McDonough took an appeal to the Commissioner of Patents, Butterworth, and on the very last day of that functionary's term of office his last official act was to confirm this corrupt, idiotic decision, notwithstanding the fact that poor McDonough implored the privilege of going before the Patent-Office and demonstrating that this apparatus would talk and that the Examiners-in-Chief perpetrated falsehood and fraud when they ruled that it would not."

"What part of the speaking telephone in use to-day is the invention of Mr. Bell, and what has become of his multiple telegraph inventions?"

"Not a solitary part of the present telephone combination as used was invented or devised by Bell. The transmitter in use is simply Edison's improvement upon that of Philip Reis, of Germany, and is so declared by no less an authority than W. H. Preece, Chief Electrician of the English Telegraph. The receiver is McDonough's, as adjudged by Examiner Church, in our Patent Office. As to Mr. Bell's telegraphic inventions, I have never heard of any use being made of them; in fact, it is well understood in telegraphic circles that they are inoperative. One great advantage set out in Mr. Bell's patent of March 7, 1876, which he claims covers the speaking telephone, is to prevent the lagging of cable signals. Such an accomplishment would be a tremendous fortune to any one, yet Bell's invention utterly failed and has slumbered for over twelve years."

"How can McDonough come in at this late day and secure a patent for an invention that has been in public use and in which a great deal of capital has become invested?"

"All these years McDonough has been struggling along with limited means, poor health and such assistance as he could command to get his rights acknowledged in the Patent Office, and has been driven nearly crazy. He has also attempted in the courts of Connecticut, New York and New Jersey to secure a fair hearing of his case and a just decision upon its merits, but the enormous money influence of the Bell corporation in controlling opinions and assistance of experts, and in shaping the course of litigation to make it endless, has worn McDonough out, and coupled with this the unfortunate fact that both his money and health gave out at a critical time he could not press these suits. Mr. McDonough now asks the Commissioner of Patents to rehear his case and to allow him to show that the instruments as originally described will talk, and that he was not dreaming when he made his application for an articulating telephone on April 10, 1876. The Patent Office, under Republican rule, gave protection to the Bell monopoly. Things at Washington, under Cleveland's Administration, are different, at least that is my hope and belief. At one time I was afraid that Commissioner Hall intended to shut us out entirely, but having waited more than six months and allowed us to spend many thousands of dollars in preparing for the test which we now propose to make, I feel reasonably certain McDonough will have a fair deal at his hands. It takes a very brave man to be Commissioner of Patents—it is a very important position and open to so very many temptations.

Boston Advertiser
Oct. 17, 1888.

ELECTRICAL NEWS.

A New Telephone Appliance—The American Co. in the Field Again.

That able, fearless, progressive exponent of the modern science, and uncompromising opponent of shams Electrical, Practical Electricity, of this city, deserves the thanks of the electrical fraternity for its recent expose of the methods of the New England Electrical Exchange. The puncturing of these methods is well done, and well told, in the August and September numbers of Practical Electricity, which should be in the hands of all interested in the true welfare of electrical industry. It is gratifying to know that the electrical companies appreciate such efforts, and Dr. Austin should have the hearty co-operation of the press as well. Limited space at this time prevents more than the calling of attention to the matter, but we shall have more to say on the subject again.

A "nameless" invention that appears to have decided merit as well as novelty is a late improvement on the telephone, which is contained in a small box that is placed near to the 'phone and connected by wire. The principle of the device is that of electrically committing telephonic communications to wax paper inside the machine. If a person is "called" and is not present, the person speaking continues talking, and when the one addressed arrives at his end of the wire he notices that a ball has dropped on the apparatus, which indicates that some one has been talking. Going to the 'phone he opens the switch, when all that has been said by the person at the other end of the line is heard in exactly the same tone of voice and at the same rate of speed. The sheets of paper are 8x11 in., and can at any time be placed in the machine and the sound be reproduced.

W. S. Hill, manufacturer of electrical apparatus, dynamos, motors, arc and incandescent lamps and fixtures, 133 Oliver st., Boston, is very busy on his specialties. He has recently issued a neat illustrated little pamphlet, telling in plain, comprehensive language how electricity is generated in a dynamo machine.

If the electrical refining of sugar under the new process now attracting marked attention among capitalists is successful, it will revolutionize the sugar trade, by reason of the comparative cheapness of the method. This cost, it is said, as compared with the present method, is as 70 cents to $14, and the time consumed in the refining as 10 minutes to 26 hours.

The American Electric Manufacturing Co., New York, which has been so badly embarrassed financially lately, is reported as again actively in the market with its excellent apparatus. The factory is now open and filling large orders, and the concern has retaken its old offices, 18 Cortlandt st., New York. The new president is R. N. Hazard.

The Boston Electric Light Co. has declared a quarterly dividend of 1½ per cent to stockholders of October 1.

The Edison Electric Illuminating Co. of Newburg, N. Y., has just finished a number of important changes in the arrangement of their electric apparatus, and have laid another feeder from their station to supply the new Academy of Music with incandescence and open up a new territory to the Edison light. The Newburg company is one of the oldest of the Edison organizations.

Sentinel, Rome, N.Y.
Nov. 1, 1888

Confession by Telephone.

Edison's inventions have been giving some trouble to the holy office. It is admitted that the Pope can bless by telegraph. But the hard-to-be-answered question whether a penitent can confess and be absolved by telephone is not so easy to settle. French bishops have been against it, but as appeals from their authority have gone to Rome, the holy office must settle the matter. On the live-and-let-live principle I should, were I a member of that body, be with the bishops. What a monopoly of *blanchissage de fin* certain preachers and directors of conscience would enjoy were the telephone admitted as a vehicle of communication between them and their penitents. The poor seaside and country Abbés, who in summer find variety and some profit in attending to fair and fashionable Parisiennes, must lose his resource if the affirmative judgment be given. Then there is a danger of prying curiosity going beyond the verge of sacrilege. The use made of the telephone in the Wilson case ought to be a warning. It appears that Italy is even more disturbed than fashionable France on this subject, and that doctors in theological casuistry differ terribly about it. Father Bernardi of Faenza says, "Yes, provided the penitent is in a case of extreme necessity." The learned Father Lehmkuhl considers that sins can't be remitted by telephone, but that censures can be given. This is the view of the head of the French Seminary at Rome, Dr. Eschbach. The *te* in *ego te absolvo* applies only to a person present. A real presence is, therefore, obligatory in his mind. Telephony, says Father Birardi, lengthens the human ear for miles and suppresses distance for the voice. Being within earshot is being, for confessional objects, present. Renan thinks the Conservatives, unless in extreme cases, are right. Old forms match with ancestral habits, which have become instincts. The church would not appear a church were it turned into a telephone bureau for the confession and remission of sins, and penitence would become mechanical, as Tetzel tried to make it.—Paris Letter to London Truth.

Otago Witness
Nov. 1, 1888.

An inventor has devised an improvement on the telephone, which it is claimed (says a contemporary) will be of great practical advantage. The arrangement is contained in a small box, which is placed in proximity to the telephone and connected by wire. No name has yet been given it. A person is called upon the 'phone, and, if not present, the person speaking continues talking, the communication being electrically committed to wax paper within the machine. When the person addressed arrives at the other end of the wire he notices that a ball has dropped on the apparatus, which indicates that someone has been talking. Going to the 'phone he opens the switch, when all that has been said previously by the person at the other end of the line commences to be heard in precisely the same tone of voice and at the same rate of speed. The sheets of paper are 8in by 11in, and can at any time be placed in the machine and the sound reproduced.

Herald, Rochester, N.Y.
Nov. 2, 1888.

CONFESSION BY WIRE.

Novel Controversy Among Catholics About Uses of the Telephone.

Edison's inventions have been giving some trouble to the holy office. It is admitted that the pope can bless by telegraph. But the hard-to-be-answered question, whether a penitent can confess and be absolved by telephone is not so easy to settle. Mrs Crawford writes from Paris on this subject as follows:

French bishops have been against it; but, as appeals from their authority have gone to Rome, the holy office must settle the matter. * * * It appears that Italy is even more disturbed than fashionable France on this subject. Telephony, says Father Birardi, lengthens the human ear for miles, and suppresses distance for the voice. Being within earshot is being, for confessional objects, present. On the live-and-let-live principle I should, were I a member of that body, be with the French bishops. * * *

Moreover, old forms match with ancestral habits, which have become instincts. The church would not appear a church were it turned into a telephonic bureau for the confession and remission of sins, and penitence would become mechanical, as Tetzel tried to make it.

A New Telephone.

Gazette, Little Rock, Ark. Dec 9 1888.

The above is a picture of the new telephone, concerning which THE GAZETTE has received several communications from the secretary of the manufacturing company, Allan C. Knapp of Chicago:

The Lowth Stetho Telephone controlled by the Lowth Stetho Telephone company, Chicago, is a new departure in the field of telephony. The instrument and the method of operating it are striking novelties, even after a dozen years of familiarity with the older systems.

An outline description of the apparatus will enable the reader to understand its characteristics, and wherein it differs from anything heretofore in use.

It is a combined transmitter and receiver: the box containing the receiver has a hollow extension about four inches long, starting from the side and ending in a small bell-shaped mouth, protruding slightly from which is a small light button. The receiver is laid against the ear in the usual manner, and the button at the end of the hollow extension is placed against the throat in the vicinity of the larynx or vocal cords. The operator then speaks and the words are transmitted with the most perfect clearness and loudness. In these particulars it is a long way in advance of all previous attempts with the older systems.

This new telephone is entirely distinct from what is usually called the Bell system, as the instrument employs no diaphragm, and is not operated by atmospheric or sound waves, but the muscular vibrations that precede and also accompany the utterance of words and other sounds. These vibrations are imparted to the button which is held against the exterior surface of the throat, and conducted by proper mechanism connected therewith to the electrodes or current-controlling elements, thereby causing the distant receiver to reproduce the words or other sounds.

Another valuable and peculiar feature of this instrument is that the operator may be surrounded by all manner of loud noises and only his voice will be transmitted: and then he may speak almost in a whisper. This is a very valuable quality, as city lines are generally troubled with induction, accidental disturbances on the diaphragms of transmitters of the common type furnishing their full share of the load. This new method shuts out all accidentals.

James Lowth, the inventor, was the first and has been the only experimenter in this field, and to his efforts and exhaustive experiments is due the present perfection of the system.

Cutting from *Ill. Newspaper*
Address of Paper, *N. Y.*
Date, *Jan. 8, 89*

TELEPHONIC REVOLUTION.

THE Chicago *News* says: "The Lowth stetho-telephone is a new departure in the field of telephony. The instrument is a marked departure from the Bell telephone, and though it has no diaphragm, it transmits sound as perfectly as the Bell system. It is a combined transmitter and receiver. A hollow extension four inches long is attached to the receiver, from the end of which a small button protrudes slightly. This button is placed against the throat near the vocal chords, and the receiver is held against the ear in the usual manner. When the operator speaks, the vibrations of the throat are transmitted with a distinct clearness. The instrument is operated not by sound-waves, as is the Bell telephone, but by the muscular vibrations that accompany the utterance of words. It is claimed by the patentees that for this reason the instrument can be used more successfully in long-distance talking than the old system, because there is no limit to the strength or number of batteries that can be used. The diaphragm of a Bell instrument will crackle so loudly when overcharged with electricity that the sound of the voice cannot be heard.

"The inventor, James Lowth, has been experimenting and working on this instrument for over ten years. When he first applied for a patent, three years ago, the authorities at Washington thought him a crank and refused to issue one. He attached the instrument to wires in the office and asked over it: 'What do you think now?' Back over the wire came the words: 'I give in. It works perfectly.'

"Some of the best patent lawyers in the country have been consulted, and say that, as the diaphragm is dispensed with, the instrument does not in any way infringe on the Bell patents. It has been successfully operated between Chicago and Milwaukee, and in Pittsburgh it worked perfectly over a line seventy-five miles in length on which were twenty-five Bell instruments. A company has been organized, with head-quarters in Chicago, and the manufacture of the instruments will soon begin."

Evening Dispatch, Columbus, Ohio
Jany. 8, 1889.

Original Inventor of the Telephone.

DES MOINES, IA., Jan. 8.—M. F. Pease, of this city, claims to be the original inventor of the telephone. He produces evidence to substantiate his claim, which will be investigated in the patent office. Pease began experiments with the transmission of sound by electricity in 1855 and in 1857 his efforts were, he claims, crowned with success. That year, he says, he filed a caveat in the patent office, giving a description of his machine, under the name of the electric musical instrument. Later, he perfected a telephone, and in 1872 his invention was described in a book entitled "Wonders of Electricity."

Comm. Bulletin, Boston, Mass.
Jany 12, 1889.

Last Thursday evening Prof. Cross gave a very instructing talk to the Lowell Society of Arts on the studies of telephoney pursued in the Institute of Technology during the past four years. Most of these studies were strictly technical. Two of the results of the experiments were of practical benefit. One of these was that the strength of working currents of the telephone wires was much larger than is commonly supposed. It was found to be 1-1000 of the current required for an Edison arc light. The other result was the measuring the loss in current in telephoning from Boston and New York. It was found that between 98 and 99 per cent is lost in transmitting and the actual work is done with the remainder. This is not criterion for the loss in dynamo wires, they being on a different principle.

Evening Sun, Jany 8, 1889.

TELEPHONE WITHOUT A DIAPHRAGM.

Vibrations of the Neck Utilized to Transmit Words and Sounds.

One of the latest inventions to attract the attention of persons interested in the application of electricity is the Lowth telephone. It differs from the Bell and other telephones inasmuch as sound waves are not used. The transmission of the words is effected by means of an electrical plug which is placed against the neck of the operator, near the vocal organs. The vibrations of the neck produced by the act of speaking shake or move the plug, thereby giving rise to corresponding electrical indulations, which pass over the wire to a receiver at the other end of the wire, and are then heard by the listener.

A receiver and plug are both combined in one instrument, the plug being practically an arm of the ear trumpet. Persons not acquainted with the new telephone will naturally ask when they first see one, "Where is the diaphragm?" The absence of any transmitter of the present type is one of the valuable claims advanced by Mr. Lowth, and in support of his new invention he says that the operator may be surrounded by all manner of loud noises and only his voice will be transmitted, and then he may speak almost in a whisper. His system is now controlled by the Lowth Stetho-Telephone Company of Chicago.

N. Y. Times
Jany 8, 1889.

ANOTHER TELEPHONE CLAIMANT.

DES MOINES, Iowa, Jan. 7.—Mr. M. F. Pease of this city claims to be the original inventor of the telephone, and produces evidence of a very convincing character to substantiate his claim, which will be investigated in the Patent Office. Mr. Pease began experimenting with the transmission of sound by electricity in 1855, and in 1857 his efforts were crowned with success. That year he filed a caveat in the Patent Office at Washington, giving a description of his machine under the name of the "electric musical instrument." Later he perfected a telephone, and in 1872 his invention was described in a book entitled, "Wonders of Electricity."

N. Y. Staats Zeitung
Jany. 9, 1889.

Der Erfinder des Telephons will jetzt, behauptet nun auch M. F. Pease von Des Moines, Iowa. Er will bereits im Jahre 1855 Versuche mit Schall-Beförderung durch Elektricität gemacht haben. Seine Ansprüche werden im Patent-Bureau in Washington geprüft werden.

Morn. Times, Oakland, Cal. Jany 13, 89.

CHICAGO is agitated over the stetho-telephone, an invention of one of its citizens. A hollow extension about four inches long is attached to the receiver of the telephone, from the end of which a small button protrudes slightly. The button is placed against the throat near the vocal cords, and the receiver is held against the ear in the usual manner. When the operator speaks, the vibrations of the throat are, it is said, transmitted with distinct clearness. The instrument is operated by the muscular vibrations that accompany the utterance of words. It is said to have worked satisfactorily between Chicago and Milwaukee.

Eve. Times. Little Falls, N. Y. Jany. 9, 1889.

THE NEW TELEPHONE.

It Dispenses With all Trouble from Sound Waves.

"Hello! hello! Do you hear all right? I am talking through 10,000 ohms of resistance, equal to 500 miles."

"Yes, that comes perfectly plain," replied the reporter, pressing a button against his throat, near the Adam's apple, instead of talking to a hole in the wall.

The Lowth stetho-telephone is a new departure in the field of telephony. The instrument is a marked departure from the Bell telephone, and though it has no diaphragm it transmits sounds as perfectly as the Bell system. It is a combined transmitter and receiver. A hollow extension about four inches long is attached to the receiver, from the end of which a small button protrudes slightly. This button is placed against the throat near the vocal chords and the receiver is held against the ear in the usual manner. When the operator speaks the vibrations of the throat are transmitted with distinct clearness.

The instrument is operated not by sound waves, as in the Bell telephone, but by the muscular vibrations that accompany the utterance of words. It is claimed by the patentees that for this reason the instrument can be used more successfully in long distance than the old system, because there is no limit to the strength or number of batteries that can be used. The diaphragm of a Bell instrument will crackle so loudly when overcharged with electricity that the sound of the voice cannot be heard.

The inventor, James Lowth, has been experimenting and working on this instrument for over ten years. When he first applied for a patent, three years ago, the authorities at Washington thought him a crank and refused to issue one. He attached the instrument to wires in the office and asked over it: "What do you think now?" Back over the wire came: "I give in. It works perfectly."

Some of the best patent lawyers in the country have been consulted, and say that, as the diaphragm is dispensed with, the instrument does not in any way infringe on the Bell patents. It has been successfully operated between this city and Milwaukee, and in Pittsburg it worked perfectly over a line seventy-five miles in length, on which were twenty-five Bell instruments. A company has been engaged, with headquarters in this city, and the manufacture of instruments will soon begin.—Chicago News.

8 Merch, Recorder, Fayetteville, N.Y.

A Novel Telephone.

The Lovell electric-telephone has been put in Chicago, and is a combined transmitter and receiver. A hollow cylinder about four inches long is attached to the receiver, from the rest of which a small button protrudes slightly. The button is placed against the listener's head by vocal chords, and the receiver is held against the ear in the usual manner. When the operator speaks the vibrations of the throat are transmitted with, it is said, distinct clearness. The instrument is operated by the usual vibratory current that accompany the utterance of words. The inventor, James Lovell, is a young man of about twenty-five, and writing on the instrument for the first time. When he first applied for a patent, three years ago, the authorities at Washington thought him a crank, and refused to listen to him. He attached the instrument to wires in the office and asked over it: "What do you think now?" Back over the wire came: "I give in, it works perfectly." Our Chicago informant says it has been successfully operated between that city and Milwaukee, and in Pittsburg (Wrinkled over a line seventy-five miles in length, on which were twenty-five Bell instruments, a perfect success.

Hardware, Meriden

Mch 6 1879

Unterseeisches Telephon.

Der Erfinder des Telephons, Prof. Bell, will bei unterseeischen Kabeln auf Entdeckung der Regierung Anwendung. Das angemeldete Instrument ist mit Erfindungen Cyrus Warners, der bekanntlich seine Patente bei 6 Millionen Dollars Gewinn an die gegenwärtige Gesellschaft verkaufte, bei der Gründung der Gesellschaft betheiligt. Seiner Aussage zufolge hat Bell Patente für 18 Millionen Dollars eingeräumt bekommen, als seine Erfindung noch keinen praktischen Werth hatte. Bell hat 18 Millionen Dollars eingeräumt bekommen, als seine Erfindung noch keinen praktischen Werth hatte. Bell hat 18 Millionen Dollars eingeräumt bekommen, als seine Erfindung noch keinen praktischen Werth hatte.

Le Figaro Paris France
Mars 14, 1879.

UN HOMME A FUSILLER

C'est M. Edison.

On nous écrivait peut-être un peu sévère pour cet inventeur de génie, auquel nous devons le téléphone, le phonographe, la lampe électrique et tant d'autres merveilles que nous ne pouvons nous empêcher d'admirer, et qui nous sentant près d'horreur et de rancune pour leur auteur.

M. Edison est tout simplement en train d'abréger les jours de l'homme et de lui rendre la vie insupportable. En fouillant les angles de la justice, je crois que l'on trouve un malfaiteur plus chargé de crimes, plus convaincu d'homicides plus coupable de drames mortels que cet Américain dont j'ose à peine prononcer le nom illustré.

Le téléphone! Quand le Parlement ajoutera-t-il un article au Code pénal pour punir les crimes du téléphone? Un mais, et l'autre brandissant le phonographe révélateur, qui répète toute heure de la nuit pour vous dire les dernières effusions de votre voix et les dernières phrases d'amour que vous avez prodiguées à votre femme, à votre maîtresse, à votre amant, à votre mari, à votre fils, à votre père, à votre mère, à votre fille, à votre sœur, à votre frère, à votre oncle, à votre tante, à votre cousin, à votre cousine, à votre neveu, à votre nièce, à votre petit-fils, à votre petite-fille, à votre arrière-petit-fils, à votre arrière-petite-fille, à votre arrière-arrière-petit-fils, à votre arrière-arrière-petite-fille, à votre arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petit-fils, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petite-fille, à votre arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-arrière-petit-fils, à votre arrière-petite-fille, à votre arrière-petit-fils, à votre arrière-petite-fille, à votre arrière-petit-fils, à votre arrière-

Baltimore Herald.
June 10, 1894.

Belfast, Bradley & Co.
Oct. 6, 1889.

Journal, Lincoln, Neb.
May 26, 1889.

THE TELEPHONE LITIGATION.

There is naturally a great deal of interest in the telephone litigation, which many thought had come to an end by the recent decision of the Supreme Court in favor of the Bell Telephone Company, but which is by no means yet ended by the determination of Drawbaugh, the Pennsylvania inventor, to secure his rights in the patent in the microphone or carbon instrument, and by the demand of the Western Union Telegraph Company that the Bell Company shall keep to its agreement and not even appear to interfere and compete with the Western Union's business, and shall pay for its violation thereof.

The questions involved in this complex litigation are, first, whether Drawbaugh was not the original inventor of the telephone which, with but slight differences, was used by the Bell Company as Bell's invention, and by the Western Union as Gallier's invention, and in this is involved the question of the patent on the art of telephoning in general, by which both Bell and Edison have acquired wealth. Drawbaugh is still poor; and second, whether the Bell Company, having secured the sole right to the Hunning English patent, by which all the long distance telephoning has been accomplished, enabling it to "interfere and compete" with the Western Union's business, has violated its agreement with the latter, which was based on the joint use of an instrument of which Bell, Edison and Drawbaugh each claimed to be the inventor.

According to current statements, Drawbaugh invented his microphone in 1870, Edison does not claim his patent before 1877, and the Bell people have admitted that Drawbaugh's instrument was constructed in the year named. What judgment may be rendered in the dispute between the Bell and the Western Union people few readers will care, except to gratify curiosity; but, as the public sympathy is very apt to be with the under dog in a fight," there will be considerable anxiety to know how Drawbaugh comes out of this contest, and everybody will hope that the litigation will not be long drawn out for the behoof of the lawyers, but will be "short, sharp and decisive," to the end that justice may not be left to the enjoyment of the next generation only.

Boston is now engaged on a "fire alarm" machine, by means of which people will be able to see long distances. The "wizard" never fails in what he undertakes, and some of these days a man in Boston will be able to see his mother-in-law over a thousand miles away. Edison has done a great deal to bless this world and render life worth living.—Utica Herald.

Statesman, Yonkers, N. Y.
March 1, 1889.

A Far-Sight Machine.

Mr. Edison is reported, in a conversation with a reporter who solicited his ideas on the subject of the projected world's fair in New York, as saying that he would take an hour or more in such a fair and completely cover it with his inventions, of which he has no less than seventy new ones under way. "One of these," Mr. Edison, "is what I might call a far-sight machine." By means of this extraordinary invention he hopes to be able to increase the range of vision by hundreds of miles, so that, for instance, "a man in New York could see the features of his friend in Boston, with as much ease as he could see a performance on the stage. That," he added, "would be an invention worthy a prominent place in the World's Fair, and I hope to have it perfected long before 1892."

Electrical Review.

Gazette, Brooklyn, Mass.
June 1, 1889.

This "sportelectric" system will soon be shooting passengers from here to Boston inside of ten minutes. Mr. Edison proclaims that in three years you can see a man hundreds of miles away, by an invention of his. There will then be no excuse for those who go out between the acts to "see a man."

World, Omaha, Neb.
May 24, 1889.

Boston, Sazette, Cincinnati, O.

Journal, Lincoln, Neb.
July 21, 1889.

Bell Lenfest, England.
June 17, 1889.

A FAR-SIGHT MACHINE.

THE PHONOGRAPH TO BE ECLIPSED.

Mr. Edison, interviewed, in a conversation with an interviewer who solicited his ideas on the subject of the projected World's Fair in New York (says Iron), as saying that he would take an hour or more in such a fair and completely cover it with his inventions, of which he has no less than seventy new ones under way. "One of these," said Mr. Edison, "is what I might call a far-sight machine." By means of this extraordinary invention he hopes to be able to increase the range of vision by hundreds of miles, so that, for instance, "a man in New York could see the features of his friend in Boston, with as much ease as he could see a performance on the stage. That," he added, "would be an invention worthy a prominent place in the World's Fair, and I hope to have it perfected long before 1892."

Record, Mt. Chester, Pa.
July 18, 1889.

Bell Mall, London, Eng.
June 15, 1889.

Tribune, Racine, Ohio
July 24, 1889.

N. Y. Sunday Sun
July 28, 1889.

Boston, Atlas, Ohio
Aug. 10, 1889.

SEEING BY ELECTRICITY

LOOKING AT PEOPLE THOUSANDS OF MILES AWAY FROM YOU.

EDISON'S SUDDEN DEPARTURE TO AVOID THE INTERVIEWER.

MAN WITH THE TELEPHONE HAS BEATEN THE TELEPHONE, AND GOT AHEAD OF HIM.

EDISON'S NOTABLE PREDICTION UPON THIS POINT IN HIS AKRON VISIT.

LAST WINTER—YET ANOTHER INVENTOR OF THE WONDER.

The following special dispatch to THE BEACON from New York to-day has a local interest to Akron readers, as it goes to show that more than one mind was at work on a greatinvention during the time that Mr. Thomas A. Edison visited Mr. and Mrs. Lewis Miller in this city several months ago. THE BEACON dispatch reads:

"NEW YORK, Aug. 9 (Special).—It is given out that scientific circles in Edison's sudden visit to Paris is directly connected with the invention of the telephote by M. Courtenay, the well known Frenchman. Edison has been long studying the same apparatus which will enable people to see at long distances just as the telephone enables them to hear far-off sounds and moving words. This, it is claimed, is accomplished by the telephote, and it will further, it is averred, transmit luminous vibrations through any kind of obstacle on a wire for hundreds or thousands of miles. Courtenay promises to give full details of his discovery as well as public experiments inside of two months."

"The above dispatch recalls an interview to this effect, which appeared in the Akron BEACON last winter, after Mr. Edison, one evening, after the party had enjoyed the phonograph in Mr. Lewis Miller's home, during the inventor's recent Christmas visit in this city, Mr. Edison himself, operating the instrument to the delight of all. The newspaper man, in the course of the conversation, asked Mr. Edison, whether new thing he was next going to give to the public to astonish them. He spoke of various things that he was at work upon and then said: "The next time I come to Akron I will show you a machine that will not only reproduce the sounds of an opera, but that will also show you all the characters in it, in short it will be the same as though you went to the opera house." He said that the proposed instrument would show the performers as they came on the stage and all the motions during the entire evening, giving of each person as distinct in picture, that they would be readily recognized by all familiar with the characters employed. He was questioned as to the process, but he went into no special detail, beyond remarking that the delicate film of a soap-bubble and the resulting reflections thereon, and said that the whole scene on any stage could be caught up by his proposed invention so that every feature would be distinct and every motion would be seen in the image on a bubble. His declarations then of what we heard, but could not half realize, that the "Wizard of Menlo" should accomplish what he then promised to bring to Akron in due season, has a peculiar interest at present, inasmuch as another Buckeye man has made another discovery with a friend, formerly of Akron, in this same line in the East, who died of himself seeing in the home of a friend, a scene of remarkable intensity, a device for seeing the persons you talked with by telephone, as well as hearing them. In fact this gentleman himself tested the apparatus more than a year ago and being through a number of miles of wire what was transpiring in a room so distant and satisfied as to practical possibility that the sight was in any other way than over the electric wires by some mysterious method of transmission. Thus three minds, at least, have been on the verge of putting this marvellous invention into practice."

The wizard of the Menlo Park is going to surpass himself. Arabian magicians and conjurers of old time have developed extraordinary talents in the way of revealing to a lover in a drop of ink or a ball of crystal the sight of his mistress, no matter how many hundred miles she might be distant. Edison has tramped this by the invention of what he calls a farsight machine, by means of which he hopes to be able to increase the range of vision by hundreds of miles, so that, for instance, "a man in New York could see the features of his friend in Boston with as much ease as he could see a performance on the stage." He hopes to have the invention perfected long before 1892. Query, will the farsight machine add to the joy or the misery of the world?

Tribune, Rochester, Pa.
Aug. 9, 1889.

Edison's Machine.

Mr. Edison is reported, in a conversation with an interviewer who solicited his ideas on the subject of the projected world's fair in New York, as saying that he would take an hour or more in such a fair and completely cover it with his inventions, of which he has no less than seventy new ones under way. "One of these," said Mr. Edison, "is what I might call a far-sight machine." By means of this extraordinary invention he hopes to be able to increase the range of vision by hundreds of miles, so that, for instance, "a man in New York could see the features of his friend in Boston with as much ease as he could see a performance on the stage. That," he added, "would be an invention worthy a prominent place in the World's Fair, and I hope to have it perfected long before 1892."

Times, Scranton, Pa.
July 24, 1889.

We shall soon have perfected an instrument upon which Edison is at work, by which two persons can actually talk to each other from different cities, but see each other at the same time. We are getting there rapidly.—Unsentertain.

The new invention may not be as pleasant when you are "rung up" by the fellow whose bill is a little past due.

Mr. Edison says that one of the most possibly of possibility of the inventions he is now working on is the far-sight machine; he hopes with it to be able to increase the range of vision by hundreds of miles, so that, for instance, a man in New York could see the features of a friend in Boston."

In this connection it may be mentioned that Edison has invented an attachment for the telephone by means of which one may see the person to whom one is talking over the telephone.

Utica—Great Scott! Is that so?

Chris—Yes, I've fact.

Utica—You're pretty tough, then!

Chris—Because if it's so I want to be able to see the girl I'm talking to over the telephone.—Troy Times.

Voice—"see that Edison has invented an attachment for the telephone by means of which one may see the person to whom one is talking over the telephone."

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Chris—Yes, I've fact.

Utica—You're pretty tough, then!

Chris—Because if it's so I want to be able to see the girl I'm talking to over the telephone.—Troy Times.

They've altogether too progressive for me.

Monitor, Fort Scott, Kansas
July 23, 1879

Thomas A. Edison announced the other day that he is at work on a new invention by which sight as well as sound may be transmitted by electric wire. It seems, however, that a young German named Kornel has anticipated him. The Centralblatt für Electricität gives an interesting account of an exhibition recently made by this gentleman, in which two of his instruments, in different cities, were connected with a telephone wire. The features of the person standing at one end of the wire were distinctly seen in a glass plate at the other end, and the larger type in a newspaper held before the instrument in one city was easily read in the other city. Everything seen was greatly reduced in size, but this was because the glass plates were small, this phenomenon being governed by the laws of optics and not those of electricity.

The secret of this wonderful invention lies in the sensitiveness of selenium to the effects of light. When a ray of light falls on a plate of selenium, one electric conductivity of the metal changes. Mr. Kornel uses a plate covered with a composition which he calls bromide of selenium gelatine for "reading" the image of the person using the telephone, which is then transmitted by the same wire that conducts the sound of his voice and throws, apparently without the use of any further apparatus, on a glass plate at the other end. In this way the persons using the telephone can not only hear but see each other.

Cleveland, London News
American Edition, N. Y. City
Aug 16, 1879

Mr. Edison, of electric and phonographic fame, promises the world an apparatus which will enable people to see at long distances, just as the telephone enables them to hear distant sounds and movements. The American inventor has a rival in a Frenchman, M. Constenne, who states that he will make public his discovery and perform experiments with his "Phonephote" at the end of the present year, so that Mr. Edison's claim may not be allowed to be first in the field. M. Constenne avers that his invention will be able to transmit luminous vibrations through any kind of obstacle on a wire not only for hundreds but thousands of kilometres.

Paramount, Idaho, Co
Aug 13, 1879

As now we see all to see long distances, as we telephone, M. Constenne has already perfected an electric invention for this purpose and Edison has gone to Paris to examine it. Edison thinks that the machine a man thinks he is working, will soon have power and control of him. Edison may be in love for a time and lose sight of his self, but soon he will have a machine that will see no more lost in distinctly and satisfied. His self could were he seated in the bed of his arrangement takes the place of the telephone between office and residence and the balance machine does all the work. Edison's machine is a wonderful invention.

Times, Petersburg, Va.
Aug. 15, 1879

Nothing can save the people of Germany from the consequences of their folly in the matter of the telephone. Edison has invented a device for the transmission of pictures by telegraph, and Constenne, a French engineer, has made a similar discovery. A new arrangement by which a person at a distance can be seen by the family at his home has been patented in Germany, and it is said that others have been under way in the same field, and one of these, Herr Kornel, of South Germany, has not only effected several important developments, but has actually brought down the invention to a working basis. The foundation of the apparatus is the ordinary house telephone. Above the diaphragm aperture is a lens, similar to the objective of a photographic camera, and above this a translucent glass plate is an elaborate frame. At the right and left of the objective are two incandescent lamps with silvered mirror reflectors. The lamps are lighted by a specially constructed battery. This constitutes the whole outward appearance of the apparatus. The objective serves for taking the picture of the person using the telephone, while the incandescent lamp illuminates his face. Upon the glass plate above is thrown the property of whatever is to be transmitted by the telephone. In the course of an exhibition of his system in Berlin, Herr Kornel connected his photoscope to a telephone, and had the central office connect him with a business friend in Potsdam, who likewise was provided with a photoscope. The moment the Potsdamer stepped to the apparatus the ground glass plate showed an excellent portrait of him, which, when connected with his photograph, was easily identified. The shape of the hand, the smile and the natural expression of the whole face was perfectly distinct.

Times, Portsmouth, N. H.
July 29, 1879

The Electrical Review is authority for the statement that Mr. Edison hopes with one of his numerous inventions to be able to increase the range of vision by hundreds of miles, so that, for instance, a man in New York could see the features of his friend in Boston with as much ease as he could see a performance on the stage; that, Edison says, "would be an invention worthy a prominent place in the world's fair, and I hope to have it perfected long before 1889."

Republican, Galloway, Ohio
July 24, 1879

Thomas A. Edison announced the other day that he is at work on a new invention by which sight as well as sound may be transmitted by electric wire. It seems, however, that a young German named Kornel has anticipated him. The Centralblatt für Electricität gives an interesting account of an exhibition recently made by this gentleman, in which two of his instruments, in different cities, were connected by a telephone wire. The features of the person standing at one end of the wire were distinctly seen in a glass plate at the other end, and the larger type in a newspaper held before the instrument in one city was easily read in the other. Everything seen was greatly reduced in size, but this was because the glass plates were small, this phenomenon being governed by the laws of optics and not those of electricity.

The secret of this wonderful invention lies in the sensitiveness of selenium to the effects of light. When a ray of light falls on a plate of selenium the electric conductivity of the metal changes. Mr. Kornel uses a plate covered with a composition which he calls bromide of selenium gelatine for "reading" the image of the person using the telephone, which is then transmitted by the same wire that conducts the sound of his voice and throws, apparently without the use of any further apparatus, on a glass plate at the other end. In this way the persons using the telephone can not only hear but see each other.

Republican, Mckinney, Tex
July 24, 1879

Edison's Latest.

Not long since the New York Commercial's Edison mania public let his intention to perfect a system of telephony by which a person at a distance can be seen as plainly as he can be heard over the telephone wire, has been heard over the telephone wire, has been under way in the same field, and one of these, Herr Kornel, of South Germany, has not only effected several important developments, but has actually brought down the invention to a working basis. The foundation of the apparatus is the ordinary house telephone. Above the diaphragm aperture is a lens, similar to the objective of a photographic camera, and above this a translucent glass plate is an elaborate frame. At the right and left of the objective are two incandescent lamps with silvered mirror reflectors. The lamps are lighted by a specially constructed battery. This constitutes the whole outward appearance of the apparatus. The objective serves for taking the picture of the person using the telephone, while the incandescent lamp illuminates his face. Upon the glass plate above is thrown the property of whatever is to be transmitted by the telephone. In the course of an exhibition of his system in Berlin, Herr Kornel connected his photoscope to a telephone, and had the central office connect him with a business friend in Potsdam, who likewise was provided with a photoscope. The moment the Potsdamer stepped to the apparatus the ground glass plate showed an excellent portrait of him, which, when connected with his photograph, was easily identified. The shape of the hand, the smile and the natural expression of the whole face was perfectly distinct.

Journal, Baltimore, Md.
June 10, 1880.

In the course of a conversation with a newspaper man, who sought his views upon the subject of the projected "Electric Fair in New York city, Edison, the electrical wizard, is reported as saying that he would take as sure of space in such an exposition and completely cover it with his invention, of which he has no less than seventy now under way. "One of the most peculiar and now perplexing good results," said Mr. Edison, "is what I may call a far-sight machine." By means of this extraordinary invention he hopes to be able to increase the range of vision by hundreds of miles, so that for instance a man in New York could see the features of his friend in Boston with as much ease as he could see a performance on the stage. That, he added, "would be an invention worthy a prominent place in the World's Fair, and I hope to have it perfected long before 1889."

Ivy, Wrentsville, Miss
July 24, 1879

Years ago an American inventor announced that he was on the track of a discovery by means of which electricity could be made to do for the eye that which through the telephone it does for the ear, and persons, objects and scenes, however distant, could be made to appear upon a screen at the end of the "telephote" wire. The announcement made here a slight impression, and nothing has been heard of it since. The invention seemed to be in the narrative, and not in any actual apparatus. Now comes a report from Europe that what was then suggested as possible, is a part of the here actually accomplished, so far as this, that by some mechanism in the telephone, the persons of the person speaking appears on a screen at the other end of the wire. Mr. Edison, of course, is said to be working on the same problem.

Traveller, Boston, Mass.
July 17, 1879

Thomas A. Edison announced the other day that he is at work on a new invention by which sight as well as sound may be transmitted by electric wire. It seems, however, that a young German named Kornel has anticipated him. The Centralblatt für Electricität gives an interesting account of an exhibition recently made by this gentleman, in which two of his instruments, in different cities, were connected with a telephone wire. The features of the person standing at one end of the wire were distinctly seen in a glass plate at the other end, and the larger type in a newspaper held before the instrument in one city was easily read in the other. Everything seen was greatly reduced in size, but this was because the glass plates were small, this phenomenon being governed by the laws of optics and not those of electricity.

The secret of this wonderful invention lies in the sensitiveness of selenium to the effects of light. When a ray of light falls on a plate of selenium the electric conductivity of the metal changes. Mr. Kornel uses a plate covered with a composition which he calls bromide of selenium gelatine for "reading" the image of the person using the telephone, which is then transmitted by the same wire that conducts the sound of his voice, and throws, apparently without the use of any further apparatus, on a glass plate at the other end. In this way the persons using the telephone can not only hear but see each other.

Republican, Denver, Colo
July 24, 1879

One of the "late inventions in the use of electricity is that by which a person may be enabled to see an object at a long distance from him. In this way the likeness of a person talking through a telephone may be seen by the person with whom he is talking. It seems that a likeness may thus be transmitted many miles, and greater probably than the distance over which a telephone may be used. Edison is working on an instrument of this sort, but he is not the first inventor. A German named Kornel preceded him. This will rank with the phonograph as a modern wonder.

Daily Rocky Mt. News, Denver, Colo
July 17, 1879

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Republican, Meridian, Miss
June 14, 1880

Edison is inventing a long distance telephone, so that you can see a fellow in New York or Boston as you talk with the boys do who tell their wives they were at the lodge. If they are in love the machine will turn down at the faro table by their loving spouses? [illegible]

American, Hackney, Conn
June 5, 1880

Edison is at work on a machine which he expects to do for the eye what the telephone has done for the ear and says it is possible for a man in New York to see the features of his man he is talking to in Boston.

The Wizard of the Menlo Park, Mr. Edison, is going to outdo himself. Another magnificent invention of his time have developed extraordinary talents in the way of revealing to a lover in a drop of ink or a ball of crystal the sight of his mistress, no matter how many hundred miles she might be distant. Edison has trumped this by the invention of what he calls a farsight machine, by means of which he hopes to be able to increase the range of vision by hundreds of miles, so that, for instance, "a man in New York could see the features of his friend in Boston with as much ease as he could see a performance on the stage." He hopes to have the invention perfected long before 1889. Query, will the farsight machine add to the joy or the misery of the world?

Times, Bethlehem, Pa.
June 25, 1889.

In the course of a conversation with a newspaper man who sought his views upon the subject of the projected world's fair in New York City, Edison, the electrical wizard, is reported ~~as~~ saying that he would take an acre of space in such an exposition and completely cover it with his inventions, of which he has no less than seventy now under way. "One of the most peculiar and now promising good results," said Mr. Edison, "is what I may call a 'far sight' machine." By means of this extraordinary invention he hopes to be able to increase the range of vision by hundreds of miles, so that, for instance, "a man in New York could see the features of his friend in Boston with as much ease as he could see a performance on the stage. That," he added, "would be an invention worthy a prominent place in the world's fair, and I hope to have it perfected long before 1892."

Journal, Boston, Mass.
May 13, 1889.

Edison's Last.

Mr. ~~Edison~~ must be careful not to invent something which shall cause even enlightened modern society to rise upon him and to threaten him with the stake—which was the portion of so many distinguished innovators in darker days than our own. There are already conservatives in Europe who fulminate against the phonograph as "irreverent" because of its daring function of preserving and perpetuating the voices of the loved and lost. The wizard of Llewellyn Park, in conversation with a reporter who solicited his ideas on the subject of the projected World's Fair in New York city, said he would take an acre of space in such a fair and completely cover it with his inventions, of which he has no less than seventy now under way. "One of the most peculiar and now promising good results," said Mr. Edison, "is what I may call a far-sight machine." By means of this extraordinary invention he hopes to be able to increase the range of vision by hundreds of miles, so that, for instance, "a man in New York could see the features of his friend in Boston with as much ease as he could see a performance on the stage. That," he added, "would be an invention worthy a prominent place in the World's Fair, and I hope to have it perfected long before 1892."

Worthy "a prominent place in the World's Fair?" Decidedly. But what a changed world it would create. There would be no more pleasant little deceptions about "being at the club until a late hour." The suspicious wife, supplied with the invention, would consult it, and would triumphantly prove that the husband was not at the club. The "electric mirror," by enabling persons hundreds of miles away to have whole tracts, whole city districts, whole categories of individuals under their examination, would place a new and wholesome restraint upon human action. Hypocrisy would go out of fashion, because it would be no longer practicable. In fact, it would be extremely dangerous. Society would have to exist in unison with truth. Private detectives would give up their profession and go in for something respectable. A fierce white light would beat around the actions of every individual. But Edison would be burned, or something worse, for witchcraft. There would be a panic, and the old barbaric rage against the innovation would break forth. Let him be warned in time and place this invention on the shelf, labeled "Dangerous; too revolutionary."

Tribune, Minneapolis, Minn.
May 20, 1889.

A New-York correspondent writes that Edison is now engaged on a "far-sight" machine, by means of which people will be able to see long distances. It is to be hoped that this machine will enable a gentleman at the theater to "see a man" without going out between the acts.

N. Y. Times, Nov. 4, 1889.

A VALUABLE INVENTION.

Of the many valuable inventions in modern warfare (which have emanated of late from Lieut. Bradley A. Fiske, United States Navy, perhaps none is more worthy of consideration than his recently-patented apparatus for finding range and position of distant objects through the agency of electricity. The greatest secrecy has always been maintained regarding the details of this device, though it has been known for some time in well-informed naval circles that such an apparatus had either been or was about to be patented, and that its salient features consisted in the determining of the exact range of any distant object by keeping trained upon it a telescope, which in moving carried along with it a dial parallel with the telescope. This dial, it was understood, had electrical contact with a graduated arc over which it moved, and by means of ranging angles registered accurately the distance of the object from the apparatus during all varying stages. So much was known of the apparatus, and it must be added that scientific circles were indebted to Mr. Park Benjamin for even this amount of information.

Starting out with the original idea of increasing the efficiency of the dynamite guns of the Vesuvius, Lieut. Fiske discovered that the range and position finder had something more than a limited field of action before it, and now we find that the device bears the patents of nearly all the principal governments in Europe, besides that of the United States. Up to the present writing the working of the "range and position finder" has been one of the secrets of modern warfare. By the means of a simple train of a telescope Mr. Fiske proposes to know at all times just how far away is the position of the enemy, and from thus knowing that position, accurately to impart the information to the batteries and secure a sight adjustment that is absolutely correct. This, in brief, is the underlying principle of the "range and position finder"; to what further practical uses it can be applied will be seen from the description, but that it is a success is undeniable, and the chances are that with the thorough practical tests to which it will be subjected on board the flagship Chicago, where the first apparatus has been placed, it will be found essential for accuracy of fire on all the new ships.

The invention of the "range and position finder," as Mr. Fiske puts it, consists in the determination of a fractional portion of a conducting body bearing in length a ratio to the angle included between two lines of sight directed upon some distant object, and the measurement of the electrical resistance of said length.

The electrical device consists of an ordinary Wheatstone bridge with its four members, in one member of which is arranged a body of conducting material in arc form and a movable arm traversing this arc. There is also the transverse member, in which is connected the galvanometer. A battery is connected to the bridge in the usual way. In two of the members are placed fixed resistances, and in the adject member to one containing the arc form is a variable resistance placed as usual. One wire from the battery connects to the end of a member containing a fixed resistance, and at the same time to the pivot of the swinging arm which plays over the arc form. The extremity of this pivot arm moves over and maintains electrical contact with the arc form of conducting material, which latter has one extremity connected to a member of the bridge. Now, when the point of this arm is brought in contact with the member having connection with the arc form, the dial at that moment is in prolongation of this member, and the pivot of the dial having wire connection with another member, there will at once be a current traversing directly from member to member instead of, as before, through the medium of the intervening arc. Now this arc form is made of such material and so proportioned that its electrical resistance to a current traversing it is proportional to the length of arc included between the point of the dial and that part of the arc having contact with a member of the bridge. This resistance that is made to interpose is commensurate with an angle whose sides are the dial itself and the line drawn from the pivot of the dial to the point where the arc form comes in contact with the adject member of the bridge.

An observer, then, stationed at the galvanometer, and at one of the points of resistance, can, by noting the galvanometer and adjusting the resistance in the usual way, determine the resistance equilibrating any position of the arm along the arc and so discover the angle of adjustment of this arc; or, having adjusted one of the points of resistance at some given figure, the observer may, by simply noting the galvanometer or any other suitable indicating device, visible or audible, determine when the dial is placed at a desired angle corresponding to the adjusted resistance, and this indicating device is obviously at the place where the moving arm is situated, so that the operator then knows when he has placed the arm at the predetermined point or at the distant station, so that the operator in charge of the resistance point can know that the arm has been properly adjusted; or two indicating devices in the same circuit may give warning to both operators, as above, simultaneously. By this means the elevation or training of a gun may thus be determined or recognized from a distant point, the longitudinal axis of the gun corresponding to the dial in the arc form.

Democrat, Hutchinson, Kas.
Aug. 17, 1889.

FAR-SIGHT MACHINE.

Mr. ~~Edison is~~ reported, in a conversation with an interviewer who solicited his ideas on the subject of the projected world's fair in New York, says Iron, as saying that he would take an acre of space in such a fair and completely cover it with his inventions, of which he has no less than seventy now under way. "One of the most peculiar, and now promising good results," said Mr. Edison, "is what I may call a far-sight machine." By means of this extraordinary invention he hopes to be able to increase the range of vision by hundreds of miles, so that, for instance, "a man in New York could see the features of his friend in Boston with as much ease as he could see a performance on the stage. "That," he added, "would be an invention worth a prominent place in the world's fair, and I hope to have it perfected long before 1892."

Eagle, Brooklyn, N.Y.
March 7, 1888.

THE ONLY HOPE

For a Reduction of Telephone Charges.

The Assembly Committee Refers to a Very Remote Contingency — Inequalities in the System Used in Brooklyn.

ALBANY, N. Y., March 7.

On the 27th day of April, 1887, the Assembly passed a resolution directing the appointment of a committee charged with the duty of investigating the affairs of the telephone companies doing business in the State. The report which was submitted to the Legislature to-day contains a voluminous and detailed statement of the capitalization, cost of construction, operating expenses, net earnings and dividends paid by each of the companies in this State. It begins with a statement regarding the American Bell Telephone Company, of which it says:

It is a corporation organized under the laws of Massachusetts, with a capital of $10,000,000, which, under the present judicial decisions, owns and controls all patents now in use upon telephonic instruments in the United States. Except as a large stockholder in local companies it does not operate any of the territory in this State. It does not sell any of the instruments manufactured under its patent, but leases them to its licensees at an annual royalty of $14 per set of instruments, excepting the Metropolitan Company, of New York and the Commercial Company, of Troy, which it charges $10 respectively, reserving the right to increase all these royalties at its pleasure. In addition to these royalties it also exacts from its licensees a further consideration in the form of a donation of 35 per cent. of the capital stock of its licensees. It also exacts a commission upon all extra territorial and telegraph business done by the licensees of 15 per cent. on the former and 50 per cent. of the latter.

Concerning the New York and New Jersey Telegraph Company, which operates Long Island, Brooklyn, Jersey City and outlying points, the report states:

It was organized in 1883, with a capital stock of $2,400,000, all of which has been issued. It is a sub licensee of the Metropolitan Company, which owns $800,000 of its stock. Its cost of construction is $1,709,000, and its net earnings during the past fiscal year were $183,760, showing a percentage of net earnings to cost of 10.8 per cent. It has 5,317 subscribers at an average rental of $70.56. This company has a special class of service furnished to sixty-five subscribers, who are large users, at an increased rate, in one case of $720 per year. This subscriber by actual count had 18,000 connections with New York City alone, aside from his local use of the instrument. Another found by actual record kept that his telephone was used four hours and thirty minutes out of seven business hours, counting from the moment it was being connected with subscribers to the moment it was released.

The committee considers the right of the Legislature to regulate the charges of local companies and find that they have such right; also upon the right of the Legislature to regulate the royalties charged by the American Bell Company, of Boston, and find that they have not the right to regulate them.

Treating of the patents and the interference between the caveats of Mr. Berliner and Mr. Edison, the committee conclude that at the option of the American Bell Company its present monopoly upon telephonic instruments will extend for a period of seventeen years from the date of the settlement of this interference. The only remedy to defeat this monopoly will be the invention by another person of a telephone of the "make and break" system, which, electricians say, is extremely doubtful. The committee think there is but one circumstance which in their judgment would justify legislative interference; that circumstance is the imposition of a charge so large that it shall be a burden to those who use it and which shall produce a revenue disproportionate to that return to which its inventors and those who put their money into it when it was an unsolved problem are entitled. That circumstance is found in the cities of New York and

Mail, Chicago, March 21, 1888.

WHO INVENTED THE TELEPHONE?

There is hope that the Bell telephone monopoly will have to go. True, the decision of the supreme court in March a year ago seemed to settle the matter the other way. The decision, four to three, not a majority of a court of nine, was that the poor Pennsylvania mechanic, Drawbaugh, was of no account and that the scientist, Bell, was entitled to the invention and its fruits. The testimony as accepted by three of the justices showed that Drawbaugh invented and had a telephone in working order and that it was used by over seventy persons four years before Bell ever appeared with his claims. As we remember the majority opinion it laid down the very doubtful principle that even though Drawbaugh's invention ante-dated that of Bell's the latter brought his to public notice first. In other words, if a man is ignorant of the value of a possession, he deserves to have it taken away. But the seventy witnesses who swore to using the Drawbaugh instrument would seem to be enough public notice for the occasion, and it is doubtful if on a retrial before a full court the first opinion will stand.

Anyway the test is to be made. The government is engaged in a suit in the circuit court at Boston against the Bell company in general and Bell himself in particular. It charges fraud in obtaining the patents, and it conjointly charges that Bell had no right to any telephone patent, even if honestly secured, because of overwhelming proof that Daniel Drawbaugh had invented the telephone four years before. The government has made its own investigations in the case, and behind it is the Drawbaugh syndicate, become more powerful since its last defeat and its members a unit for prosecuting the suit to the end.

That the Bell people are alarmed at the activity of their opponents is apparent in their every action. The syndicate makes no secret of the strength of the hopes that underlie its course. New and important evidence will be presented, and the syndicate is so sure of the justice of its case that, while preparing for set backs, it is determined to bring the matter before congress if necessary. The Bell folks fight for delay, then they ask that the fraud suit be considered first. They are bound to keep away as long as possible from the meeting of the priority of invention issue. The supreme court trial was by no means exhaustive. But twenty minutes was allowed to present a matter of evidence that took a week to argue in the court below. This time the whole truth will be spread out to full view, and many may be surprised at the slimness of the foundation on which a great monopoly rests.

Sentinel, Rome, N.Y.
July 17, 1889.

It May Be a Success.

Prof. Elisha Gray thinks he has invented a machine which will in a large degree take the place of the telephone. He has named it the "telautograph." Persons using the "telautograph" will communicate with each other in writing, a fac-simile of the message, whether it be in English, German, French, shorthand, cipher, or any other form, being produced at the other end. An "artist on the spot" may thus be enabled to transmit a picture from a point 500 miles away to his newspaper instantly, and illustrations of sensational events occurring at a distance may become historically valuable. Contracts can be entered into at long range and the signatures of the parties to instruments and agreements obtained. Parties desirous of holding conversations of a private nature with their friends will no longer be obliged to take half the town into their confidence as they must do under the "hello" process to which Prof. Bell has now the sole and undisputed title. It would be sad if, after all, the fruit Prof. Bell has plucked with infinite labor and expense should turn to ashes on his lips.

The inventor is very proud of his latest achievement, and expects to see it go into general use. It has been the dream of his life to perpetuate his name by an invention of great public importance. His telephone thunder having been stolen he must rely on his "telautograph."

Ledger, Phila. Pa. March 24, 1888.

FOLLOWING HARD UPON THE TELEPHONE DECISION comes the announcement of an invention by Professor Gray of a new telautograph, which transmits facsimiles of writings and drawings, and may be used in an exchange system, like the telephone. Six or eight years ago a machine for this purpose was worked successfully in Edison's laboratory, though the inventor did not then consider it fast enough for commercial use. The writer has an autograph reproduction of a message from Mr. Edison sent over this machine. There are also one or two entirely satisfactory systems of type-writing through exchanges which can easily be brought into competition with the telephone, if capital should see its way clear to profit in the business. The telephone monopoly stimulated invention in this direction, and it is not too much to say that, if the whole telephone system should be wiped out of existence, the world would, in a very short time, be provided with a satisfactory substitute.

N.Y. World, Dec 18, 1887.

Detecting an Enemy's Presence.

[SPECIAL TO THE WORLD.]

HARRISBURG, Pa., Dec. 17.—Daniel Drawbaugh, who resides near here and whose claim to having invented the telephone will be shortly passed upon by the Supreme Court of the United States, is now at work on an invention which, he says, will be useful in time of war, either on land or sea. It is an electrical contrivance by which the presence of large bodies of troops on land or ships on the water can be detected within a distance of ten miles.

A General with this new contrivance in his tent can tell by its peculiar motion if the enemy is near and prepare to give him a warm reception. The commander of a war vessel can also tell the approach of any vessel, hostile or otherwise, the resistance of the water on the approaching vessel causing sufficient friction to establish a current that will cause the indicator to sound the alarm.

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N.Y. World, March 20, 1888.

BELL'S PATENT SUSTAINED.

THE TELEPHONE CASES DECIDED IN HIS FAVOR YESTERDAY.

Four of the United States Supreme Court Justices Out of Seven Support His Claim to Priority of Invention Against Drawbaugh, Gray, Reiss and All Others—History of the Celebrated Litigation.

[SPECIAL TO THE WORLD.]

WASHINGTON, March 19.—Mr. Justice Blatchford to-day announced the decision of the United States Supreme Court in the telephone cases. It is in favor of the Bell Telephone Company on all the points in every one of the cases. The opinion was indorsed by only four Justices out of the seven, but its majority of one was, of course, ample to make it final. Justices Gray and Lamar did not sit in the case. Justice Bradley read a dissenting opinion, in which Justices Field and Harlan concur. The cases now decided are five in number. The Bell Company has been plaintiff in every one of them, and has beaten the defendants in the lower courts. The companies concerned are the Dolbear, the Drawbaugh, the Clay, of Philadelphia; the Molecular and the Overland, of New York.

The decision reviews the charge of fraud and collusion in the patent office, by means of which Bell, it was alleged, obtained surreptitious information with regard to the inventions of his rivals and, then amended his own specifications. The Court holds that there is not the slightest evidence to support this charge, or to cast the least reflection upon the integrity of Bell or his attorneys. Justices Bradley, Harlan and Field dissent because of Daniel Drawbaugh's claim. Their opinion is that the evidence shows beyond cavil that Drawbaugh was the inventor of the speaking telephone, although he did not realize this or know the importance of it.

The Court holds that the force of the testimony showing that Drawbaugh had telephones in use before the invention of Bell is broken by his own conduct and the indifference he manifested about his invention until years after Bell's telephones were in general use. The Drawbaugh claim is declared to be unsustained. He slept too long on his rights. The expenses in the Drawbaugh suit were $100,000 a side.

In considering the question of the alleged anticipation of Bell's invention by the telephone of Reiss, in Germany, the Court holds that Reiss discovered a means of transmitting musical tones, and nothing more. Bell's patent, being for the process or art of transmitting speech, would have been just as valid even if he had used the apparatus of Reiss in developing it. The Court holds that the apparatus of Reiss was not successful in transmitting speech, and that his invention was not in any respect an anticipation of the discovery which was made by Bell.

The first important litigation by the Bell Company upon its patents was in the suit of the American Bell Telephone Company against Dowd. Dowd was defended by the Western Union Telegraph Company, and the contest was substantially between that corporation and the Bell Company. The Western Union Company, owning the patents of Edison and others, began suit against the Bell Company for adopting their improvements. The claim of the Bell Company was founded upon the Bell patents of March 7, 1876, and of Jan. 30, 1877. The first patent in question describes a method of telegraphy, carried into effect by the employment of a vibratory or undulatory current of electricity in contradistinction to an intermittent current. The patent contains seven figures. The first six illustrate an apparatus which no one has ever claimed is capable of transmitting articulate speech. Figure 7 illustrates a form of an instrument which Mr. Bell says he and his assistant, Mr. Watson, experimented with, getting sounds, but not understanding any words. There are five claims to the patent. The first four do not relate to the transmission of speech.

The Drawbaugh suit was fought more bitterly than any of the others. It lasted for years and Justice Wallace finally gave the decision in Bell's favor. Drawbaugh is a Pennsylvania mechanic, poor, but of a very ingenious turn of mind. He claimed, and brought rude instruments into court to substantiate his claim, that in 1872 he carried on conversation over a wire several hundred yards long. He claimed that he was too poor to stand the expenses of getting a patent. Still, it was shown that he had financial backers, who about that time enabled him to get other patents.

The controversy with all the claimants to the invention of the telephone, Daniel Drawbaugh, Philip Reiss, A. K. Eaton, Elisha Gray, Thomas A. Edison and others, turns upon the right of Bell to control the whole art of the electric transmission of speech by means of his patent of 1876. As bearing upon this proposition the following facts are important, and may be summarized as follows:

1. Reiss had described what he called a telephone, and which has been described with great minuteness as transmitting speech, as early as 1861. Reiss was a German school-teacher, who seems to have come very near to inventing a practical telephone.

2. With that instrument Reiss had transmitted not only musical tones but human speech to the extent of individual words, though not with a distinctness sufficient to every one. He had also transmitted the inflections of the voice as in interrogation, exclamation, surprise, calling, &c. His instruments were capable, therefore, of reproducing, to some extent, quality of sound as well as its pitch.

3. Bell had never, up to the date of his patent, transmitted a single articulate word or any quality of sound.

4. In a statement made by Bell a few days before his application for the patent of 1876 he had admitted expressly that his instrument transmitted "the varying pitch of the voice" only, but not the quality.

5. The best that can now be done with the instruments described in the Bell patent is that under exceptionally favorable circumstances a few words can be intelligibly transmitted. This may be due in part to the increased cultivation of the ear since the practice of using telephones has been introduced.

6. No such instruments as Bell described and illustrated in his patent of 1876 have ever been used for any practical or commercial purpose without modifications of form and further patented improvements in materials.

7. It is, however, to be said in behalf of Bell that the form of transmitting telephones described in his patent exhibited one great improvement over anything suggested by Reiss. The defects of the Reiss instrument were undoubtedly due to the tendency to make and break the circuit at every movement of the membrane or diaphragm when acted upon by sound-waves. Prof. Bell devised an instrument in which the circuit was never broken, because it was not established through the diaphragm.

CONGRESSMEN WITH TIPS.

Thousands of Dollars Made in Speculating on the Telephone Decision.

[SPECIAL TO THE WORLD.]

WASHINGTON, March 19.—The decision of the Supreme Court in the famous telephone case, which was to-day given in favor of the Bell Company, was evidently no surprise to the speculative Congressmen, who relieve the monotony of a strict attention to the public business by taking an occasional flyer in the street. They had been given the tip. While this occasion is not the first on record on which an important Supreme Court decision has been given out in advance, the magnitude of the interests involved in this case and the opportunities for speculation, which have been eagerly embraced by a number of Representatives, have served to create a decided sensation. How this advance information was obtained is a problem over which there has been a deal of brain-cudgelling to-day. That it was obtained from an authoritative source there can be but little doubt.

Before the convening of the court this morning, it was whispered about the corridors that a certain prominent New England Congressman had placed a margin of $50,000 on Bell Telephone stock at 234 on the strength of the tip. As Chief-Justice Waite and his associates filed into their seats at 12 o'clock this Congressman and three or four of his collegues in the House pressed through the crowd that packed the room almost to suffocation, and stood within the bar breathlessly awaiting the decision. Justice Blatchford sat before a voluminous pile of manuscript, which he began to read in a steady, monotonous voice. As he slowly disposed of the claims of the parties contesting with Bell the priority of the invention that has almost revolutionized telegraphy, the anxious faces brightened, and first one and then another left the inclosure, and pushing through the throng, hurried to the telegraph office, in the House corridor. Near the window stood the tall young man who, in the days of the tickers, furnished stock quotations to speculative statesmen of both houses. His hands were full of despatches, but they were the anxious queries of his principals, and not stock orders; those had been sent hours before.

"How does it look?" the despatches asked. "Do you note any change? Keep us posted." "Bell is steadily, but very slowly rising." As one after another of those who had been listening to the reading of the decision left the court-room the tall young man buttonholed them for the latest details and then hurriedly scribbled despaches, which he tossed in at the window of the telegraph office. Occasionally he received a quotation on the stock, upon which he was at once surrounded by an eager crowd, many only curious, but others to whom a point either way meant a loss or gain of thousands.

Little Deacon White was very nervous. During the early part of the reading of the decision he stood in the court-room, but afterwards trotted up and down the corridor, waiting for the termination of the suspense. It was a long pull. For an hour and three-quarters Justice Blatchford threaded his way through a maze of technical terms and scientific phraseology. The claims of each opponent of the great Bell monopoly were taken up separately. One after another they went down before the argument that in many passages sounded oddly like a plea for Bell rather than a legal decision. Casey Young, of Pan-Electric fame, now counsel for Prof. Gray, sat within the bar, his thin fingers playing nervously with his watch-chain. To the left of the Court sat dapper little Storrow, chief of Bell's legal advisers, his sharp eye taking in every detail of his surroundings, and his lips parted in a half smile, which deepened as the points he had raised in his argument were one by one sustained by the decision. Opposite Storrow sat young and stalwart Charles J. Kintner, at one time Chief of the Electrical Division of the Patent Office, on whose affidavit the inventor, McDonough, bases in a large degree his claim to transmit speech by the "make-and-break" current of electricity.

When the conclusion in favor of Bell was finally announced there was a wild rush for the door and Congressmen and correspondents took part in a lively sprint for the telegraph offices. The tall young man, his hand shaking so that he could hardly hold a pencil, scrawled a message and pushed it towards the operator. In a few minutes he was handed a despatch. It read: "Bell, 244; 250 asked." As he read it aloud the faces of several who had expected the stock to jump a dozen points or more wore an expression of disappointment.

"It was discounted in advance," said Deacon White, but the New England Congressman's face was wreathed in smiles. He had made $100,000 [in] three days. It is said that among the heaviest winners by the big jump the stock has taken within a week are Henry Cabot Lodge, of Massachusetts and Archie Bliss, of New York.

Journal, Albany, N.Y. Dec. 15, 1887.

THE astuteness of corporations was illustrated Monday before the assembly telephone investigating committee in New York. From the testimony of one electrical expert it was brought out that in 1877 both Edison and Emile Berliner obtained patents on telephone transmitters. The inventions were similar and the department had ruled that the claims interfered. Nevertheless, patents were issued to both, no mention being made of the use of carbon with a tympan—the point on which the claims conflicted. It now appears that the Bell company promptly purchased all rights to both patents and, when the Bell patent expires in 1893, purposes to present the Berliner-Edison claim for a patent, specifying the use of carbon with a tympan, and thus enjoy 17 more years of telephone monopoly. The patent department should appoint some of its quickest minds to devise a way to foil this jugglery of beneficent laws. Seventeen years of protected rights are a sufficient reward for genius. Give the people a chance.

Herald, Rochester, N.Y. Dec. 14, 1887.

THE TELEPHONE MONOPOLY'S TRICKS.

Theodore M. Vail, president of the Metropolitan telephone company of New York—one of the Boston monopoly's subcreatures—testified before the assembly committee in New York on Monday. Here is a portion of the report taken while he was on the stand:

Q.—At the expiration of these patent rights in 1893 or 1894 do you understand that the field will be open to competition?

A.—I do not understand that it will be much more open than it is now. I think that in apparatus, such as switchboards and patents referring to various details, there will be some controlling features. I think that the American Bell company have appliances and patents running beyond 1893 that would enable them to give a more perfect service than others would.

William Chase Barney gave some testimony showing how the Bell telephone company intends to prolong its grip on its monopoly. In 1877 a caveat for a carbon transmitter was filed by Emil Berliner. Three months later Edison filed a caveat for a similar devise. This brought about an "interferance" case which is still pending. In the meantime the American Bell company got control of the rights of both men but lets them remain unsettled in the patent office. Just before the Bell patent will expire, it is supposed, one of the claims will be withdrawn, a patent will be granted on the other and thus the Bell company will secure seventeen years more of power and profit in view of the alleged superiority of their transmitter to the one the monopoly is now forcing the public to use.

In this scheme, says the New York *Times*, the Bell company "has had the assistance of the patent office." Is that true? If it is the patent office ought to be cleaned out.

Wall St. News, New York City Dec. 21, 1887.

The Telephone Rumors.

Considerable interest is being manifested in financial circles regarding the shortly expected decision by the United States Supreme Court in the Draubaugh vs. Bell suit.

It was currently reported yesterday that the Western Union Telegraph Company was endeavoring to purchase the Draubaugh claims to the microphone. The reasons for the negotiations are stated to be, that in the event of the Bell Telephone Company losing its broad patent to the art of telephony, their only chance to maintain a monopoly would come out of the patent office sustaining Edison's claim to a monopoly of the microphone—the carbon transmitter—and granting him his patent, which would practically control the telephone business for 17 years. This Edison claim is the property of the Western Union Telegraph Company and held in trust by the Bell Telephone Company; but if the Bell Company should lose its patent then the trust would cease and the contract of trust be declared contrary to public policy. In this case the Edison claim would revert to the Western Union Telegraph Company; but Edison cannot succeed in getting a patent unless Draubaugh's claim is out of the way.

N.Y. World, March 20, 1888 17

HELLO, CENTRAL! HELLO!

The Supreme Court of the United States yesterday rendered its decision in the Telephone cases, upholding the Bell patents. Seven Justices sat upon the case. Four decided in favor of BELL, while Justices BRADLEY, HARLAN and FIELD dissented. The monopoly has won by a majority of one, and the people who detest an unjust monopoly have lost by the lack of one.

The decision lingered in the wavering scales, first on one side and then on the other, for thirteen weary months. Before this term of court it was generally understood that the Bell Company had lost. The stock sympathized with the rumor, and after hearing the news certified to its correctness by falling fifty points. After a while the scales grew uneasy and the stock began to rise. The monopoly began to hope and the stock to recover its lost ground. The agents of the monopoly were active, and after a time confident. Without doubt every influence was brought to bear for the purpose of securing a decision. Yesterday the country was startled by the announcement that the Bell Company had scored another victory, and that, clad in the armor of a decision from the highest tribunal in the land, it would continue to fatten off the people until the year of grace 1893.

This is supposed to be the era and administration of reform, and yet how difficult to overestimate the social and judicial influence of a hundred million of dollars! Three of the Justices bravely and manfully stood by the cause of the people and the right! Their names are BRADLEY, HARLAN and FIELD. The claims of DRAWBAUGH and DOLBEAR and the Molecular Company and some others have been passed upon, and unless a rehearing is granted the decision is *absolutely final*. There is, however, something left for the public. The claim of JAMES W. MCDONOUGH was not passed upon. His inventions were not involved. He was not a party to this decision. Fearing that something might be done that would directly or indirectly affect his rights, counsel on his behalf appeared before the Supreme Court and asked the liberty of being heard. This was denied by the Chief Justice, and upon the ground that he was not a party, and that his rights could not, by any judgment rendered in that case, be affected. MCDONOUGH applied for a patent not only for a telephone but for a receiver and a transmitter. This was in 1876. He was put in interference with GRAY, BELL, EDISON and others. The Examiner found and decided that he was entitled to a patent upon his receiver and transmitter. This was reversed by the Examiners-in-Chief, and there is now pending before Commissioner HALL a motion for a rehearing. If the motion prevails, and MCDONOUGH is given an opportunity to establish the fact that the telephone invented by him would transmit speech, then the Bell monopoly will be broken, and no other monopoly can be created, for the reason that MCDONOUGH simply claims to have been an improver upon the inventions of PHILIP REIS.

Nothing seems more absurd than for the Supreme Court of the United States to decide that a principle in nature can be patented—that one of the elements can become the property of a corporation for sixteen years. A man may be granted a patent on interest tables, on adding machines, but certainly not on mathematics. Another such monopoly, a few more Trusts, a few more such decisions and another JAY GOULD or two and the country will be in a bad way.

Menlo Park Scrapbook, Cat. 1036

No. 22. "Magnetic Telephone"

This scrapbook covers the years 1879-1881 and contains clippings about the telephone. There are 144 numbered pages.

Blank pages not filmed: 10-13, 28-144.

1036

Magnetic Telephone

22

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LE TÉLÉPHONE GOWER

à Royal-Institution

L. Rodanet

Nous recevons, d'un de nos correspondants de Londres, des détails sur la conférence faite à Royal Institution par le professeur de Parnsby sur l'ingénieux instrument que nous avons été les premiers à faire connaître au public français.

Londres, 29 mars 1878.

Le professeur Tyndall a fait ici, à Royal Institution, une conférence sur le téléphone Gower, conférence qui a obtenu un tel succès, que les membres de la royale société en ont demandé une seconde pour le lendemain. Le professeur Tyndall a développé, dans ses détails techniques, l'invention de M. Gower que tous nos lecteurs connaissent déjà après avoir présenté à l'auditoire M. Gower, le confidencier a montré quel pas énorme le jeune ingénieur avait fait faire à la science. Il l'a complimenté longuement sur la valeur de son appareil, qui donne de si merveilleux résultats dans sa simplicité même, et, sans pile, sans accessoire, produit les courants électriques, *sous la seule excitation de la parole humaine.*

B. MURRAY.

TELEPHONE WITH MAGNETIC SUPER-EXCITATION.

By M. Anon.

The new telephone is founded on the principle that if a slender blade of iron or steel is placed before the poles of a magnet, it is much more strongly acted upon if there is placed behind it a piece of soft iron than if this is not the case. Thus a greater sensibility is obtained by placing in front of the diaphragm of a common Bell's telephone, an iron disk, pierced in its center, with a hole corresponding to the mouth of the apparatus. Scientific Am. Nov 240

Talking by Telephone through the Human Body

Boston Journal June 1880

As the human body is a good conductor of electricity it may be expected that telegraphic messages may be transmitted through the same, and even the weak intensity currents of the telephone, and this without the person conducting the current perceiving any thing. This has been tested recently in Glasgow and the telephonic current led through a circle of persons who joined hands, and the expectation was fully realized, the human links in the circuit notwithstanding.

ux quand, arrivés à la véritable solution, ils remplacent x par la quantité trouvée et remontent à l'origine de leurs calculs, en les vérifiant l'un après l'autre.

Ils sciences naturelles, s'il est permis de se servir de l'hypothèse comme d'un point d'appui, ce n'est qu'à la condition qu'elle sera vérifiée séance tenante par l'expérience.

L'hypothèse peut servir de procédé opératoire ; elle ne doit jamais fermer la base d'une théorie.

C'est pourquoi je commencai mes recherches par le plus simple des instruments téléphoniques, le condensateur chantant.

Je découvris bientôt les sons secondaires produits dans ces appareils par l'influence des lames inductrices.

La construction d'un grand nombre de ces instruments me fit voir le rôle des résidants et des conducteurs, les effets produits par la distance des lames entre elles, leur nombre, enfin leur forme.

Je remarquai que si on réduisait un condensateur à sa plus simple expression, c'est-à-dire à deux surfaces conductrices infiniment petites séparées par une lame isolante, le chant était reproduit.

Mais deux surfaces infiniment petites ne sont autre chose que les extrémités de deux pointes, la lame isolante peut être une lame d'air; or, j'ai démontré expérimentalement que deux pointes placées en regard l'une de l'au re suffisaient pour reproduire le son.

Mais nous savons aussi que l'épaisseur des lames est sans influence. Supposons les extrémités des pointes sans aucune ép isseur, elles se réduiront à un point : donc une se le de points séparés par des lames d'acier reproduisent le son.

Le point réduit à l'infini, c'est l'atome.

La lame d'air réduite à l'infini, c'est l'intervalle moléculaire.

Or, les corps ne sont composés que d'atomes et d'intervalles moléculaires.

D'où je conclus (voir le numéro du 29 juin) qu'un corps conducteur n'est en réalité qu'un condensateur réduit aux dimensions at-omiques.

Cette constitution des corps conducteurs me permet de formuler dès à présent cette autre proposition sur laquelle je me réserve de revenir avec de nombreuses expériences à l'appui.

L'électricité se propage dans les fils conducteurs par induction et non par circulation; par décomposition successive du fluide neutre de chaque molécule à mesure que un courant ou tension excitant d'une source quelconque.

La pile ou l'électro-moteur n'est qu'un excitateur de molécules sur ces qui déconpose en polarisé par induction les molécules passives formant le fil de conducteur.

Il n'y a ni bons conducteurs, ni corps isolants; il n'y a que des corps plus ou moins conducteurs, et on ne doit accepter les mots conducteur, meilleurs conducteur, isolant, que comme des moyens de faciliter le langage.

Un corps pouvant être bon conducteur par rapport à un second, et isolant si on le compare à un troisième.

Mais revenons aux pointes placées en regard.

La conclusion précédente n'est pas le seul enseignement qu'elles puissent nous donner.

Si nous observons ce qui se passe au moment de l'émission d'un son, nous verrons qu'elles deviennent lumineuses; il y a production d'aigrette et d'étincelle.

D'où je conclus que :

Quand un courant électrique est assez fort pour traverser une lame gazeuse médiocrement conductrice, il le fait sous forme de lumière.

Donc, si nous intercalons dans le circuit un médiocre conducteur gazeux, ce médiocre conducteur gazeux deviendra lumineux sous l'influence du courant et nous avons tout lieu de croire que l'illumination présentera des caractères particuliers dus l'analyse pourra s'emparer.

Les résultats devront être très-précis, puisque ce sera le courant lui-même que nous saisirons au passage sans le secours d'aucun instrument intermédiaire.

L'expérience est venue confirmer mon hypothèse.

Un tube de Geisseler n'a-t-il autre qu'un médiocre conducteur gazeux ; si nous le plaçons entre les pointes mobiles, il s'illumine et constituera mon nouvelle électro-manoscopique.

Je vis du premier coup que l'illumination n'était pas la même pour les différentes notes.

Restait à trouver le moyen de tirer parti au point de vue de l'étude de ce résultat expérimental.

J'eus de suite l'idée d'imprimer au tube un mouvement de rotation.

Je sais que l'on me dira que cette expérience n'est pas nouvelle, qu'elle se trouve dans toutes les boîtes de physi ue amusante.

Oui, si on la répète telle qu'elle a été faite par M. Gaver dans sa conférence.

Non, si on l'exécute telle que je la décris.

Ce qui doit caract riser tout instrument scientifique, c'est d'être propre à mesurer deux ou plu-leurs phénomènes de même nature et d'être comparable à lui-même.

Les machines employées jusqu'ici pour faire mouvoir les tubes peuvent-elle remplir ces conditions?

Non, car leurs résultats ne sont pas comparables : or, qui dit comparaison dit mesure.

Mais si on mesure ne peut s'établir qu'entre quantités de même espèce dont l'une est prise pour unité.

Toute mesure peut s'exprimer ainsi :

Rechercher combien de fois une valeur connue prise pour unité est contenue dans une autre valeur de même espèce.

Quand nous disons qu'un sac d'argent contient 1,000 francs, nous exprimons que ce sac contient 1,000 fois l'unité monétaire, appelée franc.

Quand nous disons que d'un point à un autre il y a 152 mètres et demi, nous indiquons que cette longueur renferme 152 fois, plus une fraction, l'unité de mesure, appelé mètre.

Enfin, quand dans une expérience nous trouvons qu'un corps est à la température de 70 degrés, nous constatons que la température de ce corps est à une distance de 70 fois plus grande du zéro de l'échelle que celle d'un autre corps qui serait seulement à 1 degré, la distance 0 à 1 constituant l'unité thermométrique.

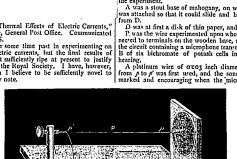
Les nombres 1,000 francs, 152 mètres et demi, 70 degrés ne sont que des quotients de division.

Comparaison : mesure et division ne sont donc que trois acceptions différentes d'une seule idée qui est la recherche d'un rapport entre deux phénomènes de même nature.

May 23.—"On some Thermal Effects of Electric Currents," by William Henry Preece, General Post Office. Communicated by Prof. Stokes, Sec. R.S.

I have been engaged for some time past in experimenting on the thermal effects of electric currents, but the final results of those experiments are not sufficiently ripe at present to justify my bringing them before the Royal Society. I have, however, obtained one result which I believe to be sufficiently novel to justify a short preliminary note.

Nature
June 1878



was spoken into. The articulation, though muffled, was clear, and words could easily be heard.

1. Experiments were first made to determine the length which gave the loudest sound and the clearest articulation, and, after repeated trials with every variation of length from 1 inch to 6 feet, it was found that a wire 6 inches long gave the maximum effect.

2. Experiments were then made to determine the diameter of the wire that gave the best effect, and after repeated trials with every gauge drawn from 0·005 inch to 0·001 inch, it was found that a wire of the diameter 0·001 inch gave the best effect.

3. Experiments were then tried with wires 6 inches in length and 0·001 inch diameter of different materials, viz., gold, iron, aluminium, silver, copper, palladium, and platinum, and they came out in the following order of merit :—

Platinum	...	...	...	Very clear.
Aluminium	...	...	...	Very variable.
Palladium	...	...	...	Clear.
Iron	...	...	...	Clear.
Copper	...	...	...	Faint.
Silver	...	...	...	Faint.
Gold	...	...	...	Very poor.

4. The effect of mechanical strain was tried. It was found not to vary the effect. When once the requisite tension, which varied with each metal, was obtained, further tightening up did not vary the clearness or loudness of articulation.

Gold would scarcely bear the tension required to reproduce sonorous vibrations, hence its low position.

5. Very thin carbon pencil, 0·025 inch diameter, was tried under compression and under tension, but no effect whatever was experienced unless a bad joint was made, when at once a faint intermittent effect was experienced.

6. No sibilant sounds whatever could be reproduced.

7. That the effect was due to heating and cooling was shown by the fact that it was possible to increase the current to such a strength as to render the temperature of the wire sensible to the touch, and then to make its elongation and contraction by regulating the current by hand.

It therefore appears from these experiments that wires conveying those currents of electricity which are required for telephonic purposes expand and contract as they are heated and cooled, and as the variations in the strength of the current are small compared with the strength of the current itself, the expansion and contraction vary in the same ratio as the condensation and rarefaction of the air particles conveying the sonorous vibrations which produced these vibrations.

The mechanical changes, or molecular vibrations in the wire, due directly or indirectly to telephonic currents, which result in the reproduction of sound, bear a close analogy to the mechanical changes due to the direct transmission of sound, but with this important difference, that while the vibrations due to sound are progressive along the wire, and their velocity is low and easily

The most striking facts elicited by these experiments are :

1. The extreme rapidity with which thin wires acquire and lose their increased temperature.

2. The excessive sensibility to linear expansion which fine wires of high resistance evince.

Now as the rate of heating, and therefore of expansion and contraction, varies very nearly directly as the increment or decrement of the current, when these vibrations are very small, it occurred to me that if a thin wire of platinum, platinoid, or gold-silver were attached to a sounding board or to the centre of a disk (such as one of those used for telephone and phonographic) and it formed part of a circuit conveying telephonic currents, sonorous vibrations ought to be reproduced.

The sketch shows the arrangement of the apparatus used for the experiment.

A was a stout base of mahogany, on which a brass support C was attached so that it could slide and be fixed at any distance from D.

D was at first a disk of thin paper, and then of thin iron.

T was the wire experimented upon whose loose ends were connected to terminals on the wooden base, so as to be inserted in the circuit containing a microphone transmitter M and a battery B of six Leclanché of potash cells in another room out of hearing.

A platinum wire of 0·0025 inch diameter and 6 inches long from *p to p* was first used, and the sonorous effects were best marked and encouraging when the microphone transmitter M

Nature Mar. 25 1880

equal proportions from either sex. I exhibited copies of fifty-four of them (made by a camera lucida) at the Anthropological Institute on Tuesday, March 9, when I read a paper on the subject. The meeting was attended by several of my correspondents, who are well known in the scientific world, and who explained to the meeting their respective forms. They were Mr. George Bidder, Q.C., the Rev. G. Henslow, Mr. Roget, Mr. Schuster, F.R.S., Mr. B. Woodd Smith, and Col. Yule, C.B. Two of these, namely, Mr. Henslow and Mr. Schuster, see the forms objectively; they can point to the direction in which at any moment any particular figure appears to them to lie, and when they move their eyes the form moves too. In the other four cases the close co-ordination between brain and eye does not exist, and their images appear in a sort of dreamland having no strict relation with external space. The form of each observer is quite unserviceable to the rest, having no meaning except to himself.

The language employed by persons in respect to some of the features of these forms is apt to be very similar. Phrases are frequently met with, such as "Ever since childhood I have always seen . . ." "I cannot account for their origin in any way;" "It is perfectly independent of the will." I have verbally questioned a great many acquaintances whether they see numerals in any particular way. They usually say No; they ask what I mean, then profess inability to understand my object, and evidently think it some nonsensical fancy. But I get my reward in the proportion of cases I have mentioned. I have already become familiar with the quick look of intelligence on these occasions, and with the reply in words denoting that the right chord had been struck. Then the details are poured forth. I am frequently told how the habit used to be mentioned to relatives, but was ridiculed, and had ceased to be spoken about; or again, how some particular brother or sister had the same habit, but that one only, and so forth. The more I follow up the inquiries, the more the accuracy of the first replies becomes evident; thus, I ask for fresh sketches, and they correspond to the first. The general result is, that these statements bear all the marks one could expect of being the reports of what is clearly seen and what the writer is anxious to describe exactly. Among my foreign correspondents whose names are well known to the scientific world, and whom I am permitted to quote, are M. Antoine d'Abbadie, the traveller, and Member of the Institute, and Baron von Osten Sacken, the Russian entomologist.

Now for the results. These forms (as distinguished from the figures now seen upon them) are survivals of a very early mental stage, and must have originated before the child learnt his letters. There is no nursery book or diagram that could suggest their fantastic shapes. Their very variety shows them to be derived from no common origin. They frequently turn with a left-handed twist, which written and printed things do not. They are more archaic than the alphabetical and historical forms used by the same persons, for these bear evident marks of their origin. The clock face has little or nothing to do with them, for its influence can only be traced in three cases. I believe the forms to have been mnemonic diagrams, invented by the children when they were learning to count *verbally*, the *sounds* of the successive numerals being associated with the successive points of the form. Also, that when the children began to read, the visual symbols of the numerals quickly supplanted the verbal ones, and established themselves permanently in their place. On this supposition we possess in these numerical forms a representation of the route along which the attention naturally travels in the mental field of view of the child. It is entirely the child's own way of working, and therefore true to his nature; and being natural, it persists through life and offers itself in the adult for our examination.

The characteristic run of the lines in each form has some general similarity to that of the correspondent's hand-writing, but it must testify more directly to his mental peculiarities than the latter. The form shows the ways that the mind most likes to travel by, but the hand-writing is a compromise between what the writer desires to produce under the joint guidance of a natural fancy, of education and of fashion, with what the muscles of the hand can most easily effect. These forms or natural lines of thought are, I presume, analogous to those that instinctively prompt each species of animal to make his lair, burrow, nest, or other piece of domestic architecture, on an identical plan, with trifling individual variations, and that prompts gregarious animals to group themselves always in the same sort of array. In these numerical forms we find real "psychograms."

One of the most obvious facts common to them is the curious proof they afford of the perplexity caused by our barbarous nomenclature of the numerals. We *say* "ten," "eleven," "fifteen," &c., when we *see* "one-nought," "one-one," "one-five," &c., and other civilised nations are as bad or worse than ourselves, as the French with their "soixante quinze." The way in which the perplexity is shown is by the wriggles and twists in the forms at 10 and 12 and by the exceptional length of the 'teens. It is not easy to describe in a few words what is so variously pourtrayed, but the general effect on looking at my collection is most striking. It is really painful to think of the vast amount of petty difficulty to the existence of which this indisputable testimony is given. The difficulty does not cease with childhood, else the twists would have been smoothed away, and I am sure from trials on myself that I for my part still feel it much. I can dictate more easily by saying on-one, on-two, &c., and I can write and sum from dictation much more quickly when some such plan is used. It should be adopted by those who want to remove as much friction as possible from their brain-work. I have little doubt that the conflict between our language and our notation is a serious though unsuspected hindrance to the ready establishment of decimal weights and measures.

I find from inquiries made for me at schools that young people see forms more commonly than adults, but that their forms are less developed and sure. I conclude that where they are vivid and serviceable they are much used, and insensibly grow in vividness, in definition, and in automatic character. Otherwise they decay from disuse and become forgotten. Hence arises the rather sharp division between the seers and non-seers in adult life.

I am still desirous of more information on this subject, especially concerning children, and on colour associations with figures, letters, and words.

FRANCIS GALTON

42, Rutland Gate, London

THE TELEPHONIC EXCHANGE IN THE UNITED STATES

THE telephone has already become firmly established in America as a medium of daily communication. Eighty-five towns are thus connected, and to the various telephonic companies there are 70,000 subscribers, and the number is rapidly increasing. For some details as to the working of this method of intercommunication we are indebted to our French contemporary *La Nature*. If we enter the great hall of the central office of the Merchants' Telephone Exchange at 198, Broadway, New York (Fig. 1), we see a series of "Switchmen" engaged in establishing communications among the subscribers. There is a switchman corresponding with one of the subscribers who has called (Fig. 2); further on is another *employé* engaged in raising the notice signal. In the city, in the subscriber's house or office, is the office telephone, which is set up in a great number of houses; this model is very convenient for business, for it permits of speaking into the mouth-piece placed on the left, of

Le Courrier
THEORY OF THE TELEPHONE.

EXPERIMENTS that I have recently made with a Bell telephone have convinced me that the sounds produced are the result of molecular change in the iron disks, and are the same in kind as those heard in the telephone of Reiss.

My experiments were made with a carbon transmitter and Bell receiver, using a small battery to generate the current. First I removed the bar magnet from the receiver, in accordance with a suggestion made by a writer in *Nature* some months ago. The effect without the magnet was the same as with it. It then occurred to me that the intensity of the sound might be increased by using two disks instead of one. Accordingly I cut two circles out of a piece of sheet iron, leaving a narrow strip of the metal to connect them, of sufficient length to enable the disks to lie on either side of the rod, so as to form, in fact, an armature to the electromagnet. On experimenting with this my anticipations were fully realized, the sound produced being more than double that of a single disk.

Now, while trying these experiments I held the disks loosely in my hand, without their being in any way fastened to the wood holding the rod, the effect being the same as if firmly secured. In the absence of a common dinner knife or a spoon of iron would you not expect if brought near enough to the core of the electro-magnet.

I have since constructed a very efficient telephone receiver out of a block of wood two inches square and three quarters of an inch thick. I then drilled a hole sufficiently large to receive the rod, and covered the face with thin sheet iron, it needs no further description, and forms the most effective telephone receiver that I have seen. But, still further to prove that the sounds produced are due to the magnetisation of the iron of the disk, and not to mechanical vibrations resulting from the electro-magnets, I made a set of the discs of which were two inches in diameter. Now, connecting the rod and plate as in circuit, the flanges of the reel gave out sound as clearly as in the Bell telephone. It was by this experiment rendered impossible to doubt that the sounds proceed from the magnetisation and demagnetisation of the iron, and are therefore precisely the same in character as those formed by a Reiss receiver.

St. John's Rectory, British Columbia. PLINIUS. 4/8/80.

Dating Association of the Telephone.—The [illegible] Bell Telephone Company, in Jersey City, [illegible] accurately the [illegible] which [illegible] effected by the [illegible] telephone in a [illegible] bridge, and [illegible] battery, and a [illegible] of the resistance [illegible] the liquid resistance [illegible] the electro-dynamic constants of the branches [illegible] very small; it further, a German silver [illegible] wire be used as measuring wire, it is found [illegible] in the position when the galvanometer shows no deflection, the tone in the telephone has a well-marked minimum of intensity. Supposing the liquid resistance has 2,000 units, a variation of even four units reveals itself in a displacement of the minimum position. A conversation was made, a few days since, by telephone between Plymouth church (Beecher's), Brooklyn, and the towns of Orange, Newark and Elizabeth in New Jersey, also several points in New York City, and all of which Beecher's church and the music were both heard. The transmitter was placed in front and below the pulpit. The farthest point was 17 miles distant.

La Lumière Pour Tous
L'emploi du téléphone dans les mines

La Chronique industrielle signale un nouvel emploi extrêmement curieux du téléphone dans les mines.

Une lampe de sûreté ordinaire a été modifiée de manière qu'on puisse lui adapter le système de l'harmonica chimique. Le tuyau chantant dans lequel brûle la flamme de la lampe se trouve relaiu d'un téléphone communiquant avec un autre téléphone au jour, placé dans le cabinet de l'ingénieur et à portée de sa main.

Si l'on place alors la lampe dans une veine à grisou, le gaz en brûlant modifie, comme on sait, la flamme suivant la proportion dans laquelle il se trouve mélangé à l'air de la mine. Il en résulte dans le tube des sons différents et qui sont transmis intégralement au jour avec toutes leurs variations par l'intermédiaire des deux téléphones.

L'ingénieur peut donc ainsi commodément se rendre compte à chaque instant de la quantité de grisou qui règne dans l'atmosphère de la mine à une profondeur quelconque, et sans avoir à se déranger de son cabinet.

M. Ader, [illegible] telephone receiver without diaphragm, composed simply of an iron wire called [illegible] and surrounded by a solenoid helix. [illegible] considered the sounds to be due to longitudinal vibrations, the core being lengthened and shortened by the magnetising current acted on did not act. With suitable apparatus he has now proved the important principle that all kind of magnetic nature submitted to [illegible] action of compression, tension, or traction, tend to recover their original molecular arrangement under influence of a current, magnetised body. (In these experiments the circuit was only closed momentarily.)

A New Telephone.

A feature in the new Ekenas telephone is its distance from the instrument at which conversation may be transmitted, without raised or to a perfect whisper. An exhibition was recently given in Montreal at which the Daily Witness says: "parties present stood at twenty paces from the mouth piece, and subsequently went into an adjoining room at least forty feet away, and the conversation was thence carried on, in both cases as clear and perfect as if within the usual six inches necessary in the Bell telephone, and without the slightest raising of the mouth piece, as in the case of the Edison. And this was done with the lock turned on the instrument equally as well as when facing it. Whispering messages were transmitted, the words coming sharp and clear from the instrument with perfect ease and distinctness. A Mr. Blake, of Montreal, has the sole appointment for the Dominion for the Ekenas telephone users, a very important central office system, by which subscribers could be put in instant communication or notified with the least possible delay by the central office. The improvement is to be made to introduce as soon as he has organized a sufficient exchange. It should be stated that the batteries and general appliances and the mode of operating are almost the same as in the Bell telephone, but, if anything, less complicated."—*Exchange.*

The Hoover Telephone.

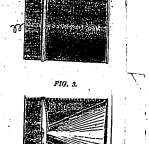
We give herewith [illegible] illustration of what may be called a mechanical telephone. It is not operated by either electricity or magnetism; but consists of a simple arrangement of metallic diaphragms, placed in intensifying drums and connected by a copper wire. The instrument is known as the "Hoover Telephone." It is being largely introduced and gives very good satisfaction over short distances. Hitherto it has not been used over a space exceeding one mile, but the proprietors have no hesitation in putting it up and guaranteeing satisfaction over any ordinary line. This telephone transmits the voice as faithfully and as distinctly as the Edison or Bell telephone, and costs much less, being furnished, with appliances for a call, at the [illegible] low price of $16 each, with an addition of five cents per rod for whatever wire is needed to make the connection between the two points. The costs of wire is also added for such fixtures, springs and battery as will be required in putting up and sustaining the wires. Insulators, five cents each. A complete telephone, without a call, is furnished for $6, the cost of wire, insulators, etc., to be added as in the first instance. Figure 1 represents a sectional view of a telephone complete, or rather of one transmitter of the same. As previously observed, is funnel-shaped, and will be used for speaking into the voice at the center of the diaphragm, from whence the vibrations are transmitted by the wire, as shown, to a similar instrument at the other extremity. In the lower portion of the instrument, as shown, there is a mechanical call, which, by the use of the spring, may be used at pleasure to cause a small hammer to beat rapidly upon the inner side of the diaphragm, the sounds from which are conveyed by the wire to the telephone at the other extremity, where they are repeated so loudly and so distinctly as to arrest attention almost as readily as the ordinary [illegible] bell. Figs. 2 and 3 represent a perspective and sectional view of the instrument without the "call." The only method of calling with these instruments is by a rapid tapping of the pencil on the diaphragm. Such a call answers very well for short distances, and where the call is not expected to arrest the attention at any great distance from the instrument.

For connecting an office or store with a factory, a physician's office or store with a residence, a private residence, an upper with a lower floor, and for many other useful instruments as well, even every practical purpose, it is cheap and can be sent by express, C. O. D., to any part of the country, with all necessary directions for putting it up and operating. We have one of these instruments to connect our editorial rooms in the front with the composition rooms in the rear of a long building, running from street to street. Quite a number are also in use in various parts of the city and in Oakland. Sold by the Hoover Telephone Co., room 54, at 526 Montgomery St. Send for circulars, which will give all particulars.

FIG. 1.

FIG. 2.

FIG. 3.



THE HOOVER TELEPHONE.

On the 26 inst. an outbreak was announced in the City Council of Chicago, looking to placing all telegraph and telephone wires in the ground. It was referred to committee.

CINCINNATI, July 31.—A company, the capital stock of which is chiefly owned by the Bell Telephone Company, has been formed in Cincinnati with the purpose of testing experiments for submitting the Edison telephone with Europe. A Bell telephone to French capitalists will be secured. The arrangements, it is thought, will be completed in a few days. The process upon which the proposed system is to be done is based upon the Orangfengh invention a year ago by the French Khoun physicist. Ample capital has already been raised for completing the plan. Several Eastern capitalists are reported to be interested in the enterprise. The trials will be made from New York City. Only the combination of the Bell, the Edison, and the Gray patents, the exclusive use of the Bell, the Edison, or any of the instruments now in active use, as the case may require, so that they are actually infringing upon many claims of invention, and the question will probably be fought out in the United States courts. It is believed that the Bell Telephone Company has already [illegible] by the [illegible] of the experiment is $200,000.

The Electrician, June 11th 1881

THE ORIENTAL TELEPHONE COMPANY (LIMITED).

The first ordinary meeting of the Company was held on Friday, June 3rd, and a full report appeared in our Special Edition of June 6th. The Chairman (John Pender, Esq., M.P.) referred to the great progress already made by the telephone, and spoke very hopefully of its future. The work of the Company would be first developed in Egypt, and he trusted that early in the winter months telephones will be at work in Cairo and Alexandria. A concession has been obtained from the Egyptian Government which was very satisfactory. In India the Company has a free field for development. The Oriental Telephone Company and the Telephone Construction Company, Limited, are working. The Hon. C. S. Hubbard also referred to the work in Egypt, and hoped interest shown in telephonic matters. Hesolute was also passed, as containing 100 subscribers to the telephone system. A vote of thanks to the Chairman was proposed, seconded, and carried unanimously.

ON SOME THERMAL EFFECTS OF ELECTRIC CURRENTS.*

By WILLIAM HENRY PREECE, Assoc. Inst. C.E.

I HAVE been engaged for some time past in experimenting on the thermal effects of electric currents, but the final results of these experiments are not sufficiently ripe at present to justify my bringing them before the Royal Society. I have, however, obtained one result which I believe to be sufficiently novel to justify a short preliminary note.

The most striking facts elicited by these experiments are :—

1. The extreme rapidity with which thin wires acquire and lose their increased temperature.

2. The excessive sensibility to linear expansion which fine wires of high resistance evince.

Now as the rate of heating, and therefore of expansion and contraction, varies very nearly directly as the increment or decrement of the currents, when these variations are very small, it occurred to me that if a long wire of small diameter and high resistance were attached to a sounding board, or to the centre of a disc (such as one of those used for telephones and phonographs) and it formed part of a circuit conveying telephonic currents, sonorous vibrations ought to be reproduced.

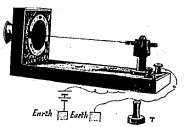
The sketch shows the arrangement of the apparatus used for the experiment.

It consists of a stout base of mahogany, on which a brass support was attached so that it could slide and be fixed at any distance from the upright at the further end of the base board.

A disc of thin paper, and then of thin iron, was mounted on the upright.

The wire experimented upon had its ends connected to terminals on the wooden base, so that it could be inserted in a circuit consisting of a microphone transmitter, T, and a battery of six bichromate of potash cells in another room out of hearing.

A platinum wire of 0·003 inch diameter and six inches long from end to end was first used, and the sonorous effects were most marked and encouraging, when the microphone transmitter, T, was spoken into. The articulation, though muffled, was clear, and words could easily be heard.



1. Experiments were first made to determine the length which gave the loudest sound and the clearest articulation, and, after repeated trials with every variation of length from one inch to six feet, it was found that a wire six inches long gave the maximum effect.

2. Experiments were then made to determine the diameter of the wire that gave the best effect, and after repeated trials with every gauge drawn from 0·005 inch to 0·001 inch, it was found that wire of the diameter 0·001 inch gave the best effect.

3. Experiments were then tried with wires six inches in length and 0·001 inch diameter of different materials, viz., gold, iron, aluminium, silver, copper, palladium, and platinum, and they came out in the following order of merit :—

Platinum	...	...	Very clear.
Aluminium	...	...	Very variable.
Palladium	...	...	Clear.
Iron	...	...	Clear.
Copper	...	...	Faint.
Silver	...	...	Faint.
Gold	...	...	Very poor.

4. The effect of mechanical strain was tried. It was found not to vary the effect. When once the requisite tension, which varied with each metal, was obtained, further tightening up did not vary the clearness or loudness of articulation.

Gold would scarcely bear the tension required to reproduce sonorous vibrations, hence its low position.

5. Very thin carbon pencil, 0·025 inch diameter, was tried under compression and under tension, but no effect whatever was experienced unless a bad joint was made, when at once a faint microphonic effect was apparent.

6. No sibilant sounds whatever could be reproduced.

7. That the effect was due to heating and cooling was shown by the fact that it was possible to increase the current to such a strength as to render the temperature of the wire sensible to the touch, and then to make its elongation and contraction by low sounds evident to the eye.

It therefore appears from these experiments, that wires conveying those currents of electricity which are required for telephonic purposes expand and contract as they are heated and cooled, and as the variations in the strength of the current are small compared with the strength of the current itself the expansion and contraction vary in the same ratio as the condensation and rarefaction of the air particles conveying the sonorous vibrations which produced those vibrations.

The mechanical changes, or molecular vibrations in the wire, due directly or indirectly to telephonic currents, which result in the reproduction of sound, bear a close analogy to the mechanical changes due to the direct transmission of sound, but with this important difference, that while the vibrations due to sound are progressive along the wire, and their velocity is low and easily measured, those due to thermal effects are practically instantaneous, and therefore affect simultaneously the whole length of the wire.

* Read before the Royal Society, May 27th, 1870.

TELEPHONIC EXCHANGE REPORTER.

Devoted to the Business Interests of Telephonic Exchanges.

VOL. 1, NO. 1. CINCINNATI, OHIO, U S. A., AUGUST, 1880. MONTHLY. $4.00 PER YEAR.

The Blake Transmitter.

The Microphone is the most abused instrument in the business. Half the inspectors don't get the swing of the thing, and don't seem to care to. If the gas meter is taken away and breaks the ground, a new microphone is suggested. If a switch lever strikes wood and leaves line open, something is "off" with the microphone. If a line wire contracts with the positive,—"just put in a new microphone." Two battery wires are short cut by one staple, and the microphone needs adjustment.

The fact is that not one microphone out of a hundred is wrong. Not one out of hundred which seems wrong need be run in for repairs. We propose here to explain the dark points of the microphone and explain the method of showing its fault if the fault is really in it, and also the method of locating the faulty spot, if it is in the microphone, and that with the tools, &c., always carried by an inspector.

The cut on this page shows the essential bowels of a microphone, arranged for easy explanation.

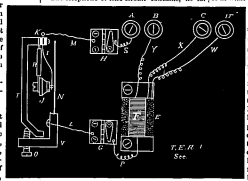
DESCRIPTION OF MICROPHONE.

Battery wire comes to binding post B. The circuit goes to primary coil F, composed of a few layers of coarse wire, thence by curl P to hinge G, thence by wire L to back frame V, thence through screw O, and adjusting bar T to spring R, on the end of which is a weighted carbon button J, thence through carbon button and platinum bead to spring I, which is insulated at K, thence by wire M to hinge H, thence by curl S to binding post A, thence to battery, thus forming a short local circuit, including a battery, a primary coil and a delicate carbon and platinum contact. The insulated diaphragm N bears against the platinum bead, and any movement of the diaphragm, by the voice or otherwise, alters the degree of pressure between the platinum bead and carbon button. Any alteration of pressure alters the conducting power at this point, and thus varies the intensity of the current which the battery is sending through the primary coil F. Under the jarring effect of the voice the contact at J is constantly altering, and thus giving a series of impulses to the current passing through the primary coil.

Notice that this battery circuit is entirely local, and does not go to line or to anything which has not been mentioned.

The line wire with telephone and other apparatus in circuit goes to binding post D, thence by curl to secondary coil E, composed of many layers of fine wire wound outside of the primary coil F, thence by curl to binding post C, thence to ground or continued line.

The telephone or line circuit contains, so far as the microphone is concerned, only the secondary coil. When a current passes through the primary coil wire it induces a strong current in the secondary coil wire, and thus sends the microphone impulse to the line. This induced current is the same as is produced on a telephone line by a telegraph line running near it and parallel with it.



In the microphone the wires are simply coiled on one spool for the sake of compactness. Such a rig is called an induction coil.

NEW MICROPHONES.

New microphones may be put up without any test or adjustment whatever. Seldom one needs anything but proper connection. They should be fixed perfectly plumb and against a solid wall or partition. As we are saying nothing about call boxes now, we will presume that the microphone is in good shape and properly connected up, and that trouble happens, and that the microphone is suspected.

FIRST EXAMPLE.

Bells ring all right, answers come all right, but the whole microphone and telephone business seems dead.

Questions. Is the fault in the microphone? If so at what point and how can it be fixed.

Procedure:—Disconnect the outer wire from the posts C and D, and splice the wires together. Now call up and use the telephone, for talking and listening. If it won't work the fault is *not* in the microphone and it must be tested for in the call box. If the telephone does work all right the fault *is* in the microphone. To locate the faulty spot, set up the battery near the instrument so as to be handy. Run a short wire from battery to binding post C. Disconnect the telephone from the call box and connect one telephone cord to the battery. Listen at the telephone and touch the other telephone cord tip to the binding post D. The telephone should remain silent when you make and break. If you hear noises in the telephone you have made a mistake in the former test which put the fault on the microphone, in such cases connect up in shape and try again, for the microphone is not at fault. There should, if the fault is in the microphone, be no noise as you make and break when testing for the spot. Now, with a knife skin back the silk where the curl wire W goes under the binding post D, and touch on naked wire. If you get a noise you have the fault located. The curl wire W does not make good connection with the binding post D. Investigate, repair and try touching on the binding post D. You should get noise.

WORLD-WIDE EXTENSION.

An Improvement Destined to Revolutionize the Present System of Working Submarine Cables—Dear prices of the Marvelous Machine.

[Special Dispatch to the Chicago Tribune.]

Boston, Sept. 21.—The Daily American to-morrow will publish a description of an improvement destined to revolutionize the present system of working submarine cables. Arrangements have been perfected for the purpose of introducing and carrying out these improvements, was formed in New York about three ago. The chief general have of that State, and all composed of capitalists prominent in that city, with several Bostonians. It has been quietly and secretly at work for more than a year, and its existence is rumored to-day only because the submarine cable, connecting New York City directly with Brest, in France, commences. It is an American enterprise, and the invention, under lieutenant of the American work, which have received the recommendation of Prof. Torrelliby, of Harvard; Prof. Silliman, of Yale; Prof. Bolbest, of Yale, and other scientific men of note. The invention has been patented with great secrecy, and from time to time it has been examined by several scientists; and during the meetings of the American Association in this city, by several of the most prominent members. The instruments, all constructed in this city, have been set up in large rooms in the Equitable Building, and a connection with a submarine cable has been established, and tested by the invention and electricians of recognized reputation. The various apparatus form a new and complete system for working submarine cables and land line, and they are: A submarine repeater relay to be used in connection with the submarine repeaters, and by means of which the weak current, after it has passed, and the submarine system will be strengthened and renewed, so that it may be increased many fold over the present feeble impulses of mechanical construction which are capable at their full capacity of polishing fifty-eight Roman letters per second, or 3,480 per minute, or, allowing six letters for the average word, 580 words per minute. The speed at which the printed record is determined by the clip at the operator only; and instruments for working the submarine system on cables of the several inventions. Most important is the submarine repeater, to be submerged in the ocean. This consists of a bronze globular zone six inches in diameter, molded at a material which is supposed to be able to resist the rust of the sea-water for many years. In the case or globe, hermetically sealed, is the complete mechanism which performs the functions of an ordinary two operators at the bottom of the sea in mid-ocean without the aid of human intelligence at that point. In the use of the submarine repeater, a cable of any length, say 2,000 miles, may be divided in the center into any number of lengths of 1,000 miles each, and a repeater of the kind described be used between each of the lengths. Therefore, four three greater than on a circuit or cable of 2,000 miles. Consequently, one cable connected by the submarine repeater would be equal to four cables worked in the usual present Atlantic cables. Another important feature of the submarine repeater is to make it practicable to operate a cable twice the length of the present Atlantic cable—3,000 miles in length, which is supposed as present cables are worked. Thus a cable might be worked between San Francisco and China, where the distance is nearly 6,000 miles, and would be put practicably or paying speed by the present. The system of working the submarine cables and receiving are to be used in connection with the submarine repeater. The parts are an entirely new principle. The syntax of working the submarine instrument is most simple, more so than the Wheatstone, of the so called "Fast Rapid." The number of keys is but two, and over a cable by these new instruments is limited only by the number of impulses which can be sent through and in the case of this new company's cable it will be over 4,000 [illegible]

TELEPHONE EXTRAORDINARY

Conversation Across the Atlantic.

The Loose of an Ocean Cable.

Cincinnati Enterprise Again Ahead.

In this busy world of ours devoted, as in outward appearances it may be, to the most practical details of every day life, there is a poetry as genuine as any ever sung or written in the so-called heroic eras. In fact, it is often the lack of antiquity alone that sheds the light in which modern poets weave their fancies. There are numbers who will dwell with delight upon descriptions of the Palace of Xerxes at Shushan, or the hanging gardens at Babylon, but who would ridicule the idea that any modern work of man's hands could present a theme for poetry or supply food for the exercise of the imagination. Nevertheless it is undoubtedly true that it is in the union of the most practical knowledge that true fancy finds the richest germ. Modern science is full of a poetry of the thoughtful and loving care of the legends of the past, and the ancient poets as all the traditions upon which even Homer founded the Iliad, as delightful as the best medieval stories of fairy land, as charming as the Oriental tales of Fatima and Scheherazade, splendid as they are in all the luxuriance of the Oriental imagination of Haroun Alraschid and the Nights of Arabian literature.

The latest truth is that in all their fertility, in all their marvelous inventions into the realm of that which, in them, was the transcendental, intangible and invisible domain of the unknown, the ancients had but a faint hint of "all the wonders that were to be." Their greatest minds, in the solemn air of their misty fairyland, had but a dim conception of the wonders to-day, and the ever nature is to-unlevel them to the light of day. Even the "winged words" of the mighty bards of Greece were but vague and indefinite shadows of the truth which is now being unfolded before us in the possibilities of the telephone. Dupe said, speaking of Homer, that England, by means of

> Many things there are that mighty be,
> But none are mightier than men,
> For he can cross the stormy sea,
> And speak the truth in Ilyria.

Shakspere, in *Hamlet*, followed, in a measure, perhaps, the same train of thought, when he said:

> There are more things in heaven and earth,
> Than are dreamed of in our philosophy.

As the transmission of articulate sound by the telephone is among the latest and the most extraordinary marvels of the age, so it is one of the most wonderful facts in the history of the development of science that lines which have already by fifteen years been in practical use for the transmission of messages spasmodically by telephone, even its most rudimentary form, Page said, something perhaps precisely:

> Repeat the swift intercourse from soul to soul,
> And as a flash from heart to heart be told."

This is very nearly true of the telegraph; in its latest, most perfected form, the telephone. Even in its infancy, Mr. Bell, therefore, is favored in some of words-wire interest a clergyman, who, in a sermon, said that the latest development of the telephone is that consisting in itself interest for the scientific and the practical, yet possibly millionaire and the statesman, to make sure how wise known how to gild with the golden light of poetry the mysteries of the most severely practical application.

It so happened, then, that in the different mechanical, gifted with a particular bringing his peculiarity in peculiar circumstances, was the Cincinnati Enterprise, which, on Thursday, Tuesday, Tuesday, Tuesday, Tuesday, Tuesday, of what was then known of electricity, and was the most wonderful of all machines. Before the banana absorbed in his work, nothing, animated, but so much by the desire to win a wife, as by the love of science, he had invented an improvement on one of the telephones then in use, the guiding star of all his investigations. He perceived the idea of the propagation of sound in the spiraling coils of the telephone, and he set to work to [illegible] for this he knew was then [illegible] for the wife and family that made his [illegible] happy. The invention was [illegible] Bell's telephone, and [illegible] for [illegible] in the middle of all nations. [illegible] ever, no sooner taken possession of his mind than his whole nature seemed to undergo a change. He was no longer the [illegible] he was before. During the process of [illegible] competition [illegible] inventing, which [illegible] his wife left him, [illegible] of the most [illegible] of [illegible] July friends, they should be called—removed [illegible] [illegible] [illegible] [illegible] seem to tell him that at last the [illegible] Hutchison had fulfilled his promise, [illegible] was the largest room in the city. [illegible] lessons and students were already [illegible] [illegible] [illegible] [illegible] [illegible] by the old or "vibrating-needle." Both was, indeed, the first, and the Stenograph [illegible] [illegible] [illegible] [illegible] [illegible]

There is an immense spring near on the West Dolores, about six miles from Rico, just across from the head of Horse gulch and near the base of Cullen peak, that has an ebb and flow that is quite singular. The basin is about 25 feet in diameter and in the morning is always full of water, but in the evening it is perfectly dry and empty. The water is cold and apparently of good quality, and the basin gradually fills to overflowing when it as slowly recedes, effervescing violently all the time. The discovery was made by a prospector who passed it in the morning when full (the basin was full, we mean) and returning at night it was empty. He watched it with the result mentioned above. It is exciting considerable curiosity in that region.

SWANSEA.—The British Association formally opened the telephone line between the Guildhall, Swansea, and the waterworks (8½ miles). Whilst they were in Swansea, the president congratulated the contractor on its success, and spoke very highly of the instruments used (Gower-Bell). It is expected that a Gower-Bell Telephone Exchange will be shortly established at Swansea.

THEILER'S PATENT TELEPHONE TRANSMITTER.

FIG. 1 represents the outside appearance of the instrument, the dimensions of which are only 5 in. by 6 in. by 1¾ in., so that the whole apparatus, containing induction coil, microphone, automatic switch and bell push, is of very small bulk. The transmitter may either be screwed or hung against a wall like a picture, and as its appearance is by no means clumsy or awkward the instrument may be fitted up in a drawing-room without disfiguring its surroundings.

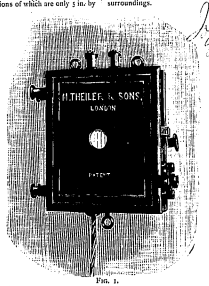


FIG. 1.

There being no adjustment of any kind, variation of temperature, &c., cannot disturb the position of its component parts.

The funnel which is required for speaking into with other transmitters is entirely dispensed with in the new transmitter. The use of such a funnel, particularly in those transmitters which require rather loud and close speaking, is not free from objection.

FIGS. 2 and 3 represent the inside of the transmitter, and show the peculiar form of microphone which, after innumerable experiments with every other possible form, was found to be the best.

It is a diaphragm of Swiss pine wood or of cork. The former substance makes a highly sensitive diaphragm, while the latter is more remarkable for the great distinctness of articulation produced.

To this diaphragm two cylindrical pieces of any conducting substance, B B (fig. 3), are cemented in a parallel line, and a connection is made from these cylinders to the battery and primary circuit of an induction coil, I I, in the usual way. The circuit is closed by the rod, A (which is also cylindrical), suspended on a silk thread from the diaphragm at an angle of about 25 degrees. The nearer this suspension approaches to the perpendicular the more sensitive the transmitter becomes, but as extreme sensitiveness also includes the transmission of any, even the feeblest, noise, and imparts to the articulation a peculiar metallic twang, it was avoided by suspending the rod, C, at an angle of 25 degrees.

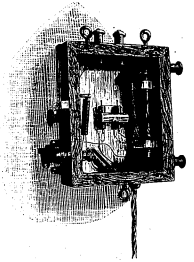


FIG. 2.

It will be seen that the incidence of the suspended contact piece with the fixed ones forms mathematically four sharp points, which are, however, free from the great liability to breakage or wasting away which *actual* sharp points would possess.

This feature was found to be essential to the production of a clear articulation. As there is no friction of surfaces in this arrangement, that grating rasping articulation so peculiar to common microphones is totally absent in this transmitter.

The contacts, as well as the points of suspension, being all on the diaphragm itself, it does not at all matter whether the tension of the latter be altered by change of temperature, &c., or not. If the fixed contacts should, from any such cause, change their position, the suspended contact would follow them, and their relative position would practically not be altered.

If the diaphragm is vibrated very violently (by shouting against it), the suspended piece, C, would separate from B B altogether, and produce a harsh sound in the receiver. This can be entirely prevented by the stop, S (fig. 3), which is adjustable in the bridge, B, and does not allow the piece, C, to separate from B B entirely. It is not as immaterial as is generally believed, or has been asserted, what kind of battery is used with a microphone transmitter. On the contrary, the results obtained will

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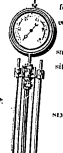


Manufactured and sold by

O. M. LEONARD

36 JOHN STREET,

NEW YORK.

Amer. Gas Eng. Telephone in Coal Mines.

Oct. 11 1879

London *Iron* has the following upon this subject: — "There are different connected with the application of electric lighting to coal mines, which, however, are not insuperable; but there can be none to the use of the telephone as a means of communication between the miners and the upper world, as well as with the authorities underground. The advantages of the telephone would be manifold in the ordinary routine of the pit. In the untimely accident to which, however, it is in use, the engineer above is able to satisfy himself as to the condition of the pumping machinery in the parts of the works the most difficult of access, by merely listening to the sounds given out by the valves, etc., independently of the advantage of sending immediate advice or instructions on an emergency; and it is evident that, in case of an explosion, were the wires properly protected, the communication they would afford with workmen suddenly entombed alive would be of the utmost importance.

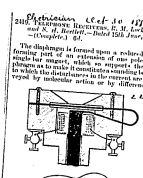
On this last account the establishment of means of instantaneous communication with those employed in mines has, we are informed, been already enforced by one of the Australian Legislatures."

* This diagram not printed.

Electrician Oct 30 1878

2402. TELEPHONIC RECEIVERS. *E. M. Locke and S. A. Bartlett.*—Dated 15th June, 1878. (Complete.) 6d.

The diaphragm is formed upon a reduced arm forming a part of an extension of one pole of a single bar magnet, which so supports the diaphragm as to render it capable of vibration according to which the disturbances in the current are conveyed by molecular action or by difference in



degree of polarity in different parts of the pole, to which it is connected, rather than by any mechanical vibration of the diaphragm due to its attraction to and repulsion by the coil. The figure shows the diaphragm at the end of the magnet.

2465. NICKEL PLATING. *J. Wetter.*—Dated 19th June, 1878. (Complete.) 4d. *Engineering*, 7 June, p. 1.

This consists, first, of a metallic electro-deposition solution to which benzoic acid has been added; secondly, of a metallic electro-depositing solution to which citric or other salicylic acid has been added; thirdly, of a metallic electro-depositing solution to which sulphic or pyrosulphic acid has been added; fourthly, of a combination of the above solutions; fifthly, the combination with the solutions, either or elements of nickel or nickel salts, of an electro-depositing metal; sixthly, of the single or double salts of nickel to which benzoic acid has been added; seventhly, an electro-depositing nickel solution to which potassium or sodium has been added either with or without the bisulphite of soda.

Telegraph Journal

Mr. H. C. Page, of Springfield, Mass, has lately patented a Dental attachment for telephones, by means of which persons having defective hearing can hear. The arrangement consists of a disk of rigid sound-conducting substance, such as wood or hard rubber, connected with the centre of the diaphragm, or with a disc attached to the centre of the diaphragm, and is supported by an elastic fulcrum attached to the mouth-piece of the telephone. The further end of this disk is held by the teeth of the deaf person, and the vibrations can thus be transmitted to the auditory nerves. The under surface of the disk is provided with an elastic coating which prevents the vibrations from affecting the teeth of the lower jaw.

THE phenomenon lately discovered by Hall of the action of a magnet in altering the path of a current of electricity in the conductor which carries it, has formed the starting-point for two investigations, which have appeared separately in the *Wiener Anzeiger*, by Bottomson and Von Ettingshausen respectively, in which they point out that this discovery may be applied to determine the absolute velocity of electricity in a conductor.

TELEPHONING ABROAD.

Electrician Oct 30 1878

The Belgians Take to the American Innovation—Novel Objections to Housetop Wire-Running—A Queer People's Queer Ideas—The "Rail-roader" Among the Flemings.

ANTWERP, BELGIUM, Aug. 19.

Telephoning is attended with a good many drawbacks, it seems. Everything has gone along smoothly with the International Company (Hubbard's) until lately, when the other concern (Bell's) commenced intriguing so much that parties who allowed the putting up of frames on their houses protested, and, in a good many instances, what had been erected was taken down, and the wires had to find other directions. The concession for the International Company has not been obtained yet, and, considering the influences and leagues brought to bear, it may take some time yet to get it. All the subscribers, and many others, signed a petition to the government to obtain it; but, on the other hand, Bell and his people got parties to protest, and among the protestations is that of the pigeon-flyers, who pretend that the net work of wires keeps the pigeons from flying; that a good many have been killed on account of it, and that it destroys the appearance of the city's architecture, &c. Others protest because the wires pass over their houses, (though not touching) such alleging that the volume of air above his property belongs to him, and is interfered with on account of the wires passing through it.

The Burgomaster is favorable to the intentions; but in the Council are gentlemen who are adverse, and the "telephone question" looks as if it might be the matter of two new political parties—the telephones and anti-telephonists. Where it will end, I don't know. Wherever established, the instruments give the very highest satisfaction, and I have heard people say that they would not be without the telephone for 5,000 francs. The people heretofore have a good deal to learn yet, and they can't accept progress without discussion.

Secrets to the Railroaders. It is a very interesting paper. Possibly I may be able to do something for you in the way of subscriptions. Many of the railroad employes speak and read English. Q.

[A few words in explanation of the above: Two companies are undertaking to do a telephone business in Antwerp, the commercial City on the European continent. These are the International Co., of New York, introducing the Bell and Blake instruments, and the Bede Co., who have exact copies of the Bell and Blake apparatus. To transact a business of this kind legally, a "concession" must be obtained from the government. This, the international people, after six months' endeavor, have yet been unable to procure. Nefarious competition of no ordinary sort account. So the contest is one of long-continued haggling between the International Co. and the Belgian government. Besides, the Bede people are comparatively poor, are inexperienced, and do their work clumsily, but have, over from the government, and patronage from the people on the ground that theirs is a Belgian company. So it is—highly Belgian—for it is based on piracy. But the Belgians naturally regard foreign innovations with a jealous eye and Bede is gaining popular sympathy. The fight is going on throughout the Kingdom, and is making considerable excitement. Meanwhile the Americans are spending money like the wind, and will keep up their end as long as the "beer" holds out.

The pigeon-flyers of Antwerp are a numerous body and possessed of some influence. "Antwerp carriers" are famous as the fanciers in the world.

The old, quaint and interesting architecture of Antwerp is indeed disfigured by the wooden "standards" of the telephone companies. Many of them are of enormous size, such as are nowhere erected in the United States, and resemble derricks more than anything else. The whole town has been made to look like a mast yard. It is no wonder that citizens are indignant.

All employes on Belgian railways speak two languages—Flemish and French. Many of them speak German and English also, and trainmen more or less familiar with half a dozen languages are not uncommon. Most of the notices to the public, in the cars and at the stations, are printed in Flemish, German, English and French.—ED. RAILROADER.]

[From the Scientific American.]

Some Experiments with Small Batteries.

M. L. Baxter, M.D. Elect 1 1878

To illustrate the capacity and sensitiveness of the telephone, I tried a small battery made in a common tumbler with a carbon and zinc pair, and a solution of ammonium muriate as an exciter. The common salammoniac will answer all purposes.

This battery I included in a circuit with a Hughes microphone and a telephone; and instead of the monotonous ticking of a watch or clock, I used a musical watch with quite a range of tone. By the use of this watch the capacity of the microphone for transmitting high or low tones with their complimentary overtones may be studied and regulated.

With the battery above described I obtained all the tones clearly and well, and tried with it what effect different depths of immersion would have. One of the claims in Professor Bell's first patent on undulatory currents covers varying immersion as a means of varying the current, but I found very little difference in the operation of the telephone when the carbon plate was withdrawn, so that merely a corner touched the surface of the liquid in the battery. This led to the withdrawal of the zinc plates also, until only its corner touched the liquid. Under these circumstances the diminution in volume of sound was very slight, the tones coming out full and clear. The zinc plate being held clear of the solution a dead silence resulted, and the transition from this to full tone ensued with the slightest possible contact.

These phenomena led me to construct very minute batteries, and the progress step by step was very interesting. One arrangement of a pair shows the battery in, to me, a new light. It is this: Make up a circuit of a microphone, a telephone, and a continuous copper wire, and, of course, there is silence in the telephone. Cut the copper wire, and to one of the ends attach a bit of zinc. Bring the ends together again and silence ensues as before; but allow the bundredth of an inch clear space to intervene and bridge the gap with a drop of battery solution, and the telephone at once finds its voice, not loud, to be sure, but clear and distinct for most of the notes.

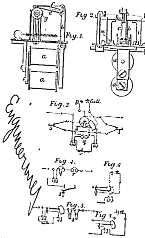
Such a "battery" as this may be even concealed in the connecting wire by being covered by the usual cotton or silk insulating covering, two or three thicknesses of tissue paper between the ends preventing metallic contact. A gum cap battery with zinc and sulphuric acid gives a strong current for the microphone circuit.

Discarding the zinc, as being too readily consumed, I have made pairs with carbon and gold, carbon and platinum, platinum and gold, zinc, and in no case have I failed in getting results; but the currents are too weak for practical uses. Two pieces of carbon, even, have diffusive enough in their structure to determine a slight current appreciable by the telephone. The study of these combinations, though not of apparent importance, is interesting, and, where all are groping, may shed a ray of light upon something else.—Washington, D. C., June, 1880.

In connection with the subject of telephonic communication, we may mention that one of the largest brewery companies of Wurtemberg, Germany, ago completed a telephonic line of 30 miles, and this stimulated the idea, and now, everywhere tried the Government telephone service, [illegible] have them applied generally on their system.

Engineering

1328. Telegraphic and Telephonic Apparatus: W. R. Lake, London. *(E. Davis, Cambridge, and P. A. Dowd Boston, Mass., U.S.A.)* [1s. 39 Figs.]—Relates to the giving of visible and audible signals by means of an electric current by the combination of two or more instruments in one circuit, each instrument consisting of an electro-magnet with two or more armatures, and mechanism actuated by the movement of the said armatures, or by clockwork controlled by one of the armatures, the said mechanism being so contrived that any one of the instruments can be so set as to sound a local alarm on any one of a number of instruments on a circuit without causing the other instruments to signal. In one form of instrument one "heavy" current, one light current, and one heavy current sent in succession will so move the parts of one of the instruments as to sound the alarm, but will not move any other instrument in the series, each instrument requiring a particular arrangement of strong and weak currents to affect it. The instrument consists of an electro-magnet with two armatures, one held up by a weak spring and one by a strong one, so that one responds only to a light current while both are moved by a strong one. The motion of each armature will move a ratchet wheel one step by a pawl, and an insulated leaf spring is so arranged with reference to each wheel that metallic contact is made with each wheel at a certain point in its revolution, these springs being the terminals of a local circuit. The instrument at station



No. 1 of circuit No. 1 has its wheels so formed that when it is "at unison" the leaf springs are both out of metallic contact with the wheels; if station No. 1 of circuit No. 1 is to be called from the central office one heavy current is sent over circuit No. 1, and both armatures are moved and both wheels revolve one step. The wheels are so shaped that a metal projection from the wheel of the heavy current armature is brought so close to its leaf spring that another motion of the armature will bring it into contact with that spring, while the projection from the wheel of the light current armature requires two motions to bring it into contact with its leaf spring. A light current is now sent over circuit No. 1, thereby moving the wheel of the light current armature, and this is followed by one heavy current which moves both wheels, and brings both projections into contact with their respective leaf springs to establish the local circuit. Stations 2, 3, 4, &c., have similar instruments, but differently adjusted, no two being alike, so that only one station is ever called at a time. The wheels may be brought into unison, that is, to the zero or starting-point, in a variety of ways, among which the following is preferred: In each ratchet wheel a tooth is cut away to form a blank space. The pawl of the strong current armature works upon both wheels, but the pawl of the light current armature has two hooks upon it at different levels, one of which works one wheel only, but when it rests in the blank space of that wheel, the pawl falls low enough owing to the shape of that blank space to bring the other hook into gear with the teeth of the heavy current wheel, and this heavy current wheel is revolved by the light current pawl until the hook rests in the blank space of that wheel also, the heavy current pawl, extending across both wheels, being in readiness to move them. After a station has been called a number of light currents are sent along the line to put all the instruments to zero. Fig. 1 is a side view of the instrument and Fig. 2 is a front elevation. From these two figures the general arrangement will be understood; *a* is the magnet *b c* the armature, *e f* the pawls, *g h* the wheels. Each wheel is shown with an arm *i k* projecting from its shaft which comes in contact with one of the blocks *l m* of insulating material, in which are the metal pieces *n o* included in the local circuit *p*, so that when the arm *i* is in contact with the piece *n* and the arm *k* with the piece *o*, the local circuit is complete. Another form of the said instrument consists of a notched wheel worked by a step-by-step motion or by clockwork. A third form consists of two armatures, each controlling a wheel, but both wheels on the same shaft. These armatures may be both permanent magnets, so arranged that a positive current will attract one of them and a negative current the other. Secondly, the invention relates to a system of circuits, in which the novelty consists in the arrangement of a series of calling instruments and a series of telephones in a single circuit so that the telephones are all cut out of the circuit when on their holders, and each telephone is brought into the circuit by cutting out its calling instrument by means of a suitable switch operated by putting the telephone on and taking it off its holder. Thirdly, the invention relates to a secret system whereby no telephone can be used until its calling instrument is properly set. The wire from the telephone to the main line is connected to an insulated spring on the instrument, and a wheel comes into contact with it when the instrument is set for calling, and this contact completes the connexion to the main line. The diagrams 3 to 7 illustrate this secret system, and also the signalling by a local circuit, and the electrical connexions of one of the instruments alluded to above. In them *q r* are the coils of the magnet, *s* is the telephone, but the various courses possible to currents under different circumstances are too intricate for description. Fourthly, the invention relates to a central switch for connecting any two or more of a large number of circuits by a combination of a switch board and movable pieces described and illustrated at great length. (March 21, 1880).

over

Journal Tel. Nov. 1. 1880

INDUCTION AND THE TELEPHONE.—According to the *Daily News* a highly important discovery has been made by a firm in Neuchatel. They have devised a means of completely preventing the induction of the electric current from one wire to contiguous wires. This invention will greatly promote the efficiency of the telephone and extend its use. Nov 27 80

Electrician

21 Journal of Tel

Another Use for the Telephone.

London Iron:—The first formal assault upon the position of the city companies is, it seems, about to be made by a body of disaffected silversmiths, who, although not perhaps from the highest motives, deny the legal right of the incorporated Goldsmiths of the city to hall-mark their plate, on the ground that the members of the company are not, as their charter constrains, practical craftsmen. As far as the public are concerned, however, both in the case of gold and silver utensils, and in the more important matter of assaying gold for the Mint, there is no injury done, as the manipulation in these cases is confided to competent experts, and the assays have, especially of late years, been remarkable for their extraordinary exactitude. According to a statement in the leading journal, it seems likely that before long cupellation will be at least partially superseded by the telephone, which has already been employed in thermometric experiments, and will doubtless prove capable of utilization in other and unlikely ways; for it may almost be regarded as, by very greatly extending the powers of one sense, conferring another on mankind. Professor Roberts, the chemist to the Mint, has discovered that equal and similar volumes of various metals and alloys have each a different effect on an electric current flowing around a coil. If two coils are connected by a wire, and a coin, say of perfect weight and fineness, is placed in one of them, a disturbance of the current is produced which an attached telephone will indicate. But if an equally perfect coin is placed in the other coil the balance is restored and the telephone is silent. If, on the contrary, either should be base or light, and the other genuine, the telephone immediately gives tongue. Nov 1st 1880

Scientific American.

AN IMPROVED TELEPHONE.

The engraving shows an improved form of telephone receiver and transmitter, and a very convenient combination of the two instruments, lately patented by Mr. John P. McDermott, of Galveston, Texas.

The combined instrument is designed to be worn upon the head, as shown in Fig. 1, so that the user may hold telephonic conversation without regard to position, and listen without fatigue or inconvenience to lectures, concerts, etc. This arrangement possesses the advantage of excluding extraneous sounds and of preventing bystanders from hearing what is said in the transmitter. The receiver magnet consists of thin strips of magnetized steel having a U-form and adapted to the head. The ends of the magnet are curved to receive the support for the diaphragms, mouthpieces, and bobbins. The iron cores of the bobbins are inserted in the curved portion of the magnet.

Nov 27 1880

The transmitter is attached to the receivers by a swinging elastic yoke, which renders it adjustable to the mouth of any user and admits of readily removing it from the mouth when not in use. A cloth band passes around the back of the head to hold the apparatus in its proper position. The compound magnet is covered with silk or other suitable material. This covering conceals the primary and secondary wires and protects them from injury.

The transmitter consists of a non-conducting mouthpiece, and a chambered hemispherical block containing two semicircular plates of carbon insulated from each other, and connected by a wire with the two metal pieces forming the yoke which supports the mouthpiece. A plane disk of carbon rests upon the two semicircular carbon plates and is free to vibrate upon them.

The primary current passes through the yoke and through the carbon disk and the two semicircular carbon plates. The variations of contact produced between the three carbon surfaces by the action of sound waves on the carbon disk disturb the primary current, inducing undulatory currents in the secondary wire of the induction coil.

The primary and secondary circuits differ little from the common practice. Mr. McDermott has dispensed with a special call bell magnet, using the magnet of the induction coil for the purpose of operating the bell hammer armature.

This arrangement of telephone transmitter and receiver possesses many obvious advantages; for example, it would be very convenient in cases of writing by dictation, or of stenographers recording speeches. Persons may remain at home listening to public addresses, sermons, or concerts, sitting comfortably and listening without the slightest inconvenience.

This invention enables two persons to carry on a conversation as readily as if they were in each other's presence. As the entire apparatus weighs but a few ounces, its weight is not at all noticeable. It is unnecessary to point out the further advantages possessed by this novel arrangement, as

entirely chimerical. It has frequently been noticed that heavy cannonading is followed by a fall of rain. Profiting by this suggestion, Mr. Ruggles has invented a method of producing a concussion or a series of concussions in the upper regions of the atmosphere which he believes will induce rain.

The invention consists in brief of a balloon carrying torpedoes and cartridges charged with such explosives as nitro-glycerine, dynamite, gun cotton, gunpowder, or fulminates,

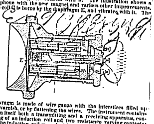
Fig. 2.

McDERMOTT'S TELEPHONE.

NOTHING NEW.—The wires stretching across the road in connection with the telephones recently adopted by the Monk Bridge Iron Company, Leeds, were recently caught by a fire-escape with so much force as to bring down a chimney-stack to which the wires were attached, and considerable damage was also caused to the roof of the building. Nov 27 1880

Electrician

1738. Permanent and Electro-Magnets, Telephones, &c.: S. Russell, Brooklyn, U.S.A. [6d. 12 Figs.] —The compound magnet consists of a plate with two series of rods projecting therefrom, one series being in a cluster at the centre, and the other arranged in a circle surrounding and enclosing the first. For a permanent magnet the apparatus is constructed of steel, and for an electro-magnet of soft iron with a coil of insulated wire between the two rings of rods. When used for a telephone, the coil is small enough to allow all the rods to vibrate without coming into contact with it. The illustration shows a telephone with the new magnet and various other improvements. The coil C is borne by the diaphragm E, and vibrates with it. The



diaphragm is made of wire gauze with the interstices filled up with varnish, or by flattening the wires. The instrument contains within itself both a transmitting and a receiving apparatus, consisting of an induction coil and two resistance varying contacts; O is the induction coil wound with two wires *h* and *i*, *h* being connected to the line, and *i* to the local battery circuit in which the varying contacts $g g^1$ are included, *g* being attached to the diaphragm, and g^1 being carried on a cushion of a soft and elastic nature which may be more or less compressed by the screw *m*; *a* and *b* are the centre and circumferential poles, of opposite name, of the magnet, which is also applicable to telegraph relays. April 28, 1880).

THE GOWER-BELL TELEPHONE.—"An interesting telephonic feat was on the 16th December performed with the Gower-Bell loud speaking telephone, erected in the telegraph office of the London and South-Western Railway Station, presided over by the superintendent of the department, Mr. Rolls. The telephone was successfully used between Exeter and Yeovil Station, a distance of forty-nine miles, with perfect success. Conversation was maintained, accompanied with laughter and whistling, between the two places with much facility and satisfactory distinctness."—*Exeter and Plymouth Gazette.*

Sensitiveness of the Telephone.

MR. W. H. ASH, of the Eastern Telegraph Company, Porthcurnow, Penzance, in a communication to *The Electrician*, gives an account of some investigations he has recently made, demonstrating the extreme sensitiveness of the telephone.

There are two cables landing at Porthcurnow, one from Vigo and the other from Lisbon, both of which happened to be broken at the same time, the former in Vigo Bay, the other about 730 miles from Porthcurnow. The two cables are joined together through a telephone. "The other two ends being so far away," he says, "I was curious to know what I should hear, and was very much surprised to hear Morse signals. After listening some time, I found

Téléphonie.

Dans la séance de l'Union électro-technique de Berlin du 26 octobre dernier, M. Elsasser a fait une conférence sur les installations téléphoniques dans les grandes villes, sujet qui tient aujourd'hui en Allemagne une des premières places dans les questions d'intérêt public; car l'administration des télégraphes de l'Empire est, comme on le sait, sur le point d'installer des bureaux téléphoniques à Berlin, à Mulhouse et se propose également d'en établir dans d'autres villes d'Allemagne. Ce savant expose les avantages qu'offre le téléphone pour les communications locales rapides, et les raisons pour lesquelles les installations téléphoniques urbaines n'ont pas encore pris sur le continent la même extension qu'en Amérique et en Angleterre, où des circonstances particulières ont favorisé tout spécialement le développement de ce moyen de communication dans les grandes villes. Le motif principal pour lequel le besoin d'installations téléphoniques ne s'est pas encore fait sentir sur le continent, doit être surtout rapporté à la nature des relations sociales et du trafic, et aussi à la disposition des habitations qui, dans les villes d'Europe, généralement très-anciennes, sont le plus souvent très-restreintes dans leur grandeur. Ainsi dans celles de ces villes où des compagnies particulières ont obtenu l'autorisation d'établir des bureaux téléphoniques, il a fallu beaucoup de temps pour obtenir un nombre d'abonnés suffisant pour permettre l'organisation de ce genre de correspondance. D'un autre côté, l'invitation faite à Berlin aux particuliers par l'administration des télégraphes de l'Empire, pour qu'ils aient à participer à une installation de ce genre, n'a pas obtenu jusqu'ici le succès que l'on aurait pu espérer en présence de l'activité commerciale et industrielle de cette capitale. On peut cependant espérer qu'il se produira plus d'empressement aussitôt que les avantages résultant de ces installations seront plus connus et mieux appréciés. C'est dans cette prévision que va être installée prochainement à Berlin une organisation téléphonique du genre de celles d'Amérique. A Mulhouse, en Alsace, l'administration des télégraphes doit livrer dans le courant de cette année, à l'exploitation, un bureau téléphonique qui compte déjà plus de 60 abonnés. Les prix d'abonnement ont été fixés par l'administration à un chiffre moins élevé que dans tous les établissements de ce genre à l'étranger. M. Elsasser s'étend ensuite sur les conditions d'abonnement que nous avons déjà rapportées dans notre numéro du 15 juillet, et après avoir montré des spécimens de tous les appareils employés dans les différents bureaux téléphoniques, il explique leur fonctionnement. Il prétend que le système d'appareils des installations téléphoniques allemandes, pour lesquels il a été tenu compte des expériences faites en Amérique, en Angleterre et à Paris, est plus simple et en même temps fonctionne plus sûrement que ceux en usage à l'étranger. Les appareils installés chez les abonnés sont renfermés dans une boîte de construction uniforme et qui renferme un téléphone transmetteur, un téléphone récepteur et une sonnerie électrique mise en mouvement par des courants de pile provenant du bureau central. Le système des communications est à peu près le même que celui qui est en usage dans toutes les installations de ce genre. Si un des abonnés, par exemple l'abonné n° 3, veut entrer en conversation avec l'abonné n° 36, il avertit par une pression sur le bouton de son appareil d'appel, le bureau central, qui établit aussitôt la communication demandée avec le n° 36. Les deux abonnés peuvent alors parler entre eux immédiatement. Pour indiquer que la conversation est terminée, le n° 3 met encore une fois en mouvement son appareil d'appel; un signal visible est alors produit au bureau central, et après son apparition, le bureau effectue l'enlèvement de la communication.

A la suite de la communication de M. Elsasser à la Société électro-technique de Berlin, M. le docteur Bris, ingénieur des télégraphes de l'Empire allemand, a fait une communication sur l'installation des câbles souterrains allemands, et il a montré que les résultats qu'ils ont fournis ont dépassé toute attente.

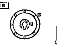
1705. LIQUID COMPOUND FOR THE ELECTRO DEPOSITION OF ALUMINIUM, *L. A. Davies.—Dated 26th April*, 1880.—(*Not proceeded with.*) 2*d*.

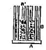
To common alum is added ammonia, the precipitate formed being alumina. This precipitate is then thrown on to a filter paper and washed, and redissolved in a hot solution of neutral tartrate of potash. This solution is then evaporated nearly to dryness and redissolved in sulphuric acid. This salt is then crystallised out of the solution and the crystals dissolved in water. This solution forms the bath, which is then ready to be used for the deposition of aluminium.

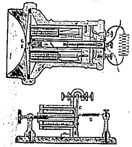
1738. IMPROVEMENTS IN PERMANENT AND ELECTRO MAGNETS AND ELECTRIC TELEPHONES AND TELEPHONE CIRCUITS.—S. *Russell.—Dated 28th April*, 1880. 6*d*.

The inventor's ideas with regard to electromagnets will be best gathered from the illustration. The figures show an end view, and a longitudinal mid-section, partly wound. From the plate A two annular series of slender bars B B, B^1 B^1, those marked B B being arranged at the circumference of the plate, those B^1 B^1 concentrically near the centre, the number and sizes of the bars in each series being equal. The wire is wound in the space between the two series of bars as shown at C. The inventor claims that such magnets when used in telephones increase greatly the sensitiveness of the instrument. In the remaining figures the magnet, the coil, the case of the telephone, and the other parts are shown with the magnet arranged electro-magnetically with an armature, E, having a retracting spring, S. The magnet used with a telephone transmitter is shown, and it is stated that the magnetic poles being

1738





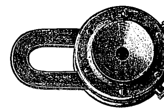


slender, vibrate in sympathy with the diaphragm. The coil C is here borne by the diaphragm E and vibrates with it, while the poles vibrate laterally. As the coil vibrates it moves to and from the neutral position of the magnet, and thus varies the mutual inductive actions, increasing the sensitiveness and power of the instrument. E is made of wire gauze instead of sheet iron, the interstices being filled up by hammering. The larger figure shows an arrangement of transmitter and receiver. The transmitter is arranged at the centre of the magnet. It consists of two resistance-varying contacts, G G^1, the contact G being fixed to the centre of the diaphragm, and the contact G^1 pressed lightly against it. The contact G is preferably of metal, with a platinum tip, and the contact G^1 is preferably a button or block of carbon, but other materials may be substituted for them.

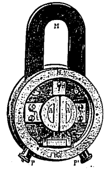
IMPROVEMENTS IN TELEPHONES.

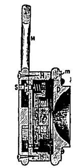
BY W. E. FEIN.

In these telephones the cores of the magnets do not consist as usual of a bar of soft iron, but of a large number of iron wires, or plates insulated the one from the other. By this arrangement the electro-magnets change their magnetism much quicker under the vibrations of the diaphragm, thus increasing the effect of induction; further, the form of the cores differs from that usually adopted; owing to the section being segmentary a general central attraction of the diaphragm is the result, which exercises a great influence on the purity of the sounds. The segmentary armatures are surrounded by semi-circular coils; by adopting this method the space is fully utilised, the coils are wound with the greatest possible length of wire, so that these telephones will act over a long distance and through a large resistance. The improved telephones do not need any particular alarum; a little



reed tube is sufficient to produce an easily audible signal at the receiving station. The engraving (Fig. 1) gives the outer view of the telephone exactly one third the ordinary size; Fig. 2 shows the internal arrangements, the mouthpiece and the diaphragm being taken off; Fig. 3 the transverse section. The poles of the steel horseshoe magnet M are provided with the armatures T T' which project from the sound box, so that the curve can be employed as a handle; moreover, the size of magnet that can thus be obtained increases considerably the magnetic force, which has a favourable influence on the efficacy of the instrument. The cores A A' are formed like a segment of a circle; the centre of the segment is on the same line as the centre of the diaphragm. By this construction the attraction





and the vibrations of the diaphragm are rendered uniform, the tones of the voice being clearly transmitted. The distance of the electro-magnet from the diaphragm is regulated by a special arrangement. Between the bars of the steel magnet is placed the lever O; one of its ends is adjusted so as to move between two screw points, the other end is held by the screw S, by turning which the adjustment is made. A strong spiral spring prevents any getting out of place. The head of the screw is on the outside of the box, and can be turned by a screw driver. The two electro-magnets A A' are fixed to the lever O, so that they follow its movements, sliding between the armatures T T'. The ends of the wires are connected to the terminals P P' which receive the line wires.

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Mining & Scientific Press
July 2 1877

NEW TELEPHONE.—A new acoustic telephone has been recently introduced by E. F. Edgecomb, of Mechanics Falls, Maine. When in connection with the compound wire, of three strands, which is also made by Mr. Edgecomb, conversation can be easily carried on. The ticking of a clock 20 ft. from the instrument can be heard at the other end of the wire, the diaphragm of the instrument is so sensitive. We also learn from a Boston journal that Prof. Hosmer, of Cook's College, Medford, Mass., has invented a telephone that promises a great improvement over those in general use, and immunity from many of the chronic disorders of present systems.

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Menlo Park Scrapbook, Cat. 1037

No. 23. "Tasimeter and Electric Light"

This scrapbook covers the years 1878-1882. The first nine pages contain clippings about Edison's tasimeter and Alexander Graham Bell's photophone; the remainder of the book relates to electric lighting. There are 140 numbered pages.

Blank pages not filmed: 110-140.

Tasimeter. 1037.

23

London Times Oct 29 1878

EDISON'S TASIMETER.

With the first news which reached us respecting the observations made during the recent eclipse there came an announcement which perplexed even some of the astronomical elect. We were told that Edison—"the modern magician," as his fellow-countrymen call him, the inventor of the phonograph and of other instruments only less wonderful, the man who "to amuse himself," as he said, had shown how a hole might be talked through a deal board—had announced with his tasimeter the heat of the sun's corona. Few European astronomers know precisely what manner of instrument Edison's tasimeter might be; some even had not heard of it. Electricians were better informed. Edison had been somewhat loudly calling their attention to the instrument, under a mistaken impression that his ingenious fellow-countryman, Professor Hughes, had borrowed his ideas and exhibited a similar instrument here. But even electricians were not able to give a satisfactory account of the method by which the tasimeter had indicated the heat of the corona. A brief description of the instrument, or rather of its general features, and an account of what it has done and promises to do hereafter will, we believe, be interesting to our readers.

The property on which the invention depends seems to have been discovered by Edison independently about the year 1873. It was, however, recognised so far back as 1866, if not earlier, by Clerac, electrician of the French Government Telegraph Department. It is this: that the electrical resistance of carbon varies to a marked degree under very slight variations of pressure—in other words, if a current of electricity has a circuit, part of which is formed by a piece of carbon, then very slight pressure applied to that piece of carbon will cause the current to pass more readily, appreciably diminishing what is technically called the resistance of the carbon to the passage of the electric current. This property, as we have said, is not an original, though doubtless it was an independent discovery of Professor Edison's. The practical application of the property to measure very small changes of pressure, and thus to measure changes of temperature, moisture, and other conditions, by causing these changes to produce changes of pressure, must be regarded as wholly Edison's.

The simplest form of the tasimeter (the tension, or pressure, measurer) may be thus described:—A flat button-shaped piece of compressed lamp-black, forming what we shall call, for convenience, the carbon button, is held between two discs of platinum. One of these is the head of a screw fixed into a stout upright and holding against that upright a larger and thicker disc of vulcanite, through whose centre the screw passes. The other platinum disc is retained in its position against the carbon disc by the outlying ring of vulcanite. Thus there are three small flat discs, the middle one of carbon, the two outside ones of platinum, imbedded in a larger disc of vulcanite, which is held against the upright by the screw projecting from one of the platinum discs. It will be understood that a certain thickness of vulcanite intervenes between the last-named disc and the stout upright, except, of course, where the screw pierces the vulcanite. The thickness of this interposed part of the vulcanite is about the same as that of each platinum disc end of the carbon button between them. The entire thickness of the vulcanite is equal to rather less than four times the thickness of these several discs, so that the outermost face of the outer platinum disc lies a little outside the face of the vulcanite disc. This outer platinum disc bears, opposite the screw of the other, a metallic cup. One end of a horizontal strip of whatever material is to be tested or employed to produce varying pressure on the carbon button rests in this cup. The other end of the strip rests in a cup supported by another stout upright, by turning which screwhead this cup may be made to advance or recede horizontally in such sort that the pressure on the carbon button may be suitably adjusted to begin with. If the reader has followed this description, he will see that the strip of matter to be tested or used in the experiment is supported in a horizontal position between two stout uprights projecting from a rigid base, and that, at one end rests in a cup carried by a platinum disc in contact with the carbon button, any expansion of the strip in length must increase the pressure on the carbon button, while any contraction in the strip must diminish this pressure. The carbon button and its platinum neighbours are imbedded in the large vulcanite disc, simply that any such change of pressure may be freely communicated to the carbon button, while yet the strips can be freely interchanged, the vulcanite holding the small discs in situ without interfering with the pressures which the outer ones exert on the central one.

So far the description relates only to mechanical adjustment. The carbon button is so placed that it will undergo greater or less pressure according as the strip of material between the uprights expands or contracts. It is now necessary to make the carbon button part of the circuit along which an electrical current runs, so that the property discovered by Clerac may come into play. To this end, a wire from one pole of a galvanic battery is brought into connexion with one of the platinum discs, while a wire from the other pole is brought into connexion with the other platinum disc. So soon as this is done the current passes from one pole along one wire, through the carbon button, and along the other wire, to the other pole. A galvanometer is made to form part of the current's track, or, in other words, the current on its way passes round and round a coil of wire surrounding a magnetic needle (or rather, one of a pair of opposed needles which exactly neutralize each other so far as terrestrial magnetism is concerned), and the intensity of the current is measured by the deflection which the needle experiences while the current is passing. It will be manifest, then, that since carbon possesses the property of varying in resistance to the electric current as it is more or less compressed, the needle of the galvanometer will respond to any changes in the condition of the carbon button. If the button is compressed its resistance will diminish, and the needle will indicate the passage of a stronger current, or its index end will move further from the zero point. If the pressure on the button is diminished, the needle, by moving towards the zero point, will indicate a weaker current, in consequence of increased resistance by the carbon button.

Those who are familiar with the use of the thermo-electric pile (for convenience called the thermopile) to indicate small changes of temperature will understand how the tasimeter, in the form just described, may be compared with the thermopile. The thermopile itself is formed of bent strips of bismuth and antimony combined together in such a way that when heat falls on one face of the thermopile, an electric current is caused to flow along a wire connecting the first of the antimony strips with the last of the bismuth strips. A galvanometer is made to form part of the circuit, as in the case of the tasimeter, and by testing the indications of the galvanometer the strength of the current is ascertained, and hence the degree of heat to which the face of the thermopile has been exposed. Having, then, a galvanometer of a certain degree of delicacy, we take the two wires of a thermopile—one from the first antimony strip, the other from the last bismuth strip—and bring them into connexion with the coil of the galvanometer; then we expose the face of the thermopile to various sources of heat, noting the indications of the galvanometer. Next, separating the galvanometer from the thermopile, we make it form in turn a part of the circuit of the tasimeter,

as above described ; then we expose the strip of matter between the uprights to the same sources of heat to which we before exposed the face of the thermopile. If the galvanometer indicates similar degrees of deflection, the teatimeter and the thermopile are least measurers of similar delicacy. If, however, greater or lesser degrees of deflection are produced when the teatimeter is used, the teatimeter is much more delicate than the thermopile, and vice versâ if much the greater deflection is produced when the thermopile is used.

Thus tested the teatimeter shows a very marked superiority over the thermopile. The *Scientific American* states that when a thin strip of hard rubber was used, the expansion caused by the heat of the hand held a few inches from the rubber sufficed to produce a deflection of several degrees in the needle of a galvanometer as "ordinary" (that is, as inferior in sensitiveness) that it was not affected in the slightest degree by a thermopile facing and near to a red-hot iron. From another source we learn that with a similar galvanometer a gas jet five feet away caused the needle to move four degrees. A match burning at a distance of six inches caused a deflection of 21 degrees. Breathing slightly on the rubbing caused a deflection of 20 degrees. Those who have attended Professor Tyndall's lectures on "Heat" will remember that he exhibited with the thermopile experiments scarcely known for more surprising. The minute quantity of heat generated when a piece of cold brass was rubbed once along the surface of a cold piece of wood caused strong deflection, even when the brass was brought for an instant only in contact with the face of the thermopile. And, as the lecturer said, would have brought the needle into violent contact with the stops, and destroyed the magnetism, if the brass had been allowed to remain in contact a single second. But the greatness of the deflection was due to the extreme sensitiveness of the galvanometer employed by the lecturer. With the galvanometer used by Edison in the experiments we have described, no effect whatever would have been produced by the slightly-heated brass brought against the face of a thermopile. With the galvanometer used by Tyndall, the heat of the burning match at a distance of ten yards would have sufficed to throw the needle against the stops. In our experiment Edison's little finger produced with the teatimeter an effect six times greater than a red-hot iron with the thermopile, the distances being the same in both cases.

With the teatimeter, even in this form, slight degrees of pressure produced effects much more than by heat can be readily measured. Thus in one series of experiments Edison interposed a film of gelatine between the uprights to measure increase of dampness produced by three inches of water on the tip of the finger, held five inches away, deflected the needle 17 degrees. A lighted cigar at the distance of nearly a foot dried seven degrees in the opposite direction from the preceding one, because the gelatine contracted in this case.

With a very slight modification of form, also, the teatimeter is a very delicate weighing machine. The pressure produced by the weight of a tiny shred of paper produces a sensible deflection of the needle. The weight of the smallest insect can be measured, while a tobacco worm causes the sound made by the insect's feet to be clear. We do not dwell, however, on these applications of the instrument, because it is not here that the originality of Mr. Edison's teatimetric researches resides.

Although the teatimeter in the form above described is far more delicate heat measurer than the thermopile, the power of the instrument can be greatly increased when still more delicate investigations are to be made. For this purpose the part first described remains unchanged, but the ordinary galvanometer used for conventionally rough researches is replaced by one of Sir W. Thomson's reflecting galvanometers. This marvellously delicate measurer of the galvanic current was originally devised, as our readers will remember, to indicate the feeble electric currents transmitted through the Atlantic cable when it was being laid. As in the ordinary galvanometer, a needle-shaped steel coil of wire surrounds a magnetic needle, but the coil consists of a far greater number of turns, and the magnet is not only far more delicately poised, but its movements are indicated in a much more obvious manner. The magnet itself is made of a piece of fine watch-spring about 1-inthe of an inch long, and not weighing more than a grain. It carries a tiny mirror slightly concave. Facing this mirror, and about a yard from it, is set a horizontal graduated scale, beyond which is placed a lamp, the rays of which, shining through a hole below the scale, fall on the mirror, and are by it reflected to the zero or middle point of the scale. This tiny point of light is virtually the extremity of an index 360. long, extending from the mirror. The least movement of the mirror causes the point of light to traverse a considerable arc of the graduated scale. Thus, when a current traverses the coil which would be far too feeble to affect the needle of an ordinary galvanometer, and which even affects the needle of the reflecting galvanometer so slightly that ordinary vision could not detect its motion, the mirror, sharing in this slight motion, sways round the converging light-beam which forms its long index, and the point of light, perhaps, one ray say), and the point of light moves in a manifest manner along the graduated scale.

Such a galvanometer largely increases, of course, the delicacy of the teatimeter. To introduce it effectively another change must be made. The current must be regulated so that the light beam of the reflector may initially fall exactly upon the zero of the scale. For this purpose the contrivance called a Wheatstone's bridge and a Rheostat are introduced into the circuit. The teatimeter, thus reinforced, as to speak, is able to indicate the minutest changes of pressure, and, therefore, of temperature, moisture, or any other conditions affecting so readily the pressure exerted on the carbon button. It is hardly necessary, perhaps, to point out that the very delicacy of the combination, while rendering the movements of the index so obvious, increases the necessity for care in the use of the instrument, and caution in drawing inferences from its indications. When a very feeble source of heat, for instance, has to be detected, the slightest currents of unequal warmth by multiplied trials under different conditions must be carefully excluded. Thus, if the source to be dealing with, and be generated by bring the heat from that source to bear on the strip of vulcanite or other substance the expansion of which causes increase of pressure on the carbon button. Even with the thermopile extreme care is necessary in delicate researches. For instance, an astronomer who was endeavouring to measure the heat received from a star of the first magnitude found at the beginning of his researches that when by shifting of the telescope he brought the light and heat of the star upon the face of the thermopile the galvanometer very obviously indicated heat ; but he soon found that this heat was due in the main to the movements of the telescope, not to the rays of that remote sun. Since Edison expects (potentially, in our opinion) to be able to measure with his teatimeter the heat from a star invisible in the very telescope used to survey the star's heat to the teatimeter-strip, it will be understood that the utmost care must be used to prevent the access of any heat resulting from mechanical movements. Edison is, of course, fully sensible of the difficulties arising from the extreme delicacy of his teatimeter. How he proposed to overcome some of them during the recent eclipse will be seen from the following account of his original plan, which, however, he was unable to carry out in all its details in practice :—A fasimeter of smaller size, and having its framework of brass, was to be enclosed in a receptacle of tin, which, in turn, was to be placed within another receptacle of the same metal. The space between the two was to be filled with boiling water to preserve evenness of temperature, because boiling water attains no higher temperature than the boiling point, and the boiling point at any given station undergoes no appreciable change in any short time. Moreover, a complete pressure is changing with altogether exceptional rapidity.

Edison was defeated during the recent eclipse, so far as the measurement of the corona's heat was concerned, in a different way, though the extreme sensitiveness of his instrument was in reality the cause of his defeat. So soon as he allowed the adjustable image of the corona to fall on the platinum strip (which he used in preference to vulcanite, as more sensitive to heat), the index-point of light which had been set to the zero of the scale sped right off the scale. The image of the corona was immediately shifted from the platinum strip, but it was too late. Before the index returned to the scale totality was over. A result less sensitive would unquestionably in reality have served much better, but, of course, Edison had not any means of estimating beforehand what amount of heat might be expected to reside in the rays of the corona. Professor Young, of Princeton, also failed to obtain satisfactory results from a teatimeter with which he had been provided by Edison. But, not to be foiled, he used a thermopile, and, though he was unable to measure the corona's heat, he obtained evidence agreeing with Edison's in showing that the heat of the corona is not enough to be made manifest without using contrivances of exceptional delicacy.

It is not solely, or chiefly, however, for astronomical purposes that Edison proposes to use the teatimeter. He has already taken steps to use the instrument for the measurement of vessels at sea. The carbon button can be arranged to act as a highly sensitive thermometer, and enclosed in a case connected with the keel of a ship. Wires will run from this case to a galvanometer in the captain's room. Thus any change in the temperature of the water will be at once indicated. The approach of an iceberg would be known long before there was any danger of collision. The teatimeter might also be arranged to act as an exceedingly delicate barometer, to give warning of fire, to indicate slight changes in the humidity and temperature of the air, and in physical researches for which the thermopile has been used with but partial success. In fact, we venture to predict that before many years have passed the teatimeter will be found among the most effective of those instruments by which science has endeavoured to solve the mysteries of molecular physics.

Ebenezer Rann Redfield

THE TIMES, TUESDAY,

NOVEMBER 5, 1878.

THE TASIMETER.

TO THE EDITOR OF THE TIMES.

SIR,—Mr. Edison having recently been good enough to send me the latest form of his teatimeter, the first, I believe, that has made its way to Europe, it may be of interest to some of your readers to have independent testimony as to the extraordinary delicacy of this novel instrument.

The principle of the teatimeter, as explained in the recent article in *The Times* on the subject, consists in slight changes of pressure upon a button of carbon, producing variations in its electric resistance, revealed through the indications afforded by a delicate galvanometer. The secret of success in this instrument, and in the carbon telephones which depends upon the same principle, consists in obtaining a sufficiently conducting mass of finely divided carbon. By a happy accident Mr. Edison hit upon some lamp-black deposited on the chimney of a smoky petroleum lamp, and this material into a button answered the purpose admirably. Hence it is from this source that all the carbon buttons are at present made.

It has been stated that Mr. Preece was the first to discover the electrical effect of pressure on carbon, but I have not met with any reference in support of this statement. H. Gilme made artificial resistances, or rheostats, of tubes filled with charcoal for telegraphic purposes ; but with this material no change in resistance of any utility in telegraphy can be obtained by variations in pressure. A well-known French electrician—the Count du Moncel, I believe, the first to notice that some slight difference in the resistance of the circuit was produced by pressing surfaces in sterile contact more or less closely together ; but this observation had not attracted much attention until recalled by Edison's invention in 1876 of the carbon "relay," the progenitor of his carbon telephone, carbon tlosetral, and micro-tasimeter. All these instruments depend upon the principle, which Edison, I think, was unquestionably the first to discover, that certain in a state of fine division undergoes a considerable diminution in the electric resistance when slightly pressed. That squeezing the particles of a semi-conducting powder more closely together should augment its conductivity is what might have been anticipated ; but that any appreciable variation in conductivity could be produced by so minute a variation, or by the movement of a screw through a space of, say, a millionth of an inch, entirely transcends all expectation, and yet this is the case. The microphone is a very remarkable instrument, and it is evident that Edison was familiar with the true principle of the microphone when he produced that "noise maker" ; for as yet it is little more, was made known by Professor Hughes in the early part of the present year. In fact, twelve months previously Mr. Edison, it seems, had to all intents and purposes discharges microphones, and rendered them unsuitable for telegraphic purposes. As however, this remarkable man, in his eagerness to press forward, has published no account of the modicum of experiments that have led up to his many and valuable inventions, Professor Hughes is entitled to all the credit of having independently discovered and first published the simple and novel arrangement that constitutes the so-called microphone—a word, by the way, first used by Wheatstone in 1827 to designate a simple acoustic apparatus he had devised for detecting or locating feeble sounds. Those of your readers interested in pursuing this subject I would refer to the fuller description and illustrations that will appear in the forthcoming and succeeding numbers of that excellent periodical *Nature*.

Returning to the tasimeter, in its present form the instrument differs considerably from that described in *The Times* a few days ago, although the essential parts are the same. The object of this modified arrangement is to insure greater sensibility and protection from accidental sources of disturbance. A sketch of the instrument will

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THE UNSEEN UNIVERSE AND THE TASIMETER.—The extreme delicacy of Edison's teatimeter has been proved during the recent solar eclipse, and we now hear that the latest pressing project of Mr. Edison is to employ it in exploring those blue fields of the night sky, which to the eye are void of stars, in order to discover the unseen orbs which transit them. His plan is to adjust the teatimeter in the focus of a telescope, then attach it to the exploring telescope, when, if in any particular direction of the heavens there is a marked and invariable deflection of the teatimeter, it may safely be inferred that there is an unknown world in line. "Seeing," says the *Scientific American*, "that the teatimeter is affected by a wider range of etheric undulations than the eye can take cognisance of, and is with all far more acutely sensitive, the probabilities are that it will open up hitherto inaccessible regions of space, and possibly extend the range of our real knowledge as far beyond the limit attained by the telescope as that is beyond the narrow reach of unaided vision. Possibly too, it may bring within human ken a vast multitude of newer bodies—latent out suns or feebly reflecting planets—now unknown because not luminous.

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be given in the next number of the *Telegraphic Journal* (Nov. 15), but meanwhile the following brief description may be of interest to some of your readers:—The carbon button is held fast within an insulating cup in the centre of a small but massive brass base; resting on the button is a light metal disc which supports a slender strip of vulcanite, about an inch long and a quarter of an inch wide. Vulcanite is used on account of the comparatively large dilatation it undergoes when warmed, but a strip of blackened zinc is more prompt in its indications. The upper end of the vulcanite strip abuts against the base of a vertical screw, capable of an extremely fine motion by means of a worm-head gearing into a second horizontal screw. Attached to the milled head of the latter is a small pointer moving over a graduated circle. Each division in this circle corresponds to a motion of the fifty-thousandth part of an inch imparted to the vulcanite strip, and thus a corresponding small degree of pressure can be brought to bear upon the carbon button below the strip. A platinised cone converges radiation upon the vulcanite, which is enclosed in a metal casing except on the side opposite to the cone. The upper and lower faces of the carbon button are in metallic communication with a cell or two of a constant voltaic battery and with a delicate reflecting galvanometer of low resistance. A Wheatstone's bridge and resistance coils are also included in the circuit to balance the resistances of the carbon; and at first a "shunt" of thick wire is necessary to derivate through itself the greater part of the current, and so ratio the motions of the galvanometer needle. When the proper balance is obtained—the fine adjustment being made by turning the micrometer screw that presses the carbon—the shunt is removed and the instrument is ready for a test experiment.

The best radiated from one finger held near the cone is more than sufficient to drive the galvanometer under right across and off the scale. In a letter relating to this instrument, Mr. Edison writes to me as follows:—"By holding a lighted paper several feet away I have thrown the light right off the scale," and by increasing the delicacy of the galvanometer, "the instrument may be made so sensitive that the heat from your body, while standing 6ft. from and in a line with the coil, will throw the light off the scale, and the radiation from a gas jet 100ft. away gives a sensible deflection."

These statements—less extravagant than those that have appeared in some newspaper reports—are quite consistent with my experience of the instrument, and they show that the tasimeter is a marvellously delicate thermoscope, and as such, or as a means of detecting minute variations in pressure, it is a really valuable addition to the cabinet of the physicist. It is not, however, likely to displace the thermopile, electric pile in experiments on radiant heat; albeit, when the small area on which the radiation falls in the tasimeter is taken into account, it no doubt a more delicate thermoscope. In fine, owing to the narrow linear surface it exposes to the radiation, it will probably do good service in such researches as the study of the spectrum of lunar and solar spectra, and in registering the variations in the solar spectrum. But as regards delicacy, characteristic of the man, Mr. Edison has shown how the tasimeter may be used as an instrument for detecting the presence of moisture in the atmosphere. All that is necessary is to remove the carbon button from its cup, and in a strip of gelatine extended across the cup, when it becomes an hygrometer of surpassing delicacy. Other applications of the tasimeter, which, perhaps, Mr. Edison will allow me to suggest, is for detecting variations in the pressure of the atmosphere, and a new form of aneroid barometer it would doubtless give with extreme promptness and delicate indications, and thus be of considerable use to meteorologists. The application of the instrument for detecting minute changes in the length of a body is obvious, but I am not sure that, save in its use in very special native experiments, further information is necessary, and several minor modifications of the present apparatus are possible.

I am, yours obediently, W. F. BARRETT.

Royal College of Science for Ireland, Dublin, Nov. 1.

Telegraph Journal July 11878

EDISON'S THERMO-PILE.

One of Mr. Edison's latest inventive effusions is the carbon thermo-pile.' It is based on the principle of the carbon telephone, now so well elucidated by the microphone. The sensitive part consists of a cube of prepared carbon or charcoal, confined between two thin iron plates, and a fine slip of boxwood, split, inserted between the second plate, and a third metal plate or clamp. This sensitive arrangement is connected in circuit with a battery, and a galvanometer. When heat-rays are allowed to fall on the slip of horn, it expands lengthwise and presses on the charcoal, reducing the electric resistance of the latter proportionately to the pressure. There is thus a corresponding rush of electricity through the circuit, causing a deflection on the galvanometer. The arrangement is exceedingly sensitive, the heat emanating from the hand being sufficient to give a deflection of 10°, with a single cell, through a galvanometer of about 100 ohms resistance. It is said that Mr. Edison hopes to measure the heat from the fixed stars with it.

THE UNSEEN UNIVERSE AND THE TASIMETER.—The extreme delicacy of Edison's tasimeter has been proved during the recent solar eclipse, and we now hear that the latest pioneering project of Mr. Edison is to employ it in exploring those blue fields of the night sky, which to the eye are void of stars, in order to discover the unseen orbs which tenant them. His plan is to adjust the tasimeter to its utmost sensitiveness, then attach it to the reflecting telescope, when, if in any particular direction of space the latter there is a marked and workable deflection of the tasimeter, it may safely be inferred that there is an unknown world in that "Seeing," says the *Scientific American*, "that the undulations than the eye can take cognisance of, and are that it will open up infinite successive regions of space, and possibly extend the range of our real knowledge so far beyond the limit attained by the telescope as that is beyond the range each of unaided vision. Possibly too, it may bring within human ken a vast multitude of nearer bodies—dark and non-self-luminous.

EDISON'S TASIMETER.

A long description of Edison's tasimeter having appeared in the *Times*, and conveyed the impression that the instrument was in use prior to its invention were not sufficient to indicate to detect the heat of the heavenly bodies, Dr. Huggins wrote to say that he had measured the heat of the stars with a thermo-pile, and Mr. A. C. Ranyard points out that more than ago as 1812 Magrini, of Milan, found that the needle of a galvanometer in circuit with an old-fashioned thermopile was thrown at right angles to its zero position, though the heat of the moon was insufficient to affect it. So far as practical experience has yet gone, it would appear that the tasimeter is really too sensitive, the heat from the observer's body, from current of air and from other sources, have as great an effect upon it that it is difficult to distinguish the amount of deflection really caused by the celestial object, the best of which it is desired to measure.

EDISON'S TASIMETER.

Dec 5 1879

MR. PROCTOR ON THE SAME—THE STATEMENTS OF PROF. YOUNG.

To the Editor of the New-York Times:

I do not doubt that, in justice to myself, Mr. Edison, and Prof. Young, you will allow me to correct a misleading statement (unintentionally misleading, of course) in THE TIMES of Dec. 4. It is there said that, whereas Prof. Young very plainly stated that the tasimeter did not disturb the eclipse of the sun in 1878 answer the purpose for which it was constructed, I am as well satisfied with it that I have suggested its application to detect the presence of meteors, "not being aware, apparently, that in order to be effective it must be adjusted to every slight alteration in the position of a vessel." And, at the close of the paragraph, the writer remarks that it is a consolation to get correct information at last, though "the manner in which it is conveyed is calculated to mark the difference between field and platform astronomer in a way not complimentary to the latter"—a remark which (I would note by the way) appears to me to be in rather bad taste, especially as both the statements commented upon came from the platform. However, the only point I care to touch upon is simply that there was no contradiction whatever. My suggestion about the use of the tasimeter originally appeared in an article in the *Times* newspaper of Nov. 15, 1878, in which I carefully set forth the opportunity of testing the limit to which this photometer could be made sensitive, but we have spoken to and found pointed (a metre (135 yards) apart, and there seeing no reason to doubt that the results will be obtained at whatever distance a beam of light can be flashed from one observatory to another.

The photophone is operated with a Siemens spiral circuit, a telephone and battery. The light is passed through an orifice in an opaque screen consisting of a circular disk pierced with holes near the circumference. Upon rapidly rotating the disk an intermittent beam of light falls upon the selenium, and a musical note of persistent character is heard, the pitch of which depends upon the rapidity of the rotation of the disk. It was necessary, in order to reduce the tone to be practical, to devise an apparatus to be operated by the voice of a speaker, by which variations could be produced in a parallel beam of light corresponding to the variations in the air produced by the voice. A large beam is therefore concentrated by means of a lens upon the diaphragm mirror, and after reflection is again rendered parallel by means of another lens. The beam is received at a distant station upon a parabolic reflector in the focus of which is placed a sensitive selenium cell connected in a local circuit with a battery and telephone. A large number of successful trials have been made with the instrument so far apart that sounds could not be heard directly through the air.

After giving a detailed account of his many experiments, Professor Bell said that it is not only pleasant to remember these things and to speak of them, but it is a duty to record them, as they give a practical refutation to the often repeated stories of the blindness of scientific men to unsuccessful novelties, and of their jealousy of unknown inventors who dared to enter the charmed circle of science.

The photophone, Professor Bell said privately, is the invention he was known some time since to be perfecting, and the existence of which gave rise to the discussion in England and America of a supposed invention for seeing by telegraph.

HARTFORD, Saturday, Dec. 6, 1879.

Tel. Journ Sept 1 1880

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Telegraph Journal

THE PHOTOPHONE. Sept 15, 1880

At the session of the American Science Association, held at Huntington Hall, Boston, Mass., Friday evening, August 27th, Professor A. Graham Bell lectured upon his new invention, the photophone. The lecture was illustrated with diagrams, and the photophone was shown. Mr. Bell began by declaring that discoveries made by Sumner Tainter and himself had resulted in apparatus for the production and reproduction of sound by light. They began to experiment with selenium, a remarkable substance that has always been regarded as one of the curiosities of the arts; but the final result of their researches widened the class of substances sensitive to light vibrations until they are able to propound the fact that each sensitiveness is a general property of all matter; the only objects which yielded no results were carbon and thin microscope glass. Professor Bell said:

We find that when a vibratory beam of light falls upon these substances they emit sounds the pitch of which depends upon the frequency of the vibratory change in the light, and that when we connect the form or character of the light vibrations on selenium and probably on other substances we control the quality of the sound and obtain all varieties of articulate speech. We can thus, without a connecting wire as in the electric telephone, speak from station to station by means of a ray of light. In practice no three men have had better opportunity of testing the limit to which this photophone could be carried than I have had, we have spoken to and found pointed (a metre (135 yards) apart, and there seeing no reason to doubt that the results will be obtained at whatever distance a beam of light can be flashed from one observatory to another.

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Sept 1880

Manufacturer and Builder

DIAGNOSIS BY THE MICROPHONE.—The principle of the microphone in medical and surgical diagnosis has recently been lectured upon by Sir Henry Thompson, of London. He showed how a small acoustic wave is converted by it into a large electrical vibration, which is reconverted into sound at the diaphragm of the telephone, where it is rendered by the ear of the operator. Thus, in case of stone in the bladder, the minute wave transmitted through the sound on its impact with a very small stone, is so magnified that the operator is enabled to determine with certainty the presence of the smallest stone or particle of stone, or other foreign substance. These experiments, it appears, were conducted with a couple of steel sounds, each fitted with the microphone, and an artificial bladder, in which was enmeshed, in turbid fluid, a naturally formed uric acid stone, about as large as a pea.

IENTIFIC PRESS.

SCIENTIFIC PROGRESS.

A Delicate Instrument.

Prof. S. P. Langley, of the Allegheny observatory, read a very interesting paper at the recent meeting of the National Academy of Sciences, in New York, on the "Measurement of Stellar Energy," in which he described a novel and very delicate instrument, which he had found it necessary to devise to take the place of the thermopile, which he found was not sufficiently sensitive for his purposes. The apparatus is founded on the principle that a wire conveying an electric current be heated, if one electricity flows through it than before.

The application of this principle is thus made: Iron or steel is rolled into sheets of extreme thinness. Of these sheets 50 laid one on the other did not together equal the thickness of light tissue paper. Minute strips, 1-32 of an inch wide and 1 of an inch long, cut from this were rolled so as to form a prominent part of the battery, through which a current of a powerful battery passed to the galvanometer. Experiment proved that an almost inconceivably minute warming of a set of these strips would reduce the passage of the electricity so as to produce very large indications on the registering instrument. The instrument thus formed was from 10 to 20 times more sensitive than the most delicate thermopiles; but this was almost a secondary advantage compared with the great precision and the readiness with which it is tested. Thethermopile is very slow in its action. Thisnew instrument, which he calls a bolometer, almost takes up the heat and parts with it again in a single second. It is almost as prompt as the luminous rays itself.

Toshow its sensitiveness, the statement was made that it would register a change in temperature of the iron strips, just described, which did not exceed 1-50,000 part of a Fahrenheit degree. When mounted in a reflecting telescope it would record the heat of a man or other animal in a distant field. It would do this equally well in the night, and might be said, in a certain sense, to give the power of seeing in the dark. A more valuable proof of its efficiency was shown in a series of measurements of the heat of the moon, made under varied circumstances, to guard against error, but each made in a few minutes. All agreed in showing that the almost inconceivably minute amount of heat from the moon could be certainly measured by it, even with a common refracting telescope.

SCIENCE:

A WEEKLY RECORD OF SCIENTIFIC PROGRESS.

JOHN MICHELS, Editor.

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Two or three weeks ago we complained of the coldness of British writers in neglecting to recognize and acknowledge the full scientific value of Bell's and Edison's discoveries, and we condemned, more particularly, their omission from Gordon's illustrated catalogue of recent advances in electrical science, which had then just appeared in London. To day, after having read a four column pean of eulogy and encomium on Prof. Bell and his Photophone, in the last number of *Engineering* we make a candid confession, that, in order to arrive at the real estimate of an American discovery in the average English mind, it is indispensable that the 'meat' of English criticism should first be drawn.

The concluding paragraph of this article reads as follows: "Who can say to what great fields of science this one discovery of Prof. Bell may not lead, fields of research not limited in locality to this earth, but reaching to the planets, and to the farthest limits of visible stellar space. It is by a beam of light that the modern astronomer is able to analyse the chemical constitution of the farthest stars and nebulæ, and is enabled to detect and to deal with metallic vapors through distances of thousands of millions of miles as surely as in his own laboratory, who, after Prof. Bell's experiments will have the hardihood to affirm that sounds taking place in the far off regions of the universe may not one day be heard on the earth, and new fields of acoustical astronomy may not be opened to the intelligence of man. When such a time arrives, the thought of the poet will be clothed with the truth of the fact, that "Light is the voice of the stars."

In the same strain which excites *Engineering* to this transcendental flight of fancy, may we not also hope, in the future, to catch the whisperings of Venus as she waltzes among her heavenly companions, and if we dare to reach so far in our aspirations for the perfection of the Photophone, may we not yet be able to hear the reflections of light, mixed with heat, which Mars, an ardent admirer of old, throws to that splendid luminary as they near each other? It is also true that Mr. Edison has helped to begin that sort of business; for did he not, long since, catch the warmth of the coronal beams, when the sun withdrew behind fair Luna's screen, and didn't Mr. Lockyer (who was there) tell us all that happened? Let us not, however, go too far and admit that the era has arrived which Gulliver predicted, when he described the process of the philosopher of Laputa who extracted sunbeams out of cucumbers.

Engineering should know that the Photophone is but a simple machine for registering heat waves that have impinged upon a piece of hard rubber, and that these waves, originally set in motion by the voice, when made to act on any material expansible by heat, will reproduce, more or less effectually, the original motion which gave them birth. Such an instrument is the Tasimeter, which Professor Bell has stripped of its swaddling clothes and made to talk.

Herald Apr 29, 1881

Measuring the Sun's Heat.

A recent English invention of great simplicity and sensitiveness promises to open up to scientists a new field of meteorological research. The invention is by Mr. David Winstanley, and is designed as a meter, self-recording, both of the duration and intensity of each day's sunshine. This instrument consists of a curved tube fixed on the rim of a brass wheel and free to revolving in two hollow bushes, one of which is blackened and exposed to the sun, the lower half of the tube being filled with mercury. The wheel carries a fine steel needle resting against a metal drum covered with ginned paper and revolving at regular speed by clockwork, and the sun's rays falling upon the black bulb the enclosed air expands, driving the mercurial column toward the protected bulb, thus causing the wheel to move and its attached needle to mark the movement on the paper. The slightest cloud passing over the sun reverses this movement and thus a continuous record of the intensity of solar radiation every hour is secured.

The value of this simple contrivance, says the London *Journal of Science*, lies in the fact that it will enable meteorologists to decide whether a noted degree of temperature is due to the action of clear sunshine or to a transient air current. The two kinds of heat differ in their effect on animal and vegetable life, bright sunshine being needed to ripen grain, while warm air unaccompanied by direct sunlight is desired for the germination of seeds. Hence, if we are to learn where certain crops will succeed, it must be ascertained which of these two sources of heat plays the

most prominent part. Bunsen long ago pointed out that "the more refrangible solar rays exert the most marked influence on the chemical changes upon which the vegetable world depends," and observations with sensitive-recording instruments have been regularly taken at Kew, England, and Para, in Brazil, to determine the sun's chemical forces. Para sensitive, it has been found, is chemically six times stronger than English, even in summer; that of Cairo, Egypt, is five times as intense as German sensitive, and the latter twice as strong as what has been observed at Melville Island in the Arctic Ocean.

These highly interesting observations, if continued over the United States with such an instrument as Mr. Winslow's melinograph, would greatly enrich the Signal Service investigations, and would assist agriculturists to define the limits in which the cotton and sugar belts might be wisely and profitably expanded. But the province of the melinograph is also to facilitate the solution of the grand problem of the varying amount of heat received by the earth from the sun from year to year, partly with a view to the provision and forecast of the phenomenal characteristics of coming seasons. As the lower strata of the atmosphere are so replete with aqueous vapor, which obstructs the sun's rays, observations to this end must be made at high stations and preferably in the tropics. But, inconvenient as these geographical conditions may be, the scientific and practical value of such solar observations is so commanding that they cannot be longer postponed. The British journal, *Nature*, of April 14, publishes a letter from the Spanish government to Professor Piazzi Smyth, making him a liberal offer to occupy the majestic dome of Teneriffe, in the Canary Islands, for solar investigations. Degrees, in the Colombian Andes, nearly nine thousand feet above the ocean, presents another exceedingly eligible point for such studies, which our own Signal Service might convey with great advantage to solar physics.

Die Einlage wird gebildet aus ineinandergeschobenen, mit Schlitzen und Löchern versehenen trichterförmigen Blechen, welche den Dämpfen und Gasen eine möglichst grosse Berührungsfläche bieten sollen. (D. R. P. 14474 vom W. Menzel in Meerane.)

Practisches—Electrische Lichte.
Erzeugung von electrischem Lichte.

Die Neuerungen (D. R. P. 14058 von Th. A. Edison in Menlo-Park, Amerika) beziehen sich auf Verbesserungen an den unter No. 9165 patentirten Vorrichtungen und bestehen in der Construction des Brenners, der automatischen Regelirung des Stromes, in dem Systeme der Leitung, in den Mitteln zur Erzeugung und zur Messung der Electricität, sowie in andern mit der electrischen Beleuchtung zusammenhängenden Einrichtungen.

Fig. 1.

Fig 2.

Den Brenner a stellt Erfinder aus einer Spirale, einem Draht oder dgl. aus Platin her, das er mit Magnesiumoxyd überzieht und in eine völlig evacuirte Glasglocke b einschliesst. Zur Regulirung benutzt Erfinder die vom Brenner entwickelte Hitze, indem er die Luft, welche in dem die eigentliche Lampe b umgebenden Gefässe c enthalten ist, wenn sie durch die Hitze ausgedehnt wird, auf eine elastische Klammer l wirken lässt, die dann durch Oeffnen eines Federcontactes e den Strom nach dem Brenner so lange unterbricht, bis die Temperatur desselben wieder entsprechend gesunken ist.

Zur Leitung von den Stromerzeugern M dienen zwei Haupt-Conductoren A und B (Fig. 2). Ersterer ist ein in die Erde gelegtes Rohr, letzterer ein in dieses Rohr gelegtes isolirtes Kabel, von dem durch Zweigrohre A^1 einzelne Drähte nach den Verbrauchsstellen $a\,a\,a$ abgezweigt werden.

Zur Messung des verbrauchten Electricitätsquantums benutzt Erfinder eine electrolytische Zelle, in der eine dicke und eine dünne Kupferelectrode in isolirter Kupfervitriollösung sich befinden. Nach der Ablagerung von Kupfer auf der dünnen Electrode soll diese das Quantum verbrauchter Electricität bestimmt werden.

Alle diese Einrichtungen hat Erfinder in zahlreichen Modificationen ausgeführt und beschrieben.

It is gratifying to note how promptly the dangers of fire that might arise from the introduction of electric lighting are being dealt with. We have before us two documents bearing on the same subject, both covering the same ground approximately, and both making substantially the same recommendations. The one is the report of a committee of the Franklin Institute of Philadelphia, the other is a paper read by Mr. William A. Anderson, of New York, at the first annual meeting of the United Fire Underwriters. As the latter document is by far more authoritative and reaches further, being a report to the New York Board of Fire Underwriters, we need deal with it alone. The requirements of the Board have been precisely formulated, and are now being complied with by the leading illuminating companies as rapidly as circumstances will admit, remodelling old plant and making arrangements to alter the construction of new apparatus turned out. In order to prevent the possibility of heating a wire if it has not conductivity enough, and the dangers of conflagration arising therefrom, it is recommended that "wires have fifty per cent excess of conductivity above the amount calculated as necessary for the number of lights to be supplied by the wire." Experienced electricians state that if the conducting wire is two and one half times greater in weight per foot than the wire wound around the dynamo-electric machine, it will be amply safe. A very important point, insisted upon by all who have given the subject careful study, is to thoroughly insulate the wires. To this Mr. Anderson adds that the wire must be doubly coated. He expresses it as his conviction that the wire of the future must be different from any now in use. With the same object in view, thorough insulation, he recommends that all wires be secured to walls, etc., by some approved non-conducting fastening. There appears to have been much negligence in this respect hitherto. Now, however, porcelain fastenings are being rapidly substituted in lieu of metal staples. For the distance between wires, a minimum of two and one half inches for incandescent light wires and eight inches for arc light wires is prescribed. All arc lights must be protected by glass globes inclosed at the bottom, so as to effectually prevent sparks or particles of the carbon from falling from the lamps; and when necessary, chimneys with spark-arresters must be placed at the top of the globe. The conducting frame-work of chandeliers and lamps must be insulated and covered the same as wires, and an absolute cut-off must be placed at the point of entrance of the electricity into buildings. So far as present experience has shown and can suggest, all beyond number of the practical and economical application possibilities of fires by the introduction of electric lighting have been of this mode of illumination can now be pointed to, such as effectually guarded against by these requirements, and, according to all were scarcely thought possible by most persons within a indications, the light-giving agent is destined to be the fire underwriters' short a time, when the fire underwriters' report was drawn up. friend. Factious opposition will not stand long against a light which proves that they fully appreciate the importance of the subject.

The Crystal Palace International Electric Exhibition.—In connection with the forthcoming electrical exhibition at the Crystal Palace, we are informed that allotments of space are already nearly made to about one exhibitors. Included in the list of intending exhibitors we notice the following:—Her Majesty's Post Office (Right Hon. H. Fawcett, M.P.), the Anglo-American Brush Light Corporation, the Electric Light and Power Generating Company, the Edison Electric Light Company, M. Gaulard, for the Compagnie Générale d'Electricité, Messrs. Siemens Brothers and Co., Mr. Edison, Messrs. Rowan and Tyer (the Pilsen and Joel Light), Mr. Graham, M. Werdermann, Messrs. R. E. Crompton and Co., Messrs. Siemi and Co., M. Gaulard, M. Gerard, Messrs. Hammond and Co., Messrs. Hawkes and Co., Mr. Edmundson, the Lighting Supply Company, Messrs. Legrand and Sautin, Messrs. Gould and Co., Messrs. Zonin and Co., and Messrs. Latimer Clark, Muirhead, and Co. The list of exhibitors, a copy of the rough draft of which has been forwarded to us, serves to convey some idea of the magnitude and variety of the forthcoming exhibition; but it is still, we are told, far from complete, as many letters of protest allotments are still being made, and many applications for space are still under consideration.

THE METROPOLITAN.

DECEMBER 3, 1881.

The Edison Electric Light.—As we were able to announce last week, the City Commissioners of Sewers have given their consent to the lighting of the Holborn Viaduct by means of the Edison system of electric lighting. We have since been informed that the parties by whom the experiment is to be carried out have also arranged to light the City Temple, Messrs. Spicer and Pond's Imperial Hotel, and several shops on the Viaduct. The plans of the promoters of the Edison system in this country, as described in previous issues of the *Metropolitan*, are thus, it will be seen, being gradually developed, and we hear it rumoured that the proprietors of another incandescent system contemplate adopting a similar mode of bringing their light more prominently under the notice of the public.

Electric Lighting Bills for Next Session.—The subject of electric lighting bids fair to occupy a very considerable share of the attention of Parliamentary committees during the ensuing Session, and even of the House of Commons itself. The notices which have been published in the course of the past month show that numerous Bills are to be promoted in respect of cities and towns in all parts of the country, seeking powers to supply the public with this means of illuminations. Municipal authorities are particularly appear to be on the fore, and in several instances we notice that Corporations who are not the owners of the gasworks in their respective towns ask permission to set up electric lighting establishments, and thus enter into competition with the gas companies. There are, also, six notices on the part of independent companies (one gas companies) of their intention to seek the necessary powers to open roads and distribute electricity for lighting, and for the various other purposes to which it may be rendered applicable. As might have been expected, as a result of the publication of these notices, attention has been directed to the report of Mr. Lyon Playfair's Committee on the subject. That committee, which, it will be remembered, sat for many days in 1879, took a vast amount of evidence and issued a very valuable report, but we never certainly are within sight of those who anticipate that anything contained therein will in any way rule the decision of Parliament on the Bills to be brought forward next year. The condition of things existing now is altogether different from that which prevailed over two years ago. Indeed, the progress of the light during this period, readers of the *Metropolitan* hardly need reminding, has been most marked, and instances of this mode of illumination can now be pointed to, such as were scarcely thought possible by most persons within a short a time, when the fire underwriters' report was drawn up. Factious opposition will not stand long against a light which proves that they fully appreciate the importance of the subject. Other parties, by the present legislation to any extent, and they will best consult their own interests by adopting a course which shall, at any rate, show some regard for the requirements and convenience of the public at large. The question has only been raised as to the desirability of a monopoly of the power to supply the electric light in a given district being in the hands of a company or Corporation. This is a point which will require very careful consideration at the hands of the committee or committees to which these Bills may be referred. We are aware that there are many, even among those who think with us on the main question, who hold that combined, or, indeed, competition at all, in anything involving the disturbance of the public ways has, so far as London is concerned, had its day; but, on the other hand, it has been only too plainly demonstrated that in the case of private undertakings, such as gas and water companies, for instance, it has hitherto been exceedingly difficult, if not practically impossible, to impose conditions which shall adequately protect the consumers. Possibly such an arrangement may be come to as will remove the necessity for any decision on this point until a future occasion. In any event, it will be seen that the public generally, and local authorities in particular, have every reason to watch with very considerable interest the proceedings of Parliament in relation to the subject.

Dec. 6, 1881.] THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT.

A GRAND WEST OF ENGLAND ELECTRIC LIGHTING SCHEME.

THE interesting process of forming an electric lighting company may now be observed in action in Bristol, and dispassionate spectators may extract a considerable amount of amusement from the performance. The people of Bristol have for many years been cogitating as to what use they can make of the River Avon, besides the obvious purposes of navigation. Lately there has been considerable talk about the wasted power of the tides, and the Bristol folk have apparently fully persuaded themselves that the tides in the Avon, which are popularly credited with a rise and fall of about 40 feet, should be set to work in some useful way. There is this further inducement to such an enterprise, that the water of the Avon, from its usual extraordinary load of mud, is manifestly heavier, and therefore more powerful, than a cleaner fluid. Whether this idea has worked on the minds of the local public or not, it has occurred to a few smart individuals that the time is favourable for starting an electric lighting company, with the admitted collateral possibility of lighting the city by means of a conversion of the power of mud and water which is such a conspicuous natural advantage of the locality. The agent of the Brush Electric Light Company and Mr. St. George Lane Fox have opened the campaign with a course of public meetings on the approved pattern; and the services of a portion of the staff of the University College have been impressed to give a public lecture, with experiments, on electric storage and lighting. Professor S. P. Thompson was the lecturer, and in the course of his remarks he is reported to have said that Faure accumulators wasted ten per cent. of power in charging and discharging; while further on he also said that incandescent lamps could be lighted from Faure's accumulators more economically than when fed directly from the generator. After this it is scarcely necessary to add that the lecturer was enthusiastically applauded, especially when he referred to the probability of the Edison lamps being successfully tried in New York. Indeed, for a supporter of the local lighting scheme, which was to favour Messrs. Brush and Lane Fox, the lecturer talked most unaccountably of Edison and his doings. The upshot of all this ingenious advertising is the proposed registration of a Company with a nominal capital of £500,000, to acquire the right of using Brush and Lane Fox lamps in the West of England. The Bristol public will display little of the acuteness with which they are popularly credited if they allow themselves to be inveigled into parting with any sum of money, to say nothing of half-a-million sterling, for the supposed privilege of using two systems of lighting, the best that can be said of which is that they are certainly not superior to any of half-a-dozen others which will always be free to cut up the electric lighting business in the West of England, as elsewhere, so soon as it can be shown to pay. Bristol gas is 2s. 10d. per thousand cubic feet, and the Gas Company pay full dividends. We should be interested to learn, from any of the promoters of the Bristol Electric Lighting Company, where there exists a single instance of a similar Company to theirs making a profit from lighting, in competition with gas at any figure. We observe that this particular Company contemplate earning at least fifteen per cent. Can they cite a precedent for this expectation? While the statements relating to electric lighting companies which appeared in these columns last week remain as indisputable facts, we are justified in regarding with the gravest possible suspicion such schemes as this Bristol enterprise, with its flaunted fifteen per cent dividends.

ELECTRIC LIGHTING AT GODALMING.

We have received from Mr. A. Thomas, Manager of the Basingstoke Gas-Works, a letter on the subject of the electric light as at present in use at Godalming, in the course of which he says:—

Having heard much, and reading so many glowing accounts of the success of the electric light, also reading Mr. Dawson's remarks in the JOURNAL of the 22nd ult., I determined to see for myself. I arrived at Godalming with a friend about 5.30 p.m. on Thursday, the 1st inst. The first electric light we saw was the one near the Town Hall. We first saw it about 50 yards off, and made straight for the place; but before arriving there, out went the light, and a rush of men, boys, and women came against us, being driven away from the column by a policeman. The boys appeared to have been hugging the pillar, as though they were trying to shake the light out, and laughing at the policeman as if they had actually done so (Can the light be shook out?), for the column appeared to be very loose in the ground. Seeing another light down the High Street, we went towards it. When about 100 yards from the first lamp, *minus* its light, we turned round to see if it was re-lighted. The light began to come up, but as it appeared to be exhaused it went out again. I took out my watch and stood for two minutes watching it, and in that time it went out seven times, and I went on, leaving it out, for it appeared to be like a drunken man who was trying his utmost to rise, and finding he could not do so, gives it up for a bad job and lies still. We went on and looked at the other three lamps, which appeared to give a very fair light, excepting for the constant flickering. While looking at the one at the corner of the road leading to Wharf Street, a dray went near it, and the light went nearly out. (Was this the cause of its doing so?)

Afterwards we went on to view the 100-candle Bray lamp erected by the Gas Company on the River Bridge, and I think any unbiassed mind will admit that this is the best light in the town. As we could not find any one who could give us any information upon the subject, we determined to find out the Manager of the gas-works. We did so, and then he took us over the ground again. I asked him (Mr. Bark) where the Swan lights, or rather the bits of "polished copper wire" were; and was informed they were replaced with oil lamps, which I saw were put in ordinary street lanterns. Mr. Bark informed me that they had been taken out a fortnight; also that last Saturday, Sunday, and part of Monday night the arc lights would not light; and owing to the wind and rain the oil lamps would not burn. Consequently, during the severe storm that raged at Godalming on Saturday and Sunday the place was in total darkness, except, owing to the kindness of the Corporation, who had the blinds of the Town Hall windows removed, and so lighted the streets by the lights in the hall, which was a great boon to the town, especially to the church-going people, who had the full benefit of it when coming from there.

Mr. Bark then invited us to accompany him to the Town Hall, as he wished to show us something interesting. On arriving there he pointed out to us that a policeman was on sentry, to keep the people off the lamp-pillar—a nice state of things! The poor fellow seemed to have all his work cut out; and appeared to be out of temper with his job. The lamp was still out, and as we passed an hotel the electrician was pointed out to us as standing by the entrance. He was looking at the policeman's bugbear, and from the face he had upon him he appeared to be seriously affected at the dying struggle of the hen that laid the golden eggs. Poor fellow! It is hard to lose one's pet, or to find one's "claim" is worked out. We went again to see the departed, and to hear the mournful wail for the dead. Mr. Bark asked the sentry if the poor fellow was any better. He replied, "No; it is worse, and dangerous"—meaning the lamp-pillar was unsafe. I was then informed that on the previous evening one policeman was not sufficient to keep off the crowd, for young and old, to the number of at least 100, swarmed round the pillar to have a shock, as they called it, by touching it. One man, at about eleven o'clock that night, was especially delighted with his performance. He took his wife there, and held her hand in his, putting his other upon the pillar, which gave her such a shock that she was brought to her knees begging him with loud cries to release her, which he did, exclaiming, "This is the first time I have ever been able to subdue my wife."

In conclusion, I may say that although disappointed in not seeing Mr. Dawson's bits of bright copper wire, I was pleased with my journey. I should remark that the water power is a failure, I believe, as it cannot be depended upon, so the authorities have to-day received a 10-horse engine, which is to give new life to the poor hen, and it is to be hoped she may yet prove that she has not laid out.

Country corporations will do well to visit Godalming and see for themselves before committing their burgesses to an expense which may cost them their seat at the Council, and which I am informed will most likely be the case with them next November.

In confirmation of one of the statements made above by our correspondent, Mr. R. Sheppard, of Horsham, sends a cutting from the local paper, which writes as follows:—"Those enterprising municipalities which are leading the way with the adoption of the electric light should be careful to be well 'on with the new love' before they are 'off with the old'—in other words, to make sure of their motive power. This is furnished at Godalming by a water-wheel, but when the river rises above a certain height, the wheel becomes useless, as the inhabitants learned the other night, when the town was suddenly plunged into darkness. The gas had been cut off from the street lamps, and all that could be done was to light up the Town Hall, and pull up the window-blinds, which, it seems, enabled the people in the High Street to see their way about."

American Gas Light Journal.

Nov. 2, 1881.

for the boiler, should

Danger Attending the Use of Electric Light.

The public have always been particularly advised, in glowing terms, by those interested in advancing at all hazards lighting by electricity that, among its many advantages, its safety, as regards life and property, was prominently to be considered. The public, ever ready for novelties, and eager to carry out their function, as they consider it, of aiding by their favor and means the so-called higher developments of science, have not deemed it wise to carefully scrutinize statements that a conservative member of society might consider to be partisan or exaggerated.

The innocence of the public might, perhaps, be called willful, as, among others, no less an authority than Mr. W. H. Preece has frequently called attention to the fact that the currents used in the production of the electric light were dangerous, and should be handled with great care.

The confidence so readily given by the public is being as radically changed into distrust as the accounts of the many accidents, resulting from the use of electricity, appear from day to day in the newspapers. A number of instantly fatal accidents have occurred, within the last two years, to persons who were handling the conducting wires or the lamps, and a number have been fortunate to escape after suffering severe shocks. The insurance companies have awakened to the necessity of some decided action, and, as noted elsewhere, the Board of Underwriters have given the question their earnest attention.

Perhaps the most striking evidence of the possibilities of this danger may be inferred from what happened at the Paris Electrical Exhibition, where one would think they would have been able to erect perfectly safe conductors; the competing electricians having much at stake, and being assisted by the most skilled workmen, who were well aware of the absolute necessity for everything to be right in the trial that was to take place before the public and experts in their own line; still, with all the precautions taken, several fires occurred from the overheating of the wires, and, in addition, a number of visitors suffered severe injuries. One is led, therefore, to imagine what the result would have been had the building been wired by the ordinary workman, little of whose work could be inspected by an expert.

But all of these accidents, except as showing the danger, were of minor importance as compared with the terrible disaster in Philadelphia. By this lamentable fire no less than nine lives were lost and fifteen persons were injured. An investigation was made and the coroner's jury, after examining a number of witnesses, found that the fire was caused by the improperly constructed and inefficiently managed electrical apparatus for lighting the buildings. A summary of the evidence, which was extensive, and the verdict of the jury, is given below—

"There were 29 witnesses altogether. The two great questions were: How did the fire originate in the Randolph Mills, and could the victims have been saved if proper measures had been resorted to? To determine these questions a score of employees were called to give testimony concerning the electric lights. Every one united in saying the lights were working badly. They would flicker up into a great glare, and then sink down and die almost out. There were two in the second floor, where the fire orginated, both of which had globes. In the third and fourth floors, where all the work was going on, there were six lights each, and these were without globes, as they gave a more brilliant light. Fires had been kindled there before by sparks from these electric lights. Warps of yarn and rags had been burned by them on different occasions. Ten minutes before the fire Atkinson, night watchman, had been on the floor where the fire originated. He saw the lights were not burning right, and went to the cellar to consult the engineer, thinking that he was running the generator unsteadily and that this was the cause of it. Together with the engineer they examined the machine and could find nothing wrong. A superintendent of the Maxim electric light company had been there that same day examining them, and had pronounced everything right. Before Atkinson could return from the cellar to the upper floors the building was on fire. Edward Gadsby, an Englishman and day foreman at the mill, gave important testimony. It was customary to run these electric lights on the second floor, where the fire occurred, in daytime on some occasions. On one occasion a light got out of order and the globe got red hot. The girls who were working near screamed, and he was compelled to stand near the light to prevent a panic. He never considered the lights safe after that. Daniel Killian, an employee of the Maxim electric light company testified that the rise and fall in the lights were caused by slight variations in the currents, one light sometimes robbing another. This he did not consider dangerous. The jury last night rendered the following verdict:

"The jury find that the deceased came to their deaths from burns and injuries received at a fire in the Randolph Mills, Nos. 1,711 and 1,713 Randolph street, Oct. 12, 1881. The jury find that the fire was caused by the improperly constructed and inefficiently managed electrical apparatus for lighting the buildings. The jury find that Jos. Harvey, owner of the mills, is criminally responsible for the loss of life, in neglecting to furnish proper means of escape in case of fire. The jury find that the city of Philadelphia is responsible for not enforcing the laws in compelling Joseph Harvey to erect proper fire escapes. The jury believe that the book-keeper, William R. Hassenpat, is censurable for not making some efforts to save the lives of the operatives instead of the effects of the office."—Philadelphia *Times*, Oct. 19.

...erican Gas Light Journal. Sept. 16, 1881.

Electric Lighting at Cardiff

The correspondent, whose account of the trial of the electric light at Cardiff was published in our issue of the 2d inst., sends the following account of "further escapades"—

The exhibition is now in at the large drill-hall in Cardiff during the Exhibition of Fine Arts are giving the committee considerable exercise and trouble, not unmixed with anxiety. The committee are responsible for drawing a large concourse of persons together to witness the many valuable objects collected within the largest building in the town. Previously, gas has admirably answered every requirement as an illuminant within its walls; but, of course, something modern and more pretentious than gas was needed for the exhibition.

The electric light was the consequence of such an idea gaining ground, and to the movement we are indebted for a novel proceeding on the part of the present method of attempting to light up a great space by its aid. A large building and large open spaces are the *forte* claimed as special vantage-ground for the electric light. The exhibition is accompanied each day with performances, chiefly vocal and instrumental, of a high order. One evening last week circumstances of a somewhat grim character seemed to coincide, with a view to give a life-like, or rather a death-like reality to this particular occasion. An *artiste* was announced to sing the "Death of Nelson," and a crowded audience was present. The electric light had apparently its part, or *rôle*, allotted to it, for when the singer commenced the song the electric light suddenly disappeared. Of course the gas was immediately called upon to do duty in the emergency.

From previous experience of the electric light this was a contingency quite looked for; the committee having very thoughtfully ordered that the gas should be *lit up but turned down so as to have it ready if unexpectedly required.* The man in charge of the hall was quickly on the alert, and the gas-tap was manipulated, but to the intense disappointment of the committee in particular, and the disgust of the public in general, the tap was turned the wrong way! Thus the small glimmer of gas kept in waiting for the electric lights to perform one of their "fantastic tricks," was put out, and all was darkness.

Is not this a burlesque on lighting? The meeting thus had an unpleasant, but withal a somewhat grotesque ending. Strange things within and yet stranger things without. The large hall thus lighted is by one electric system which shall be nameless; the approach to the hall, in Dumfries Place, is also lighted by electricity, but by a separate and entirely different system. As the audience left the large but dismal hall, and emerged into Dumfries Place with its brilliant lights, the effect upon the visual organs was most marked and indeed painful.

This sensation was of short duration, and had instantaneously to give way to another cut to be had. The electric lights were by some means unexpectedly extinguished, and where a few moments before everything seemed to be flooded in an effulgence of light nothing but universal blackness prevailed. This is called electric lighting; but some people are beginning to think a few more substitute term might be found with which to describe such a nondescript method of extending zones of misery from those who seem to expect something better than gas for their pains.—*Journal of Gas Lighting.*

Sept. 3, 1881.

ENGINEERING NEWS.

THE ELECTRIC LIGHT IN A SCOTCH COLLIERY.

On Tuesday afternoon, Aug. 2, Earnock Colliery, near Hamilton, belonging to Mr. John Watson, of Earnock, was the scene of an interesting ceremonial which may well be said to mark a new era in mining annals. In proceeding to win the rich mineral wealth of his estate Mr. Watson determined that, in respect of fittings, machinery and general appointments, it should be a model, and he has been highly successful in giving practical effect to his aims. Among other things he early resolved to, if at all practicable, substitute the electric light for the ordinary modes of illuminating the workings, and after investigating the various systems he decided on giving that of Mr. Swan a trial. Accordingly, since April last, Messrs. D. & E. Graham, electrical engineers, Glasgow, have been engaged fitting up the Swan incandescent lamp with modifications, to adapt it for safe use in the mine, and on Tuesday the inauguration of the new light took place in presence of a large company of leading gentlemen from Glasgow, Hamilton and the West. Arrived at the colliery about half past one o'clock, the visitors were received by Mr. Watson, and after a brief pause spent in inspecting the three magnificent winding and fan engines, the Guibal fan, and framework for screening the coal, they were conducted by Mr. James Gilchrist, manager, down one of the workings in the William at a depth of 138 fathoms. Here at the pit bottom, in the roads and at the face, twenty-one Swan lamps were burning, giving forth a brilliant, steady flame, the luminosity of which, while sufficient to supply the desired light, had none of the disagreeable intensity associated with most systems of electric lighting. Besides the pear-shaped Swan lamps, in which the glowing or incandescence is carried on in vacuo, there is an outer lantern, the invention of Mr. David Graham, consisting of a strong glass globe, air-tight, protected with steel guards. Each lamp was also connected with two different forms of Graham's patent safety cut-outs and switches for cutting off and letting on the current. The effect of which, it is believed, would be to render the lamps quite safe, even in the presence of explosive gas. At first the intention was to employ the fan engine to drive the dynamo-electric machine or generator, but this was departed from, and an engine of 25-horse power was erected in the workings on the surface for the purpose. From the generator the electric cables, five in number, are conducted along the road of the workings over ordinary miners' pulley to the pit-head at No. 2 shaft, and thence down into the workings. From the pit-bottom of workshops to the pit-head, a distance of several hundred yards, the cables consist of ordinary copper wire, 7-16 in. diameter, inside the workings and below ground, to allow of their safe handling, they are composed of insulated wires, while on the way down the shaft they are inclosed in a galvanized tube. Near the bottom of the shaft, branches are taken off for supply light to the principal roads and for the haulage engine-room, the main cables being carried into one of the sections of the mine, a distance of half-a-mile. After careful inspection of the lamps at the pit bottom, the party were shown, grouped in three groups, with the aid of the electric light, Mr. Arnan, of Glasgow, who may well be credited with the distinction of being the first to exercise his skill in the bowels of the earth. They were led to the haulage engine-room and into the workings, where they witnessed the effects of the light. At the latter point, while, of course, the visitors were at a safe distance, a shot was fired, bringing down a large mass of coal. Having spent fully an hour below ground, the party returned to the surface, where carriages were in waiting to convey them to Earnock Mansion House, where luncheon was served.—*Colliery Guardian.*

GAS AND ELECTRICITY IN LIVERPOOL.

The annual meeting of the Shareholders of the Liverpool United Gaslight Company was held on Tuesday last, when full statutory dividends were declared. The report stated that the gross profit on the past year's working amounted to £99,624. Payment of the second half-dividends will leave a balance of £26,629 on the net profits of the year; consequently the Directors announce a reduction of twopence per thousand cubic feet in the price of gas, and the Chairman, Mr. Edward Lawrence, stated that the reduction would have been at least a penny more, had it not been that quite half of the extraordinary net profit was secured in consequence of the exceptional demand for coke during the past severe winter. This fact was reasonably held to affect the disposal of the surplus, it being, of course, quite uncertain whether the operations of the current year will be equally successful. One penny per thousand cubic feet of gas means in Liverpool about £7500, so that a reduction of threepence would have shown an apparent loss of £22,500. It would thus be rash to say that the Company could positively afford a greater reduction than that which they have given. At the same time, they do not seem to reckon sufficiently on the increased consumption which the cheapened price will probably bring. They have also a balance carried over from previous years, so that a further reduction cannot be very far off. We do not mean to imply that the present determination of the Directors is an evidence of excessive caution on their part, especially as their action appears to have given considerable satisfaction in the city. The utmost that can be said is that while they have not seen their way to take off threepence this year, next Midsummer may find the undertaking well able to bear another remission equal to that now announced.

An interesting episode marked the Chairman's opening speech, in connection with the electric lighting experiments in Water Street. It appears that the British Electric Light Company were employed to light this thoroughfare with a tramway was being laid. After some nights' experience, in the course of which much trouble was occasioned by the lamps going out, &c., the Corporation were compelled to return to the use of gas, and this has been the method of lighting since preferred. The Chairman naturally mentioned this incident with unfeasible satisfaction; but it has since transpired that the affair is not so pleasing to the other side. Consequently, the Engineer to the Electric Light Company has written to the local newspapers, stating that the fault chiefly complained of arose from the carelessness of a workman, and, of course, "in no respect affects the principles or the ultimate success of street lighting by electricity." This is the usual way of accounting for a failure. As with the City of London experiments, when all the lights on a circuit have gone out—which has happened on several occasions—it is never the fault of the "system." There is always some workman, or defective wire, or some other irresponsible thing upon which the blame may be cast—that mysterious entity called the "system" is always held sacred. The only way to meet these excuses is by the plain, straightforward remark that the light on such an occasion *went out*—how, or why, is of no interest whatever to the public. They are not supposed to know or care how gas may sometimes fall below the prescribed standards of purity and illuminating power; the gas manufacturer has to look to this part of the business as well as to others, and he is heavily fined in case of default. We wonder if it has ever struck the authorities of towns where electric lighting has been tried, that if there were penalties to be incurred by the contractors, just as in the parallel instance of a Gas Company, there would either be no offers to supply from the electricians, or the cost of the lighting would vary directly with the amount of the fines. The Liverpool Gas Company have certainly scored heavily at the expense of their rivals in the matter of the Water Street lighting; and as we have had occasion to remark in these columns, we believe that much instruction would be derived from a record of every instance where electricity has been superseded by gas.

THE DAILY NEWS, OCTOBER 5, 1886.

CRYSTAL PALACE INTERNATIONAL ELECTRIC EXHIBITION.—The period of the series of international exhibitions at the Crystal Palace inaugurated thirteen years ago by the late Prince Consort, the Duke of Connaught will be an Electric Exhibition. It is intended that this exhibition should be opened in the autumn of 1887, and continue seven months. Nearly all the systems of electric lighting will be represented at the Crystal Palace, so that manufacturers, theatrical managers, and others who are thinking of applying electric lighting to their premises will have opportunities, &c., will for the first time in England have an opportunity of comparing the various electric lights, and judging for themselves which will suit their local circumstances best. The water is the best time for an electric exhibition, as the season will allow of the lights being seen from about 4 p.m. or even earlier. In addition to the many and various systems of electric lighting, the Crystal Palace will have a complete exhibit of its numerous inventions. Subscription to these various forms will be already represented—Faure's, Sellon's, De Mantier's secondary batteries, Trouvé's boats, and many other scientific exhibits will render the exhibition the most interesting to the public and the most important to a scientific view that has ever taken place in England. Influential committees have been formed to advise and aid the directors in the undertaking.

THE COST OF INCANDESCENT ELECTRIC LIGHTING.

Some correspondence has been going on during the past week in *The Times* and other newspapers, respecting the cost of domestic lighting by incandescent electric lamps, with the result usual in similar disputed questions, of the subject remaining as vague as ever. The matter is mentioned in another column in connection with statements published in the *Quarterly Review*, and it is therefore unnecessary to argue here the case of gas *versus* incandescent lamps, although a few observations on the correspondence above mentioned may not be out of place. One of *The Times* correspondents complained of the great cost of setting up the necessary apparatus for electric lighting; and also drew attention to the excessive prices charged for some of the fittings, such as lamps, which are sold at 25s. each, while intrinsically worth about 2s. 6d.; and Faure batteries sold at £4 per cell, which cost less than 10s. Another correspondent, in reply to this indictment, contended that the inventors of electrical apparatus have a right to charge as much for their goods as the public can be induced to give; and also claimed that the cost of electricity is not to be reckoned at the rate at which private and separate users can now generate it, but that taken in a manufactured and distributed wholesale, electricity will be much cheaper than gas. This argument is so often used that it cannot be too frequently reported, on the part of the partisans of gas lighting, that there cannot possibly be such economy in the wholesale production and distribution of electro-motive force as in the apparently parallel but really very different case of gas manufacture and distribution. The cost of steam power is well ascertained to be little less per horse power per hour for a large than for the smallest engine which fully occupies the attendant's time. This being the case, taking the example of a large consumption requiring about 60-horse power for from 300 to 400 lights, the question of expense resolves itself into this—whether it would be cheaper to purchase this power from a Company having a station, say, half a mile away, or to produce it by steam or gas engines on the premises. In the former case it is clear that the possibly smaller proportionate expense of obtaining the power from a large engine will be more than counterbalanced by the separate establishment expenses and separate profit of the generating Company, besides the cost of the conductor, meter, and other obvious charges. We are now assuming the expense of the power, supposing it to be always fully utilized. But in the case of a Company supplying electromotive force generally, so far from their difficulties and expenses diminishing with the amount of their business, the reverse will be found to be true; and in support of this statement we are content to cite the undoubted authority of Mr. William Crookes, F.R.S., who is Electrician of the Electric Light and Power Generator Company, into whose possession the Maxim patents for the United Kingdom have just passed. Professor Crookes corroborates the observing, to the effect that if there are twenty lamps in a room three must still be maintained as at first. We can easily imagine what would be thought of the economy of gas lighting by consumers, and how unsaleable it would be deemed by philosophers, if the cost of supplying one burner were the same as for twenty. In the interest of gas lighting we much desire to see the supply of a Metropolitan district undertaken on business terms by an electric generator Company, and to learn the exact result of competition of incandescent electric lamps with gas at 2s. per thousand cubic feet. We shall be greatly surprised, when such a clear of business is attempted, if electricians do not accomplish that they still want something to make them quite happy.

theories should be confined to their proper place. Prophesy in another column, also, is not altogether objectionable in its season, and especially when it suggests or contains the germs of its own fulfilment; consequently it should be indulged in sparingly, if considered by any means a legitimate exercise for a commentator on passing events. When, therefore, it is found that a communication on a technical subject appearing as a review, and obviously intended to impart trustworthy impartial evidence on the subject of which it treats, is chiefly occupied with the writer's own largely in theorizing and prophesy—and more particularly the latter—we are justified in considering that the reviewer has overshot his duty both to his subject and to his readers.

The *Scientific Review* contains in the current number a long article on the "Development of Electric Lighting," an attentive perusal of which has suggested the foregoing reflections. It is seemingly based on the Parliamentary Blue Book of Aug. 13, 1879, which contains the report of the Select Committee on Lighting by Electricity, and on the Official Catalogue of the Paris Electrical Exhibition. The tenor of the article may be inferred at starting from the opening paragraphs, which state in as many words that the opinions of the witnesses examined before the Electric Lighting Committee of 1879 have been proved to be altogether erroneous by the proceedings of the electricians in Paris during the present year. It is interesting in this connection to find that the report of the Committee is really as applicable to the present day as it was to the conditions of 1870. The Reviewer states that the commercial establishment of electric lights, which was "the dream of the visionary and enthusiast" two years ago, and was condemned as impossible by the "universal consensus of opinion among all the scientific witnesses," is now realised, and what was impossible then may be now done in daily action at the exhibition. We cannot find any reference to impossibilities in the report of the Committee, and must therefore conclude that the Reviewer has attempted to throw unjustifiable discredit on the result of their labours; for if the "dream" is now a reality, it is important, it is remarkable that no mention of such a determination appears in the report. The Reviewer has apparently forgotten that the Committee was appointed for a definite purpose, and this purpose was fulfilled as perfectly as the results then to be had, notwithstanding the assumed difference between the state of electric lighting now and in 1879.

The Reviewer gives a very readable account of the principles governing the development and application of the magneto-electric currents for the purpose of lighting by means of the arc and by incandescence. His descriptions of the various dynamo machines, and their differences, are very clear, and are worth perusing by any one who may require a succinct guidance in the distinctions between "alternating" and "direct current" machines, and similar elementary matters in reference to electric engineering. The information given in respect of dynamo machines is indeed much more ample than with regard to the lamps or regulators, which are dismissed with a very insufficient amount of attention. There is no reference of the Reviewer to the difficulties with the management of the somewhat amusing. He says that the "alternation" between the positive and negative carbons "takes place sixty times a minute, and the sudden increase and diminution of the length of the arc produces those flickerings which were so much complained of in the early days of electric lighting, two years since." Is it intended to be understood that are lights have given up flickering since this epoch? It would appear so, for the Reviewer informs us that in the best modern regulators "the light is practically steady"—for how long?

The Reviewer's sympathies and hopes are, however, most strongly enlisted on the part of the incandescent lamp, between the various descriptions of which he does not attempt to pass judgement by specific reference, and any one will find, by methods of executing a number of incandescent lamps for domestic lighting are well described, as also is the system of electric measurement, the units of the latter being very clearly explained. It is not mentioned, however, that the production of electric energy required for an incandescent lamp is the same whether the light is turned up or down. This circumstance is too frequently ignored when, in lecture-rooms and elsewhere, the sensitivity of the incandescent lamp to control in the matter of illuminating power is demonstrated. How many observers of this operation know that the power of the lamp is only modified by the friction of internal resistance coils, which absorb and practically waste the force that is not employed in affording light?

With reference to the glare of the electric light in houses, the Reviewer is somewhat remiss in his statements. He contends that only those people need complain of glare who, having been accustomed to 10 or 20 candle power gaslight in their drawing-rooms, are not satisfied unless they replace the gas-burners with lamps of equivalent power in the form of electric lamps. Assuming the incandescent lamps to be of equal brilliancy with the discarded gas-lights, and further reckoning these at only 10 candles each, it is difficult to believe in the existence of individuals who would submit to rate for 1 or 2 gas-burners no less than 70 or 80 incandescent lamps. The Reviewer, however, goes on to remark that if "people will be content to substitute for their 50-candle power gas light, 80 to 90 candle power electric light, they will find that they have a beautiful soft light, which, if the shape of the lamps is hidden by a shade, *is impossible to distinguish from pure, except that it is steady* and does not vitiate the air." The italics are ours, and while it is new to find superior steadiness claimed for electric as compared with gas light, we will pardon this slight mistake for the sake of the compliment expressed in regard to the beauty and softness of gas.

On the question of expense the Reviewer is sanguine. He starts, however, with a grand blunder respecting the annual cost of the electric lighting of the City of London streets, which he states to be about the same annually as the previous cost of gas, whereas the "electric light companies are all paying good dividends." As a matter of fact, the yearly charge for the 640 gas lamps extinguished was under £1700, at the rates then prevailing, which have since been reduced. The actual cost of the electric lighting experiment is not known, but the amount of the accepted tenders for lighting only, besides establishment charges, was £5000 for the current year. Consequently the cost of the experimental lighting in 1882 per cent. higher than that of the gas formerly used—without reckoning the cost to the electric lighting contractors of the gas occasionally used when their lamps have been accidentally extinguished. This error on the part of the Reviewer is so gross, and from the misuse which he makes of his wrongful assumption so unpardonable, that his authority in the further question of expense is worthless. Moreover, as to the quantity of light afforded, there can be no available basis of comparison between the two systems of lighting while the electricians are busily permitted to obtain temporary powers for their lamps; and the matter of the "good dividends" said to be made by electric light companies is also one on which outsiders are scarcely competent to form an opinion while authentic returns and statements of accounts are less common than statistical quotations.

Fortunately the Reviewer does not commit himself to a statement of the probable cost of incandescent lighting, but deals only in the usual generalities. One specious argument is to say notice, in which it is stated that "to estimate what will shortly be the relative cost of lighting a house by gas and by electricity, we might, if we maintain the cost of electricity at its present price, to be under the mark, and it will place more coals, but at what gas-works in his own back yard." The above comparison is obviously not fair. The reason why gas cannot generally be made in a small undertaking are already known, as can be bought of a large public undertaking are already economical, and easily enumerated by any one who cares to take the trouble to do so. Where there is a point, however, when private consumption becomes independent of the public undertaking, and it would pay the consumer to manufacture his own gas. We do not know how much cheaper a house power of energy will be in the near future, when the cost of copper conductors is taken into electric energy can be obtained as cheaply as it could be purchased from a central generating station with the cost of the main conductors superadded, as they must be in the latter case. It is therefore impossible to believe, as suggested by the Reviewer, that the mere production of electro-motive force in a central station, and its distribution through the streets by means of costly conductors, can operate materially in the direction of lessening the estimated present cost of electric lighting. The error that Mr. Edison is engaged in laying down nearly 200 miles of electric light mains in New York City, and has contracted to light certain districts by means of his incandescent lamps, and to charge to the consumers exactly the same as they now pay for gas, "plus the cost of the coal company," may or may not be true; but it is sufficient to remark, by way of rejoinder, that London gas is not sold at 2s. per 1000 cubic feet, and that the Edison Electric Lighting Company do not publish their accounts.

The Reviewer concludes his effusion with the prophecy that we may "even now confidently look forward to the time in the immediate future when gas-lamps for lighting purposes will be as much as wooden torches," and so on, in the usual vein. The prophet is welcome to his opinions in this matter, as the expression of them will do us harm, nor even need the most timid holder of gas shares a moment's uneasiness. To the readers of the *Quarterly Review* it is, however, a trifle hard that the scientific writer who has invaded the calm repose of their literary circle with profound information on one of the most absorbing subjects of the day, should, when brought face to face with the financial aspect of the matter, find cause for a shocking blunder, and then hurriedly proceed to cover up his poverty of correct statistics with the well-worn mantle of prophesy. Notwithstanding all his show of deep convenience with his subject, his acknowledged visit to Paris, and conversation with Mr. Edison, the Reviewer cannot tell what his favoured method of lighting costs now, or is likely to cost in the immediate future. Moreover, he has utterly forgotten the critic in the partisan, and has said nothing about the real reason—the common instrumentalness—why it is that all electric lighting continues in the experimental stage. He has sought to convey the impression that all difficulties in the way of the daily and nightly application of electric lighting are overcome, and in so doing has overstepped the bounds even of fair advocacy, to say nothing of the limits of impartial criticism. In his haste to consign gas lighting to oblivion, he has omitted to notice and study the imperfections of electric lighting, but also the improvements in gas-lamps which are revolutionizing the aspect of the streets of London by night, in a way even more striking than the City electric experiment. In the demand for "more light," which is now heard from all sides in our thickly-populated towns, where busy streets and bustling interiors have to be illuminated, the *despised* gas of the writer in the *Quarterly Review* will not be overlooked, so long as it retains in a pre-eminent degree the properties of cheapness in use, and remaining alight as long as required.

THE Directors of Messrs. Newton, Chambers, and Co., Limited, have given notice that no further application for shares in the Company will be received after Thursday next, the 10th inst.

The Fire Risk of Electric Lighting

The Boston *Globe* says: The dangers incident to the employment of electricity for illuminating purposes are being illustrated daily in all sections of the country. Only a few evenings since a man who was making a connection of the wires at the Mechanics' Fair Building was knocked almost senseless by the fluid, and another man in an establishment on Washington street was badly "shook up" by the same imperial agency. But the saddest effect of the new invention yet recorded was at the burning of a mill in Philadelphia last week, when half a dozen were killed and more than twice as many made cripples for life. Quite a serious fire occurred in Chicago the other day from one of the electric light wires in the city getting "crossed" with a telephone line. It seem that Mr. Orcutt, manager of the Telephone Exchange, noticed some smoke coming from the annexing board, which is composed of brass strips one-eighth of an inch apart, ten of them being connected with a key or a peg for the purpose of putting subscribers in communication with each other. In a minute or two little blue and white flames began jumping from one strip to another across the space between them. The telephone manager at once suspected a cross with an electric light wire, and the wires were immediately disconnected. Returning to the board, he saw that the transmitter was burning, the current having jumped two feet to reach it. After cutting off another wire the loss was cooled by throwing water upon it. Nothing more was observed until the lapse of one-quarter of an hour, when another section of the board, eight feet from the first one which was on fire, began to smoke. The blue and white flames was seen here too. Disconnecting the ground wire ended the display, some water being used. Half an hour later the switch-board, through which connections were made with the trunk lines, commenced to smoke, the current having jumped ten feet this time. The flames ran along for two feet, and the board smoked for five minutes before the fire was put out.

This cross was a very expensive one, the damage resulting from it being the loss of a microphone and a head instrument in the office, and about 25 feet of the Owl Club's line on the roof. The wire melted like lead. An instrument in the store of the Chicago Music Company, situated on State street was also destroyed, the induction coils on the inside melting. About $200 will restore everything as it was. Investigation showed that a wire had been run from Willoughby, Hill & Co.'s store to McVicker's Theater for the purpose of furnishing the electric light used there a part of last week. Its use was discontinued Thursday, but the dead wire in some way dropped down on the telephone wire, the tremendous current passing through the former thus finding its way to the central office.

The Chicago *Tribune*, in commenting on the affair, says that the effect of this "cross" shows how dangerous electric light lines are. A current that will burn carbon will set wood on fire, if it is within two feet of the wire and damp, and, finding a better current than carbon, the current will take to it. If great care is not taken in stringing the lines, fires will be frequent when the electric light comes into general use.—*Iron Age.*

SOME NOTES FROM AMERICA.

[FROM OUR OWN CORRESPONDENT.]

August 24.

A sort of endless controversy has been going on of late in the New York papers, between the representatives of the Edison and the Maxim Electric Companies, in reference to a decision of the Commissioner of Patents, by which he recently adjudged in favour of the latter Company in the matter of a claim in regard to the question of invention of the thermostatic regulator. It seems that this interesting device claimed both for Edison and for Maxim; and the question was referred to the Commissioner of Interferences, who decided in favour of Maxim. Mr. Edison appealed to the Examiners-in-Chief, and they also declared in favour of Maxim. Mr. Edison then appealed to the Commissioner of Patents, and he has affirmed the decision of his subordinates. Now, however, as the matter has been decided in this manner, the Edison Company claim that the invention is valueless, upon which the Maxim Company retorts asks the pertinent question, why did the Edison Company expend time and money in fighting for the title to a worthless patent? So the matter stands, and will probably remain until the fierce cones when lighting by incandescence have proved a commercial success. Then we may hear of it in the Courts.

I have frequently alluded in my letters, during the last year, to the Edison central station which was "just going to be established" in a section of the business part of New York city; according to the statement of the Vice-President of that Company, which has appeared in the daily papers, the Company hopes to last proclaim a building wherein to establish the station. However, it does not yet appear when they are going to commence supplying light.

Anticipating difficulty in procuring competent workmen to run their engines, the Edison Company have established a sort of school for the training of the employés. So far, the instruction consists of lectures by a Mr. E. H. Johnson, the Company's principal assistant—on electric lighting, and the Edison light in particular; to which was recently added instruction in the way of running the wires, particular reference being made to the fitting up of houses.

It will be remembered that in a former letter—published in your issue of June 7—I stated that a contract had been entered into between the City of New York and the Brush Electric Company for the lighting of several of the principal squares of the city. At the time it was expected that the lights would be in operation by the 1st of June; but, as a matter of fact, the Company have not yet commenced to carry out their contract. Part of the delay has been caused by some of the property owners—in front of whose houses the poles for carrying the wires are to be erected—obtaining a temporary injunction against the Company erecting them pending action thereon with the view of putting up the poles. Lately a motion was made to dissolve the injunction permanent; but this was denied, and the case, said, "The embarrassment of the Judge in giving his decision on the question of erecting poles in certain parts of the city, with cross-bars of 7 or 8 feet in extension, for the purpose of carrying the wires over them in the city where these poles are erected. . . . I feel constrained to say that I cannot decide the question without creating a nuisance, to the actually lessening the value of residences. This question, however, cannot be properly examined and determined on this motion, but should be left for the trial. . . . The question of irreparable injury raised as to the diminution or continuance of the preliminary injunction restraining the defendants from erecting the well-settled rule, in equity, of preventing irreparable injury to the interposition of the Court. The contract is completed with the execution of the erection of one pole, and it therefore is a year. Under the circumstances, with considerable hesitation, I think the temporary injunction should be continued.

The Brush lights on Broadway, between Fourteenth and Thirty-fourth streets, were again out part of last evening. The officials of the Company assign various explanations to account for these repeated failures of the lamps; that time it is the wet weather; then the slipping of a driving band at the station. The night when the party in charge of the central station was aggrieved, he did succeed in getting the dynamo at work, but the explanation of this, the last failure, the reporter was unwilling, that there were several causes; but that he was too busy to explain them.

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extent they are right. It seems only natural that the *dejecta* of man and beast—containing, as they are well known to do, highly manurial properties—should be employed in restoring fecundity to the earth. But the question is, How and in what form are they to be applied so that their fertilizing power may be utilized to the full without causing nuisance? Should the sewage of our towns be applied to the soil almost in its natural state, or only after chemical or other treatment? This is a matter which must be left for experts to decide.

The question of sewage disposal is one which must necessarily be of importance to all those bodies in whose hands are placed the sanitary affairs of our towns. To these the Native Guano Company, Limited, are prepared to give advice and assistance. They are willing, for a fixed annual payment, to undertake the whole trouble and responsibility of dealing with the sewage of towns, and guarantee an effluent water of sufficient purity to flow into any river, together with entire freedom from nuisance. Local boards and town authorities can thus be entirely relieved of their sewage difficulties. At Aylesbury, where, as we have already said, the Company's operations have been carried on for the past five years, the effluent water from the sewage works flows into the River Tame in a state of limpid purity, its chemical analysis having shown it to contain only 3·2 grains of chlorine per gallon, and 0·05 part of free ammonia, and 0·30 part of albuminoid ammonia per million; the standard demanded by the Rivers Pollution Commissioners fixing the limit of the latter impurity at 0·21 grain per gallon, which is equal to 3 parts per million, or 10 times the quantity contained in this water. Furthermore, the treatment of the solid portion of the sewage by the "A.B.C." process does not give rise to any offensive odour. This is testified to by the Aylesbury Local Board of Health, whose certificate, given on July 23, 1880, states that since the date of their previous certificate (Jan., 1878) there had been no complaint of any kind, and that the whole of the Company's operations were carried out without creating any nuisance to the neighbourhood. As a testimony to the worth of the Company's processes of rendering innocuous to fish life streams polluted by sewage and chemical matter, the Jurors at the recent National Fisheries Exhibition, held in Norwich, awarded to them the prize of £20, given by the Mayor, and a special silver medal.

The multiplication of works for the treatment of sewage by some such system as the one above described would unquestionably not only improve the sanitary condition of towns, but become a source of profit to the country generally; and it is therefore to be wished that in the near future the Native Guano Company may find the area of their operations widely extended.

NOTES FROM SCOTLAND.
(FROM OUR EDINBURGH CORRESPONDENT.)

EDINBURGH, *Saturday.*

Since last week the municipal torch has been lighted, and in the most populous cities as well as in the meanest of clachans, it has blazed with more or less of intensity according to its composition. Looking over the metropolitan and provincial papers, one realizes, more particularly at a period of the year such as the present, the deep interest that is everywhere manifested in the progress of lighting. Towns already supplied with gas have serious intentions of acquiring local works; villages not yet ambitious enough, or not yet wealthy enough, are resolving to illuminate the dark places of their habitation with paraffin oil, or are cautiously making inquiries as to the propriety of introducing the handier gas; and cities which have for two or three generations enjoyed all the benefits of a good gas supply, are looking, irresolutely certainly, but still looking in another direction for the light which is to guide the ways of citizens after dark, charmed by the bright visions conjured up by electric light prophets. With this latter and now by no means rare species of the human race, assertion too frequently takes the place of argument, and apparently they believe that assertion oft repeated may be credited with having much the same effect as the constant dripping of water upon the hardest rock. It gradually insinuates itself into the minds of Town Councillors who are more interested in the date of the next municipal trip or dinner than in the advancement of scientific modes of lighting, until at length, parrot-like, they begin to utter responsive assertions, and that, too, with such fervour and zeal as to carry considerable weight with that section of the community who are simple enough to be led. Numerous examples might be culled from this week's prints, if the "game" were at all "worth the candle." I have devoted special attention to the "Grey Metropolis of the North," as Tennyson poetically describes Edinburgh, in the matter of lighting, and I do not mean to allow the subject to fall into abeyance until the working authorities have seen the absolute necessity of improvement. This week I purpose reviewing the public speeches of one or two members of Council who have been airing their opinions on the absorbing question, with many citizens, of electricity *versus* gas. In doing so, I shall give the place of honour to the Convener of the Cleaning and Lighting Committee in Edinburgh, who, from a gas point of view, has been the head and front of the offending. Publicly Mr. Landale has repudiated all personal responsibility in the matter. He has thrown upon the entire Committee the odium—or the credit, as the case may be—of introducing electricity; and perhaps it is no more than proper that each individual member should accept his share; but when a man blows hot and cold at the same meeting, when in the one breath he asserts that the Committee, and not he individually, must take the onus of the innovation, and in the other he triumphantly exclaims, "If there is one thing I take credit for—if there is one thing I am proud of in connection with my convenership, it is that I have been the means of introducing the electric light," what conclusion can be reached? If he is not strictly accurate on such a detail, the listener has good reason to doubt any of his other assertions. Just let me examine one or two of the Convener's statements to the electors this week on the occasion of his asking their suffrages for another term of office. "The electric light is yet in its infancy; it is in an imperfect state. I think it has a bright future. It has many objections to overcome—many stages to go through before it comes to be a light for household purposes; but for lighting streets I think there is no doubt of its success, because it is cheaper than gas." At this point an elector, interrupting, said, "Not a bit;" and the Convener, resuming, sadly remarked, "The man who says 'not a bit' talks about what he does not know, because I tell you that the London Company who are supplying us just now have offered to supply London and Edinburgh at a cheaper rate than gas." Was ever there a more glaring attempt to gull the electors? I say nothing about the reasoning of the sentences quoted, but I should like to see the assertion established that electricity is cheaper than gas. If it is cheaper than the amount paid for gas at the present moment—that is, £6000 for the entire city—I should even be doubtful of adopting it, unless, indeed, there was an element of steadiness which has hitherto been wanting in the experiments in Edinburgh. But by the Convener's own words I think I shall be able to show that he does not know the subject he is talking about, notwithstanding the style in which he tried to demolish the poor doubting elector. Another elector at a later stage of the proceedings was anxious to know what would be the cost of providing equally good illumination to electricity by means of ordinary gas, and the response he received was, "I cannot answer that question, because I do not think we could have such an illumination by ordinary gas." Here is a gentleman at the head of the Lighting Committee of the Metropolis of Scotland, who asserts that electricity is cheaper than gas, who snubs one elector who questions it, and who, in answer to another elector, admits that he cannot tell what would be the cost of gas to give an illumination equal to electricity, "because," &c. But this is not all. When he is asked on another occasion how much the city saves by using the electric light, he answers, "I cannot tell." And yet electricity is cheaper than gas, according to this oracular Convener. He cannot tell the cost of the electric light to the city, beyond this, that the Company are to have £400 for supplying the current only—and such a current!—and he cannot tell the cost for an equal amount of light by gas; nay, he does not believe that it can be obtained by gas. Surely it was on account of his negative qualifications that the Council promoted him to the position of Convener of the Lighting Committee. So much for Mr. Landale's appearance before his constituents. His temper hardly ever gave way; but when he met his peers in the Council Chamber on the succeeding day, and when he was tackled, first by one Councillor and then by another, about accounts amounting to nearly £300 for new electric light posts, he fairly lost command over himself, and shouted out that the way in which he was annoyed was contemptible. There is no question that the impression produced outside was that the whole expense in connection with the experiments was not to exceed £100, and now that other £300 has been added, the Councillors are quite right in seeking to know the reason why. Of course, the accounts for the lamp-posts, which had given rise to this discussion, were passed, but there was general dissatisfaction. In the course of the "scene," Councillor White said it would be shown that this light would not suit; but Bailie Cranston, who may have reasons for desiring "more light," answered, with that accuracy of statement which characterizes all, or nearly all, the supporters of the electric light, and with that incisiveness which is Bailie Cranston's own, that Mr. White "was the only man who was of that idea, for he considered it would yet become the light of the world." I would not for a moment suggest that there was any irreverent idea in the mind of the Bailie when he uttered this statement; but I would point out the strong similarity between the Bailie and the Convener in the use of conjunctions. According to their words, anything they say is right, *because* they say it. Reasoning of this description is not usually convincing. Convener Landale is to be opposed in his ward; but I am afraid the opponent is not strong enough to oust him from his position.

According to the Lord Provost of Aberdeen, the Town Council of that city were treated, on Wednesday last, to a "great and prophetic speech" by Bailie Macdonald, on the subject of electric lighting. The same speech "quite startled" Bailie Duffus, who had "no idea that his friend had at his fingers' ends so much technical knowledge about electric lighting." The cause of this exhibition of prophecy and science was a motion proposed by Bailie Macdonald, which was as follows:—"As the electric light is being extensively adopted by municipal authorities for lighting the streets, and for other similar purposes, it be remitted to the Corporation Gas Committee to report as to the propriety of introducing this system of lighting in Aberdeen, and the extent to which it may with advantage be used." The speech which has caused such a flutter of sensation, so far as I can see, consists of a denunciation of all those who cannot regard the electric light with the same favour as men of the Landale and Macdonald type, and swallow the oft-repeated assertion that electricity is the light of the future. With all his glorification of electricity, however, the Bailie observes that "there is nothing in the electric light to disturb the equanimity of investors in gas." An assurance like this, coming from such a quarter, is likely to allay excited feelings on the part of unfortunate holders of gas shares, and so far the gas world has reason to be thankful to the Bailie. I have looked through the speech carefully for the evidence of technical knowledge; but the reporter has negligently failed to give it to the world. I dare say no one will blame the reporter. The seconder of the motion gave excellent reasons for its rejection; and it was only adopted by the Council because it did not involve the outlay of any corporation funds. There is some satisfaction in the thought that the terrible fate of Edinburgh has had a salutary influence on the corporate mind of Aberdeen.

Turning from electricity to gas, I see that the Aberdeen gas accounts, which have just been issued, show that the Corporation works are still being conducted with that care and efficiency which are so characteristic of Mr. A. Smith's management. Last year, and again this year, the price of gas has been reduced to the extent of 1d. per 1000 feet, bringing down the price to 4s. per 1000 feet for gas of 30-candle power. When the distance at which Aberdeen is situated from the coal-fields is taken into account, it is astonishing to find the Corporation able to sell so cheaply. This year the Committee have applied £3400 of the sinking fund towards paying off borrowed money. From the revenue and expenditure account it appears that £33,338 17s. 10½d. has been expended in the manufacture of gas—this sum including £21,525 3s. 9d. for cannel coal; in the distribution, £1740 5s. 4d.; new buildings, mains, and other apparatus, £2615 8s. 8½d.; rents, rates, and taxes, £1550 16s. 10½d.; management, £1068 17s. 2d.; discount and bad debts, £159. These, with several other items, make up a total of £12,892 6s. 1½d. On the other side of the account it is shown that the sum of £44,155 1s. 10d. has been received for gas sold; £1652 5s. 8d. for meters; £539 16s. 5d. for coke; and £1591 0s. 5d. for tar and ammoniacal liquor. These, with a small sum for transfer fees, bring up the total to £51,217 9s. 10d., giving a balance in favour of the Corporation of £1855 3s. 8½d. The accounts will be presented to the Town Council on an early day.

Going still farther north, there is the same tale to be told of success in gas undertakings. At a meeting of the Gas and Water Committee of the Inverness Corporation on Wednesday evening, Mr. J. Thomson, the Manager, submitted a report on the estimated revenue for the year ending May 31, 1882. In this report the Manager states: "The profits last year amounted to £1087, and I have made my calculations on the same quantity of gas being sold as in the previous year, although, during the last five years, the increase has been over one million cubic feet per annum. I am of opinion, therefore, that the Commissioners may reduce the price of gas from 6s. 8d. to 5s. 10d. per 1000 cubic feet, as there would still be a balance of £194 in your favour. But I have no doubt there will be an increase this year also, which will make the balance still larger. This reduction to 5s. 10d. per 1000 cubic feet makes 2s. 6d. per 1000 feet that the Commissioners have been able to reduce the price of gas since they came into possession of the works five years ago, or a saving to consumers of £2668 per annum." With such a flattering and satisfactory report before them the Committee have adopted a motion recommending to the Commissioners that the price of gas be reduced to 5s. 10d. per 1000 cubic feet, the reduction to take effect from the beginning of the present financial year. While making this reduction in the price of gas, it is pleasant to note that the Committee have not been unmindful of the gentleman to whose energy and care so much of the success of the undertaking is attributable. They have formally recommended, but practically they have decided that the salary of Mr. Thomson be increased by £50 per annum.

The Provost of Elgin addressed the electors of the town this week, and,

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SOME NOTES FROM AMERICA.
(FROM OUR OWN CORRESPONDENT.)

Oct. 7, 1881.

The most interesting topic at the present time in the gas world on this side of the Ocean is the forthcoming meeting of the American Gaslight Association, which is to be held in Boston on the 19th, 20th, and 21st of the present month. The annual meeting of the Association is always looked forward to with a great deal of interest by the gas fraternity—an interest similar to that with which English managers regard the yearly meeting of the British Association, only that it may be a little more intensified in our case because there are very few local Associations here. Hence the occasions when managers are enabled to meet together and compare notes have more of the charm of novelty about them. There is every reason to believe that the forthcoming meeting will be in every way equal to its predecessors. Truly there may not be so many papers read as we are usually favoured with; but nevertheless there will probably be enough to fill up the time comfortably. If, however, there should be any lack of subject-matter for discussion, the extra time can very well be utilized in carrying out the social part of the programme. This latter feature of the meeting will doubtless be so enjoyable that the Boston gathering will stand as one of the red-letter meetings, for the Association will be the guest of the Boston Gas Company and also of the New England Association of Gas Engineers.

At last the large electric lights in Madison Square, New York, have been brought into working order, and shed their light on the surrounding space for the first time last Saturday evening. It can hardly be said that the lights are a success, and it would be premature to denounce them as failures. As the lamps and their reflectors are now placed, a large portion of the light is lost on the roofs of the surrounding buildings; and further, the foliage of the trees is a great hindrance to the proper diffusion of the light. There also seems to be a difficulty in keeping the lamps lighted. Experiments are in progress having for their object the removal of these difficulties; therefore further comment on the "tall pole" lights, as they are called, will be deferred to a future occasion. Madison Square

This same system of lighting is being tried at Denver, Colorado. Four towers have been erected in the suburbs of the city, one being situated at each of the four points of the compass. They were brought into action a few evenings since, and their success is of a similarly dubious character. The *Denver Tribune*, alluding to them, says: "The test was not very encouraging. But it surely must not be presumed that these four lights are intended to illuminate the city. The reflector of the rays is strong enough as far as it goes, but the one thing lacking is diffusiveness. Each tower reflects a dim shadow, at a distance of about six squares, to all points; but the actual illuminated area is reduced to about four blocks distant on all sides. The towers, therefore, are practically useful to a very small part of the city's area, but demonstrate the fact that they may become a very desirable substitute for gas, when a sufficient number are erected to illuminate every street in every portion of the city. The four towers now in use will furnish the basis of an estimate for the number that may be required." An attempt to carry out the same plan for lighting Hoboken, New Jersey, has had a *quietus* put on it for the present, in the shape of an injunction obtained by some of the citizens. Whether the order of the Court will be made permanent, or be dissolved, remains to be seen.

The danger resulting from the multiplication of the electric light wires in our large cities is exciting a considerable amount of attention at the present time. The discussion has been brought about by several accidents which have been occasioned by these wires, or more properly by the electric fluid with which they are charged. In Boston, a telephone wire of the Gas Company by some chance came in contact with an electric light wire; the result was the partial destruction of the two telephone instruments. The damage would not, however, have been so insignificant if the Gas Company's *employés* had not been on hand at the time. The whole subject was thoroughly ventilated at the recent meeting of the National Association of Fire Engineers of the United States, held at Richmond, Virginia. The outcome of the discussion was the passing of the following resolution:—"Resolved, that we, the National Association of Fire Engineers of the United States, urge upon the authorities of all cities and towns where the electric light is about to be introduced the absolute necessity of passing ordinances governing the manner in which all wires shall be strung for the purpose of producing the electric light. First, that the wires shall be distinct from all others; secondly, that they shall be thoroughly insulated; thirdly, that there shall be upon the exterior of all buildings, where the wires are introduced, an absolute cut out (not a mere shunt), so that in case the firemen are called upon, by cause of fire, to enter there, the danger of instant death—the inevitable result of coming in contact with improperly insulated or broken wires under very many situations—may be in a very great measure avoided."

Mr. Edison's latest achievement is a 1000-light dynamo machine, which has just been completed under his directions. It is stated that this is the largest dynamo machine ever made. By 1000 lights is meant that number of his loop lamps of 16-candle power. The machine has 12 magnets of 685 lbs. each. The cost of it is said to have been 6000 dols., and it is further reported that it has already been forwarded to London

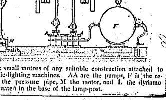
THE TRADESMAN.

A Powerful Light.

The London Times describes some experiments in public at the glass works of Messrs. Chance Brothers & Co., Smethwick, near Birmingham, with a new lamp which they have just constructed to crown the summit of the South Head Light-house, Macquari Harbor, Sydney, New South Wales. It is called a first order, dioptric, revolving light, with the electrical arc. The lamp has a special arrangement of prisms for securing vertical divergence of the beam. It is over six feet in diameter, and the height is about nine feet, and it is said to be the first time such dimensions have been applied to illumination by the electric arc. The lamp or regulator has a power of about 12,000 candles in the focus of light, and the merging beam has a luminous intensity exceeding 12,000,000 candles. The light will give flashes around half the horizon at intervals of a minute, and will make a complete revolution every sixteen minutes. On an average the light will be visible a distance of forty or fifty miles. The lamp was designed for Messrs. Chance by Dr. Hopkinson, F. R. S., and is constructed for the government of New South Wales. Its makers claim that it will be the largest and most powerful light in the world. The experiments were thoroughly successful, the light being so intense that it could hardly be endured with the naked eye.

The Metropolitan, Nov. 12. 1881.

Apparatus for Electric Lighting.—Letters patent have been granted to M. G. A. Tambourin, of Marseilles, in respect of an improved apparatus for electric lighting, of which apparatus we give a sketch-engraving. The invention relates to the separate and direct production of electric lights on different and distant points by means of compressed air or other fluids, which are prepared at a central station, and conducted through conduits at a proper pressure into the interiors of the lamp-posts, where these



fluids work small motors of any suitable construction attached to little electric-lighting machines. AA are the pumps, F is the receiver, H the pressure pipe, M the motor, and L the dynamo machine situated in the base of the lamp-post.

considered the electric lighting of mines would be easy to accomplish, he could not give a satisfactory answer, for he saw great difficulties in the way. These difficulties had been manfully dealt with by the gentlemen who had spoken, and from what he had heard there seemed to be a greater prospect of success than he had anticipated. The backbone of the question was the incandescent lamp, the Swan lamp, which would enable them to keep the light from the atmosphere of the mine. Mr. Swan had shown them that they could produce a lamp of 2-candle power, such as miners would require at their work. The great difficulty that must assuredly exist in the mind of every electrician was that of contact, such as might produce a flash of light, which would fire the mine. In dealing with this, Mr. Jamieson had advised several means whereby the contact and disconnection of the wires could be carried out without a spark. This was one step towards the taking away of danger. Mr. Swan's little lamp commended itself to him (the Chairman), for it was one that could be carried away entirely from the conductor, and the miner could go and fill it with a chemical charge, which would enable him to produce electricity, the same as he now filled it with oil. With this store he could return to his work for a whole shift without any connection, which would be a serious difficulty in mines. The area, too, of mines being exceedingly rough, the danger of the breakage of the wires would be very great. Taking it all in all, he thought it had been shown that the risks which had heretofore been thought insuperable in the lighting of mines by electricity had been overcome, and he hoped to see the system introduced. With regard to the question raised by Sir John Hawkshaw, he thought the Swan light would be found eminently useful, and quite suitable for the purpose, as they would be able to get a good distribution of light without any risk.

Mr. J. W. Swan (Newcastle-on-Tyne) subsequently read, before the same section, a paper on

THE SWAN INCANDESCENT ELECTRIC LAMP.

The author said the great difficulties in producing electric light with carbon points were to make it steady, and to moderate its excessive brilliance. By dint of improvements in the form and quality of the charcoal pencils, and ingenious mechanism for maintaining the points of these pencils at one constant distance from each other, the first of these difficulties had, to a very large extent, been overcome. The second had remained, and must remain, as an insuperable obstacle to the application of this form of electric light to the general purposes of artificial illumination. This form of electric light was applicable only to the illumination of railway stations, streets, &c., leaving the greater number and the more important wants in respect of artificial light unprovided for. It was in his (Mr. Swan's) opinion inapplicable to domestic lighting; and it was there that the evils of the existing modes of artificial illumination, by means of gas and oil lamps, were experienced the most keenly. In order to adapt the electric light to house illumination it was necessary to entirely change the method of producing it. Starr was the first to conceive the idea that it might be possible to produce an electric light, both small and steady, by heating to a white heat a thin piece of carbon. Electric light produced on the principle of incandescence had many good properties which the arc electric light had not. If the current which produced the incandescence was constant, the light emitted by the white carbon was absolutely steady; there was not the slightest flicker or variation in it. It was, moreover, quite under control as to its brilliance, and might be made as yellow as gaslight or as white almost as sunlight. It communicated no noxious vapours to the air, and was not too costly; but the crowning merit of electric lighting produced on the principle of incandescence was that it was indefinitely divisible without sacrifice of economy. A lamp might be so constructed as to give a light of 10 candles, or it might be constructed with larger carbon conductors so as to obtain a light of 100 candles from the incandescent carbon; and the smaller lamp would be almost as economical as the larger, light for light. That was to say, the 10-candle lamp would only use one-tenth of the power, and therefore cost one-tenth of the amount to maintain it, that was required by the lamp which gave ten times the light. This property of divisibility into as small centres of illumination as might be required, combined with the steadiness of this species of light, its good colour, and its wholesomeness, gave to it a character of very general applicability which was not possessed by any other kind of electric light. It was 40 years, the paper continued, since Starr took out his patent for producing light on this principle; but it was only within the last two or three years that the many practical difficulties that beset the utilization of this method had been surmounted. Nothing could well be simpler than the ideal incandescent lamp. A slip of carbon, in a vacuum, that was all. To realize this idea much experimentation had to be gone through, and much disappointment to be suffered. In the vacuum lamps of earlier date it was neither possible to produce, nor to maintain a perfect vacuum; there were always screws and washers about them, and these and the carbon itself, in a cold state, formed a reservoir of air quite sufficient to cause the disintegration and rupture of the carbon after a few hours' ignition. Besides this difficulty of the carbon soon breaking, there was a further difficulty in the blackening of the glass enclosure. From elaborate experiments made by M. Fontaine, and published in his work on "Electric Lighting," the conclusion was arrived at that the blackening of the lamp-bells was due to the volatilization of the carbon, and that the breakage of the carbon was also a consequence of this action—objections, if valid, quite final to the practicability of this method. In short, at the period of his (Mr. Swan's) experiments, four or five years ago, electric lighting by the incandescence of carbon in vacuo, was completely discredited by the crudity of all the attempts that had been made to apply the principle, and by the fallacies which had grown out of these unsuccessful attempts, and which obtained general acceptance. So much was this the case that in the report of the Select Committee of the House of Commons on Electric Lighting, issued in June, 1879, and in connection with which evidence was given by all the highest electrical authorities of the time, there was no mention whatever of the possibility of producing light in this way. [illegible]

[illegible]

hich took place on this paper, Mr. Douglass, Engineer y Board, expressed his belief that the light of the future ses would be a combination of gas and electricity; while ey described electricity as "a wild animal which can ; in subjection whilst confined in a cage, and is uncon- en turned loose." On this account, and on the question was in favour of gas.

esday, Mr. Hawksley read a very interesting paper on sure on Plane Surfaces, to which subject the fearful Tay ident recently attracted so much attention. The author hat in structural calculations a wind pressure of 40 lbs. re foot may be safely adopted as the maximum in this le stated:

rd to the phenomenon called "a gust of wind," nothing is er as to its cause, as to its exceptional but almost momen- , or as to the extent of the area over which it temporarily t it is, notwithstanding, certain that a wind pressure of even he square foot is unknown in these islands, because, as may hown, the intensity of pressure would suffice to have over- t of the long existing factory chimneys, to have overset post and to have scattered the greater number of the slighter-built d other structures which have nevertheless "weathered many d still remain intact. As to whirlwinds, tornadoes, and water- the results of spiral motions, apparently produced in some nner by electrical action—these phenomena are very rarely occur on an important scale in these kingdoms. The powerful erned in or generated by these erratic movements have never red, and consequently cannot be formulated; but it may be at were they known they could not be introduced with pro- calculations of the strength of structures intended to have a value, because of the extreme improbability of any particular lling within the range of their destructive effects. They fall, hin the legal category of "Actus Dei."

scussion took place on this paper, in the course of which as, the President of the Meteorological Society, observed aper did not appear to take note of whirlwinds, of which been four in this country during the present year. He that the roof of a large railway station at Vienna had ed away by one of these phenomena, and he should not be some day to hear of the roof of Cannon Street station or r of our large stations being lifted off and borne away. ted to hear of more wonderful results of this mechanical n the neighbourhood of Baldock, four malt-houses had been and some of the slates from them were embedded in living axe-heads. If they had to construct their buildings strong o provide against whirlwinds the cost would be something . Sir F. J. Bramwell concluded the discussion by pointing the practical question was whether it was worth while to uctures of such strength as would enable them to resist es, or only sufficiently strong to meet ordinary storms. It l to him to be one of those things where a certain amount of nust be run. Bridges and structures of this kind, if made to irlwinds, would not only be very costly but too weighty.

Notes.

THE NEW JAMIN LAMP.

amin, already famous for his improvements in electric lighting, y described a new electric lamp, in a memoir presented to the nie des Sciences. This new design appears to be an attempt bine in one apparatus the more prominent advantages of the d the incandescent lamps. The most remarkable feature of the s the placing of the carbons, by which the usual arc-light is ained, in a closed globe filled with inert gas, or otherwise in a um. If the sealed globe is full of common air when the current urned on, a curious phenomenon is observed—the vessel is first ed with ruddy vapours from the combination of oxygen and trogen under the electric influence. This compound is soon destroyed, and the gas again becomes colourless; the hypo-nitric acid ing decomposed, to supply oxygen to the carbon. Ultimately thing remains but nitrogen and carbonic oxide. The electric arc eanwhile undergoes regular modifications of colour; and, when all he chemical transformations of its atmosphere are completed, it is reduced to a well-defined flame of a bluish-green tint. It also becomes absolutely fixed, without (it is said) any fading of intensity, or shifting in colour or position. M. Jamin states that he has not observed the same invariability of lustre in any other case. The spectrum of this light is crossed by a great number of fine lines, and is of very [illegible] brightness in different parts. The *maxima* of brilliancy are [illegible] in the yellow-green, the green, the blue, and the violet, which consequently alone remain visible when the light is diminished. It is the electric spectrum of the vapour of carbon rendered incandescent without burning. Ordinarily, in air, the case is different. Then the carbon burns, and the arc is red; and, alternating with the foregoing spectrum, is the totally different one which proceeds from simple combustion. It is therefore evident, according to M. Jamin, that in an inert gas the arc is simply a current, a purely electric phenomenon; and as it is divested of the irregularities due to combustion, the light may be much more easily fixed and controlled. An important consideration is that in the new Jamin arrangement the carbons do not wear away. In the close globe the carbons only consume at the rate of 2 millimètres per hour, and each lamp is made for 800 consecutive hours' burning. In practice it is found necessary to reduce the size of the globe containing the carbons as much as possible; and, as in the Swan or Edison lamps, to carefully prevent the outer air from entering when the apparatus is cold, whilst allowing the interior gas to escape by means of a valve when the lamp is in action. We have here the same difficulty as was experienced by Edison and others—the liability of the vacuum globes to admit external air—and there is no description given by M. Jamin of the means he proposes to overcome this hitherto fatal defect in all similar arrangements.

A CURIOUS GAS-PRODUCING SUBSTANCE.

There has recently been found in Mexico—according to the *Coal Trade Journal*, of New York—a kind of light brown sun-baked clay, which (on analysis) has shown the following percentage composition:—Moisture, 2·71; hydrocarbons, volatile at a red heat, 71·00; fixed organic carbon, 8·99; ash, 17·30. The ash consists mostly of grains of quartz, and the hydrocarbons—much larger in quantity than is afforded by the best bituminous coals—give, when burned, a clear luminous flame, apparently free from sulphur vapours. Distillation affords a red, oily substance, of nearly the consistency of butter, and having a very offensive odour, which however is not perceived when burned. The origin of this mineral is not clear; but is thought to be probably due to causes similar to those which originated the oil-bearing strata of Pennsylvania. It is assumed that, in such instances, gaseous hydrocarbons are formed from the decomposition of organic remains, which become liquid under pressure, and the liquid is readily absorbed by disintegrated rock or quartzose sand. The structure of the substance is said to show lamination—proving that it has been under great pressure.

WIND POWER FOR ELECTRIC LIGHTING.

In an address delivered before one of the sections of the British Association at York, Sir W. Thomson spoke of the utility of wind power as of possible service in electric lighting. He said that cheap windmills, in connection with dynamo-electric machines and Faure's batteries, would supply a great want. A Faure cell, containing 20 kilos. of lead and minium, charged, and employed to excite Swan's lamps, would give 60 candle-hours—that is, an aggregate light of 60 candles for one hour, or the light of one candle during 60 hours. The charging of such a cell could be done, with good dynamo economy, in any time from six to twelve hours, or more; and the charge might be drawn off, very economically, in any time of from five hours to a week or more. As calms do not often last above three or four days at a time, Sir W. Thomson argues that a five days' storeage capacity would, in general, be sufficient. One of the 20-kilo. cells already mentioned, charged at any time when the windmill works for five or six hours, could be used six hours a day for five days, giving a 2-candle light. Thus 32 cells would be required to give the light of four burners of London 16-candle gas. The probable cost of dynamo machine and accumulator (which we may take at £250 in this case) would not, in Sir W. Thomson's opinion, be fatal to the plan here sketched out, if the windmill could be obtained at anything like the cost of a steam-engine of equal power. Sir W. Thomson confesses, however, that windmills are very costly machines; and, without inventions not yet made, could not be economically used to give power for storing up electricity in Faure cells or in any other manner.

THE EFFECTS OF HEAT AND LIGHT FROM GAS ON VEGETATION.

Some experiments have recently been carried out to show the effect of gaslight, as well as the heat produced by its combustion, upon vegetation. These have resulted in a curious modification of the normal structure of plant-stems being observed by a M. Prillieux, when the temperature of the ground about the plant was made higher than that of the air above. Beans and pumpkins gave the best results. The seeds were placed in earth in a large dish, in which was inserted part of a brass rod bent at a right angle and having a gas-flame applied to its horizontal end. The chamber was moist and cold. The seeds germinated well; but on coming above ground the plants acquired a peculiar shape. They grew but little in length, and became unusually thick; the latter growth involving much tension in the surface layers, so that deep rifts before long appeared (mostly transverse) and made further growth impossible. The excess of the temperature of the ground over that of the air was about 10°. Again, the view adopted by the older botanists that light is either without effect on germination, or has an adverse effect, fails to harmonize with some results lately arrived at by Herr Stebler, in the case of many seeds of agricultural importance, such as varieties of meadow grass, the germination of which he finds to be favoured considerably more by light than by heat. Thus, with two groups of 400 seeds each in one experiment, there germinated in light 62 per cent., and in darkness 3 per cent. Similarly with another species of seed—in light, 59 per cent.; in darkness, 7 per cent.; and so on. Sunlight being a very variable force, difficult of determination, experiments were further made with gaslight, and with the same result—that light favours the germination of certain seeds, especially grasses, and that these germinate either not at all, or very scantily, in darkness.

MOTIVE POWER AT THE PARIS ELECTRICAL EXHIBITION.

The provision of the necessary motive power for the various electric lamps at the exhibition now open at the Palais de l'Industrie in Paris has been a matter of great anxiety to the administration. After many other courses had been discussed and dismissed, it was decided to allow the exhibitors to form a syndicate to undertake the establishment of motor engines, and the distribution of power to the different stands, according to the requirements of the exhibitors. About two dozen of these latter gave adherence to the plan; but some important names do not appear in the list. The number of lights supplied by the syndicate is 523, of which 446 are classed as small, and only 77 are large. The whole of the engines and dynamo machines occupy a space 315 feet long and 98 feet wide, or about

THE METROPOLITAN.

THE ELECTRIC LIGHT.

On Thursday, in the Mathematical and Physical Science Section, Dr. C. W. Siemens read a paper detailing a series of experiments he had made with the view of showing the influence of the electric light on vegetation, and the application of electric energy to farming operations. The most recent of these experiments were made between October of last and May of present year, the electric light being in operation from 5 and 6 p.m. until the dawn of the following morning. The general results of these experiments went to show that the electric light was capable of producing on plants effects comparable to those of solar radiation and favourable to healthy growth. As to the theory of plants not being necessary to plant life, Dr. Siemens gave as his opinion that the result of his experiments, that, although parasitic plants evidently favoured growth, the continual stimulus of light appeared to promote healthy development and to reconcentre the plant through its different stages of flower and fruit. The questions, however, of temperature and the intensity of the electric light still remained to be dealt with experimentally with the view of determining the best conditions. Dr. Siemens also gave the results of experiments which he had made in applying electric energy to farming operations, including the pumping of water, ploughing, &c. He had been so strongly impressed with the results obtained that he thought the electric transmission of power might eventually be applied to the thrashing, reaping, and ploughing—in fact, that all the work of a farm might be directed from a central station of electric power, instead of being carried out, as at present, through the agency of steam. So far as he had gone, the electric apparatus had been under the sole charge of his head gardener, with the assistance of under-gardeners and field labourers, who had probably never before heard of electricity.

The Journal of Gas Lighting, Water Supply & Sanitary Improvement. Sept. 6. 1881.

THE PROGRESS OF ELECTRIC LIGHTING.

From different parts of the country we continue to receive conflicting accounts of the fortunes of electric lighting. At Edinburgh, as described in our own correspondent's letters last week and in the present issue, the experiments with the Brush light, which were to have lent additional brilliancy, to a masterly manner, to the occasion of Her Majesty's visit to the Scottish capital, ended in a complete *fiasco*. The commercial men of the local newspapers on this affair are amusing. Although on the first occasion when the light was tried, it went out altogether after a flickering existence of only about twenty minutes, the Scotsman described in a lively print as "eminently successful." On the following night the collapse was even more signal, for the gas lamps, which on the former occasion were still available, had been turned off to allow the electric light full swing. When, therefore, the sudden extinction experienced on the previous evening was repeated, the crowds of people thronging the streets were left without guidance to find their way home as best they might. In Glasgow, the Committee of the Corporation, to whom a proposal to introduce the electric lighting into the city was recently referred, have reported adversely thereto, on the ground that they had not sufficient confidence in any of the electric light systems now before the public; and this when it is consequently to be used indefinitely. In Dublin the electric lighting contractors have had to explain why the district confided to them was recently plunged in darkness. "This mishap we trust," they "will not discourage again." As against this concensus of complaint, the Crompton light at Norwich must be recorded as having given great satisfaction, notably to the self-appointed test members of the British Gaslight Company in the Corporation. As even a child's nightlight would, by those gentlemen, be considered superior to the finest Argand burning the Company's gas, their judgment in the matter of the Crompton light may not be deemed quite impartial. We do not consider it necessary to devote space to congratulate Mr. Crompton, or to condole with the British Company, on either of the one sinecure light to be called in question; but our readers may be allowed to form their own opinion on these brief records of interesting facts.

ANSWERS TO CORRESPONDENTS.

L. C. G.—The publication of your letter would be an useful process, the Board of Trade having declined to sanction the proposition of Mr. Preece.

L. London.—Apply to the Secretary of the Metropolitan Gas Company's stock will take place early in November next.

The Cost of Electric Lighting.—The annual report of Lieut.-Colonel Donnelly, the Assistant-Director of the South Kensington Museum, which has recently been issued, contains some interesting particulars in regard to the cost of electric lighting as compared with that of gas. We find on reference that some of the figures included in this report have already been published in these columns; but as they are now given in a more complete form, and on the authority of the official specially entrusted with the charge of the building, we offer no apology for returning to the subject. Colonel Festing stated that the consumption of gas at South Kensington during the past twelve months shows a diminution as compared with the previous year of 2,230,000 feet, and of 5,647,000 feet. This diminution he attributes to the fact that since March, 1880, one-half, and since June the whole of Lord President's Court has been lighted by the electric light. The circumstances under which the rest of this new mode of illumination was suggested may be briefly stated. Sir Frederick Leighton having expressed his fears that the mural painting recently executed by him in the Lord President's Court might be injured by the gas, it was decided to try to light this court by the electric light. The "Brush" system, which had quite lately been introduced into this country from America, appeared to the authorities in many respects to be that best suited for the purpose, and a dynamo-electric machine and eight lamps on this system were therefore purchased to light up the eastern half of the court. The machine was driven by the gas engine, and the result was so far satisfactory that it was determined to extend the lighting to the other half of the court; but as the gas engine is not sufficiently powerful to work the sixteen lamps a more powerful steam engine was purchased for the purpose, and placed in a temporary shed outside the building. Towards the end of June the lighting of the whole court was commenced, and has been uninterruptedly continued ever since. Between the 22nd of June and the 31st of December the sixteen lamps were at work on eighty-seven nights for a total of 370 hours, and the working expenses for this period amounted to £69 2s. or 3s. 10d. per hour of lighting. The consumption of gas which used to be at the rate of 2ft. an hour for the same period has been at the rate of 1,230 ft. The annual working expenses, Col. Festing says, has therefore been £218 2s., or at the rate of about £420 per annum. The outlay for dynamo-electric machine, lamps, steam engine, shafting, &c., including the cost of fixing the machinery, amounted to £1,041. "As, however," adds Colonel Festing, "the steam engine is capable of driving two such machines, the cost of the machinery and apparatus for lighting the court may be set down in round figures to have been £2,000, while to outlay the saving on working expenses, as compared with gas, amounts to 17 per cent. per annum."

Electrical Exhibition at the Crystal Palace.—The second series of international exhibitions at the Crystal Palace inaugurated this summer by his Royal Highness the Duke of Connaught will be an electric exhibition. It is intended that this exhibition shall be opened in December, and that it shall continue during several months. Nearly all the systems of electric lighting will be represented at the Crystal Palace, so that manufacturers, theatrical managers, and others, who are thinking of applying electric lighting to their factories, warehouses, theatres, &c., will, for the first time in England, have an opportunity of comparing the various electric lights, and judging for themselves which will suit their local circumstances best. In addition to the many and various systems of electric lights, Mr. Edison will have a complete exhibit of his numerous inventions. The Edison-Gower-Bell Company will be strongly represented. Faure's and De Meritens's secondary batteries, Trouvé's boats, and many other scientific exhibits will be seen; and the managers hope to make this exhibition the most interesting to the public and the most important in a scientific point of view, that has ever taken place in England. As hon. secretary to the exhibition and industrial gentlemen is now being formed to advise and assist the directors in their undertaking. The Lord Mayor has convened a meeting at the Mansion House for Monday, Oct. 24, at 3 p.m., to consider the question of holding the exhibition at the Crystal Palace.

FORMS AND FUNCTIONS OF THE ELECTRIC DISCHARGE.

ON the Monday evening devoted to the meeting of the British Association, 1877, Professor Tyndall, F.R.S., delivered a lecture on "Electrical Discharges: its Forms and Functions," in the course of which he remarked:—"We have only to observe the phenomena which we have been studying here to perceive that they are in the highest degree significant, not merely as regards science, but whether the conclusions of science be true or false, as regards any explanation of natural facts. Many natural phenomena doubtless fundamentally connected with electricity have many years been left lying before us. But there are two in particular—namely, lightning and the aurora—which have attracted the attention of mankind, and which are undoubtedly electric in their origin, and with the characters of which the most distinguished men have occupied themselves. We have no aggregation of aqueous vapour, which is enough to show that electricity is suspended in the air. All of these phenomena are, I think, strongly suggestive of electrical action, and are certainly not excluded from further conclusions. By these considerations I was led to the experiments which I have described in the opposite scenes, and as soon as the electric light was sufficiently within reach, I endeavoured to see if its discharges assume sufficient resemblance to the lightning discharge to throw any light on the origin of lightning. A similar action may naturally take place in the case of the aurora borealis. The quantity of light required for a flash of lightning is of course enormous. The light of a candle is less than 3,500,000 cells would be required. There is, however, no reason why the light of a flash of lightning should not be produced by electricity. It is, on the contrary, extremely probable, to say no more than that the electricity of the cloud which produces the flash of lightning is discharged in the form of a luminous arc. The most striking general characteristic of the discharge is its zigzag course or its sinuosity, and disappearing in the air, and the manner in which it breaks up into branches. Then the question arises, what is the function of which it is the mechanical expression? Is it merely a necessity, a thing which must be, but which has no function? Or has it a function? Is it, for example, the means by which the electricity of the cloud is distributed over the earth? Is it the means by which the electricity of the earth is distributed over the cloud? Is it the means by which the electricity of the earth is distributed over the cloud? Is it the means by which the electricity of the earth is distributed over the cloud

Chamber's Journal, Dec 1887.

OCTOBER 15, 1881.

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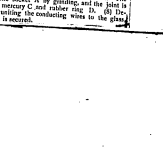
Board of Works announce that they are prepared to receive proposals and estimates from electric lighting companies and others for lighting certain parts of the Strand district with the electric light.

Electric Lighting at the Mansion House.—The General Purposes Committee of the Corporation having invited tenders for the lighting of the state rooms in Egyptian Hall of the Mansion House with the electric light, seven companies responded. After due consideration the committee have resolved to submit to the Court of Common Council for approval the tender of Mr. Crompton, of Mansion House-street. The system is the same as that used at Sandringham during the visit of H.R.H. the Prince. The contract is to light the saloon and Egyptian Hall for 100 nights at £415, £300 being for the lights, and £115 for working expenses. If, at the expiration of twelve months, the Court decide to purchase all the necessary fittings, the expense will be £1,200, less the £300 paid for the year's lighting.

Electric Lighting at the British Museum.—Since the use of the electric light in the Reading-room of the British Museum was last discontinued for the summer season slight improvements have been introduced with a view to get rid of the glare, which caused readers some annoyance. Each ground glass globe has been divided laterally, and the upper half removed, leaving the light in a sort of glare cup, and open in the direction of shade immediately above, which reflects the rays down into the room. The change answers its purpose, though the glare has become somewhat stronger. The electric lighting was resumed for the winter on the 1st inst., and the average attendance of late readers—the number who, between 6 o'clock and 9, and at 10 o'clock, 121. At 9—is only about 1,000 books except the books of reference in the room, for which no tickets have to be filled out, must be given in to the attendant—there were 88 persons present, most of whom remained till seven o'clock, the time of closing. Each reader's place has been allowed for library books, which may now be retained for a quarter to seven. Saturday, as our readers are no doubt aware, is the busiest of all days at the reading room, the number of readers in the earlier hours of the afternoon on that day being generally between 500 and 600. On Saturday last no fewer than 1,000 were counted at the time of lighting up; at six there were 780, and shortly before closing time 130. The system of extended hour rendered possible by the use of the electric light first came into operation on October, 1879. The proportion of readers who avail themselves of this valuable concession shows, on comparison of month with month, a slight tendency to increase.

Electric Lamps.—We illustrate below the main features of an invention of T. A. Edison, of Menlo-park, New Jersey, U.S., in respect of which letters patent have been granted to Mr. J. G. Stewart, of 33, Chancery-lane. The invention relates (1) to the conductors by means of which the current is brought, and is led away or out, as the case may be, from the lamps, and is not a new upwards by a vertical platinum carrying a conductor. (2) In order to prevent heat from the incandescent material being carried down to the point where the conducting wires are fused into the glass, a long interval is interposed between the clamps of the carbon and globe, and the conducting wires are supported by a glass pillar. (3) Lamps to be used in mines may be cheaply constructed of a globe, a sealed glass sphere, and protecting conductors. (4) Figs. 1 and 2 show an arrangement whereby the intensity of a lamp may be modulated at will. The case B contains in its clearance ring of heavy carbon, shown in Fig. 2. One main conductor is attached to the stud in the centre, and the current flows through the metal arm F to any one of the contact pieces a, to which the arm may be applied, by means of its external knob. In the illustration the arm rests on the contact of the second leading wire and the carbon resistance is out of circuit, but any number of its wings may be included in the path of the current. (5) Several forms of glass supports to prevent the heated air from over the fuse are illustrated. (6) The form of the glass stem through which the wires pass is modified so as to obtain an air-tight joint. (7) Fig. 3 illustrates a modified method of sealing the lamps; W is a wooden base A a glass socket fitted thereto, of a form resembling a W in cross section. The globe B is fitted into the socket A by grinding, and the joint is further secured by the cement C and rubber ring D. (8) Describes a new way of uniting the conducting wires to the glass, whereby a long contact is secured.



Journal of Gas Lighting &c. Oct 11th 1881.

Electric Light at the Rolling Stock.

Mr. J. H. Vail, representing the Edison Electric Light Company of New York city, has completed his contract for placing one hundred and twenty-five eight-candle power incandescent electric lights in the works of the United States Rolling Stock Company, in this city, and which, we learn, is the first of the Edison system introduced in Ohio. These lights were on exhibition to the public on Tuesday evening, and great satisfaction was expressed by all spectators at the exceeding steadiness and pleasantness of the light.

The dynamo electric machine is placed in one corner of the wood working room, and is driven at a speed of thirteen hundred revolutions per minute. The power is taken from the line shaft to a countershaft, having a tight and loose pulley, and thence belted direct to the dynamo. One hundred and twenty-five of these lights are placed in various portions of the extensive building, including the office, and at various machines as occasion may require. Each light is of full eight-candle power, or about equal to a five-foot gas light. Any one light can be turned on or off independently of all others. The lights in the above works are arranged to be turned off in sections or rooms.

The Edison system of lighting is particularly safe from all danger of fire, and the beauty, brilliancy and steadiness of the lights render them particularly valuable for lighting houses, stores, mills, factories, etc.

Since the excellent lighting qualities and cheapness of this light was satisfactorily displayed at the rolling stock, several of our merchants are negotiating with Mr. Vail, and we may, ere long, have the Edison electric light in several stores, factories, etc., in this city.

Messrs. J. H. Vail and C. E. Terbune, who have been placing the electric light in rolling stock works, are accomodating gentlemen, and their attention given the visitors on Tuesday evening, was highly appreciated by all.

ELECTRICITY *VERSUS* GAS.

The past week was to have seen recorded two new and striking illustrations of the advance of electric lighting, and of its success as a rival to gas. One of these was the lighting of the new Savoy Theatre; the other, that of the great temporary hall erected by the Lebanis of Leeds in which to give Mr. Gladstone. The Savoy Theatre is still unopened as we go to press, but we have been told, in the words of the proprietor, "the very complicated works and experiments" seem to be with the applications of the electric light to the "stage." We can readily imagine that the complication has increased as the works have progressed, as the inability of the contractors to meet the difficulties which have arisen has already necessitated two postponements of the opening night. A rehearsal of the lighting arrangements last Saturday evening resulted in a breakdown, and there is every probability that when the public are at last admitted, "Patience" will be recommended for yet a little while, and in the meantime the familiar gas will be employed till these difficulties are finally overcome. The system here adopted is that of Swan's incandescent lamps; and, as an address to the public, issued by the Manager, states that "the enterprise of Messrs. Siemens Brothers and Company has enabled us to try the experiment of exhibiting "this light in my theatre," we assume that this firm have undertaken the responsibility, and in some measure the expense of the work—looking to it, in the event of its success, as a great advertisement. Consequently we shall again find an impossible to ascertain the cost at which the work has been executed and the lighting carried on. We shall probably have occasion to return to this experiment next week, and in the meantime it is satisfactory to know that the Company has held on, "in case of accident the theatre can be flooded with gaslight in a few seconds."

The lighting of the "Gladstone Hall" at Leeds, as described in our news columns, furnished a rare opportunity for comparing the two illuminants; and it is matter for congratulation that Mr. Henry Woodall, on behalf of the Gas Committee, made such excellent use of it. Called in to serve a very humble secondary part, gas appears to have taken the chief place, and to have carried off all the honours. This is in no respect surprising. Whatever may be the effect produced by a multitude of incandescent electric lamps, there can be no doubt that none are powerful are lights are not suited to the purpose of a holiday gathering, where bright colours in dress or decorations need to be reckoned with. On the night in question rain was falling, and the air was damp and chill; and if one had wished ill to the prospects of the electric light in Leeds, a worse fate could hardly have been desired for it than to be left alone, with its cold and cheerless radiance, to receive the unmerited disgraced guests under such conditions.

Turning from the question of beauty of appearance and of comfort, what can be said to that of cost? Time it is not the good fortune of other towns to have a gas supply at quite so cheap a rate as Leeds; but at any ordinary rates the comparison will be sufficiently striking. To light a hall such as described *elsewhere*—having, we believe, a superficial area of about 20,000 square feet—as it was lighted with an expenditure of 1800 cubic feet of gas per hour, even though it cost considerably more than the Leeds price of 2s3d per thousand, is to give any competitor a difficult task to equal. The arrangements attended that effort to show the capabilities of gas in the position to which it has become rather a fashion to say that the electric light is peculiarly adapted, should encourage other contests at a similar nature whenever opportunity is afforded. The great improvements which have recently been made in burners, and by which Leeds gas was greatly aided on the occasion in question, help decorative point of view; and in this direction—the further improvement of burners, and still more in the wise use and arrangement of them so as to produce the best effect from the gas used—there lies a field as large (we wish to put this strongly) as there does before electricians in their efforts to compete with gas as it is commonly employed at the present time.

DANGERS OF ELECTRIC CURRENTS.

It at least one respect the result of the Paris Electrical Exhibition is not to the advantage of the electricians. To say nothing of lighting, it has been attempted to be shown at the Palais de l'Industrie that currents of electricity at high potentials are competent to serve unmolested purposes in dwelling-houses, warerooms, &c. Unfortunately, several minor outbreaks of fire from overheated wires, and not a few serious accidents to incautious visitors, have left an impression that electricity is not always the docile, harmless agent it has been claimed to be. We have all heard how edifices and other fires were to become unknown when electric lighting should be general; and how the danger of explosion—always present when coal gas is carelessly handled—would not be represented by any drawback of like potency when the reign of Edison and Swan should commence. It is well known now that while the risk of fire is at least equal in the cases of gas and electric lighting, the careless individual, in exchanging one for the other, merely avoids the danger of explosion for that of a lightning-stroke. The *Times* correspondent has lastened to reassure the public that when electric wires are laid and lamps constructed under the supervision of competent electricians, there is no danger of either fire or shock; and that the frequency of both at the exhibition was due to the fact that too much responsibility for such details had been left with ignorant workmen. We are not accustomed to hear the attendants at show places accused of ignorance of their business; and we may be considered that if the Palais de l'Industrie, under all the various Syndicates, Boards, and Commissions there in session, was badly fitted, it is a poor outlook for the security of smaller installations. And, on the other hand, if competent electricians, with commensurate salaries, are required to be as common as gas-fitters, the cost of retail electric force is likely to remain high; or a new and superlatively intelligent race of workmen, content to work for humble rates of wages, will have to be developed.

M. Y. Jones
Observer Sep 4, 1881.

THE EDISON ELECTRIC LIGHT.

WHY THE MASTS IN THE DOWN-TOWN DISTRICTS HAVE NOT YET BEEN LAID.

No little excitement exists among those who blieved their hopes upon the success of the Edison Electric Light Company in the matter of the down-town end of the system, and who had base their investments upon the understanding of October last. The company have sufficient capital, and the work of laying the mains is being pushed forward as rapidly as can be consistent, that are as far away from that end of the system as ever. Some months ago a number of poles were erected in the down-town districts, and these are beginning to require wires. Accordingly the company have applied to the Board of Aldermen for permission to string the wires on these poles, but the Aldermen positively refuse to grant the permission. We Aldermen positively refuse to grant the permission. We are heavy to make connection. We Aldermen positively refuse to grant the permission. We are heavy to make connection. We Aldermen positively refuse to grant the permission. We are heavy to make connection

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THE EVENING POST: DECEMBER 1, 1881.

THE ELECTRIC LIGHT.

Its General Introduction Down Town Postponed until Spring—The Troubles of the Edison Company—Unfulfilled Contracts.

The electric-light companies of this city are all more or less embarrassed by the difficulty of obtaining machinery and material for their mains and wires. The Edison Company especially has been delayed by the want of boilers and the need of large quantities of iron pipe for their street mains, of which nearly five miles have been laid in the down-town district since summer. About one-third of the district has been finished, and the work is now going on at the rate of one thousand feet a night, no work being done during the day to avoid interruption to traffic. Since the contracts for material were made last spring the prices have gone up, and many of the contractors delay carrying out their agreements. Suits have been begun against some of them. In the matter of copper wire, the large consumption by electric-lighting companies in the last two years has resulted in raising the prices to unreasonable figures. Major Eaton, of the Edison Company, estimated to-day that the company had used two hundred tons of ingot copper since spring, and would continue to use about two million pounds a year until the work in this city was done. The contracts for iron tubing stipulated that it should all be delivered by the 15th of August, whereas no one knows now when the work will be done.

The difficulty in getting boilers has also been one of the chief troubles of the Edison Company, the boilers furnished last month proving to be defective, owing to errors in construction resulting, as alleged, from hurried work. It is therefore now probable that the work of putting down mains will have to be suspended when frost sets in and the lighting of the down-town district postponed until spring. During the winter material can be stored up and the machinery made ready to begin lighting upon a large scale in April. Several buildings which want the Edison lamps sooner than that and have steam power at hand have contracted for the use of the proper machinery and will not wait for the street mains. Mr. Bennett signed a contract the day he sailed for Europe, providing for the introduction of 653 lamps in the *Herald* building; the boilers and dynamos will be placed in the Bennett building in Ann Street, the mains now running under Fulton Street. Provision is also to be made for the use of twenty-five-horse power of electricity for the running of small presses, wetting-machines, etc. Wallack's Theatre will not be lighted by electricity because Mr. Wallack considered the price demanded for the use of the patent (said to be $15,000) exorbitant. Major Eaton said to-day that to sell Mr. Wallack the right to use their light during the life of the Edison patents would be injuring the regular business of supplying customers from a central station. He was sure that eventually Mr. Wallack would use the Edison light when it was brought to his door just as gas is now, and the company's price for the use of the patent will have to be sufficiently high to equal the profits of many years' consumption of electricity. Especially in theatres would the small incandescent lamp of Edison be indispensable, because any number of lights can be placed in all sorts of positions, up in the flies or under the stage, or in the middle of fountains, without the necessity of running cumbrous gas-pipes or the slightest danger from fire.

The Edison Company have just received news through Mr. Henry Villard, who has recently returned from the Pacific coast, of the perfect success of one of the first of the company's experiments in practical lighting. In May, 1880, the company put a number of their lamps in the *Columbia*, one of the Oregon Navigation Company's steamships plying on the Pacific coast, and the lamps are still in use and give perfect satisfaction.

Mr. Edison has been for several weeks at Menlo Park, working at the lamp with a view to making it last longer than at present. He is also finishing his machines for the electric railway two miles long which has been built across-country near his factory to demonstrate to railroad men the practicability of electricity as a motive power. One Western road has invited Edison to make electric engines for a branch road fifteen miles long, and Edison has accepted. This will be many times the length of the Siemens road near Berlin.

Mr. A. A. Hayes, Jr., the secretary of the Brush Electric Light Company in this city, said this morning that his company was suffering like all others from the impossibility of getting machinery. Their new building in Elizabeth Street, near Prince, is one hundred feet square, and will be the finest "station" yet built; but the machine men are all behind, and the Brush company cannot furnish any more lights until they can get more machinery. At present they are running 550 lamps, their wires covering an area of several square miles. An important feature of the business is getting to be the lighting of dark stores and basements where a light for distinguishing colors is required. Ninety lamps are now in use down-town, and the whole force of 500 lamps could be used if the current for the up-town lights was not needed long before business hours were over down-town. Since the excitement about fire from electric wires the Brush Company have had all their wires taken from house tops and placed on poles of their own.

THE SUN, DECEMBER 5, 1881.

DELAY IN ELECTRIC MAIN LAYING.

A Scarcity of Materials Caused by the Sudden Demand—Edison's Other Enterprises.

There has been some delay lately in laying the conductors of the Edison Electric Light Company, but now men are again at work in Gold and William streets, near Fulton. The delay was caused in large part by the insufficient supply of iron pipe and copper conductors. Since the contracts for pipes and conductors were made, the materials have risen with the increasing demand for them made by the electric companies, and many contractors have failed to supply their quota of the material. Major Eaton estimates that the Edison Company alone will use about two million pounds of ingot copper annually. It is not probable that the district will be wired before midwinter. When the ground is deeply frozen the hot insulating fluid cannot be poured into the boxes and pipes without danger of its not adhering to the conductors and thus not effecting the insulation.

So far nearly one-half of the district has been wired as follows: Peck slip, Ferry, and Spruce streets from South to Nassau; Wall and Pine streets and Maiden lane from South to Nassau; Front street from Fulton to Wall; Water street from Ferry to Wall; William street from John to Wall; Gold street from Beekman to Maiden lane; Cliff street from Ferry to John; Liberty street from Nassau to Maiden lane; and Cedar street from Nassau to Pearl.

Engineer Dodge said that, in addition to the regular network through every street, separate conductors or feeders will run from the central station in Pearl street to particular points, the Morse building, for instance, where much light is needed, and at these points these feeders will connect with the regular system of tubes. The Mills building, it is said, will be supplied with over 5,000 lights. Some of the large buildings will have their own dynamos.

Mr. Edison hopes soon to improve the durability of his lamps. He is also working at electrical engines for railroad use. He has built a two-mile railroad across country from Menlo Park for experiments, and has accepted a contract to build electric engines for a fifteen-mile branch of a Western road.

Major Eaton says that the Edison Company will soon light several warehouses in London. A number of mills and factories out of town have the Edison light in use, as have also the Pacific coast steamships Columbia and Oregon and the Sound steamer City of Worcester.

The Brush Company now has its own poles for its wires, and is running 550 lamps, ninety of which are down town. This company, too, has been delayed by the scarcity of iron tubing and of copper.

ENGINEERING NEWS.

Tribune Building. New York City.

GEO. H. FROST, Proprietor.

SATURDAY, OCT. 15, 1881.

THE AMERICAN INSTITUTE SEMI-CENTENNIAL EXHIBITION.

Last year we gave a brief history of the Institute and of the work it had accomplished. This year we propose to confine our remarks to exhibits not previously mentioned.

THE BRUSH ELECTRIC LIGHT.

In summing up the most difficult problems in electric lighting, the *Scientific American* of April 20, 1881, enumerates as follows:

"(1) To provide an efficient and economical means of converting mechanical power into electric energy, that is, a good dynamo-electric machine. (2) To devise a generator able to evolve an electric current capable of subdivision, to supply a series of lamps in one circuit. (3) To invent a self-regulating lamp adapted to such an electric circuit, and so constructed that any accidental disturbance of it, or its extinction, would have no effect upon the other lamps in the same circuit. The lamp to be at the same time easy to keep in order, durable and economical in power. (4) To discover an automatic method of regulating the supply of electricity so that the current would be always exactly equal to the varying requirements of the circuit."

In a monograph by Mr. Brush is a full description of his entire system, from this we make the following abstract:

"The most important peculiarities of the dynamo-electric machine are embodied in the armature, the arrangement of the field magnets and the commutator. The armature is a flat ring of soft cast-iron, which revolves in its own plane, and is composed of two or more parts, each provided with a series of grooves, and insulated from each other in such a manner as to prevent the induction of currents in the iron itself while being revolved in a magnetic field. There are wound on this ring eight bobbins of armature conductor, whose planes radiate from the axis of rotation. The field magnets face both sides of the armature, in the plane of its rotation, and by this arrangement both sides of the flat bobbins are exposed to the inductive influence of the magnets.

"Field magnets of opposite polarity are applied to diametrically opposite points of the annular armature, which then consists practically of two semi-circular magnets, having their like poles joined. Each of these semi-circular armature magnets, if straightened out, would be much longer than its own diameter, and would have its bobbins wound at right angles to its axis, and covering the greater part of its length. Now, it will be evident, that with a given length and weight of armature conductor, a very much greater number of convolutions may be formed on such an armature than would be possible on other armatures whose length from pole to pole is short compared with their diameter. But inasmuch as the field magnets are applied to both sides and very nearly the whole length of the long armature, the magnetic field in which the bobbins of conductor move, is quite as intense as that obtainable when any other form of armature is employed, and perhaps more so; hence, the electromotive force of current obtainable with an armature conductor of given resistance is, *ceteris paribus*, very much greater with this form of armature than with any other. The bobbins of wire on the armature are not connected together, but only each pair diametrically opposite. The two free ends of the conductor thus formed are carried to diametrically opposite segments of the commutator—these segments being attached to no other bobbins. Each pair is absolutely independent of any other pair.

"The commutator consists of four separate rings of metal, each ring consisting of two nearly semi-circular segments, whose ends, on one side, are separated by a considerable space. This space is occupied by a piece of metal attached to an adjoining ring, and known as an 'insulator.' It is insulated by an air space from each of the segments between whose ends it is located, the other ends of the segments being simply separated by a single air space. The office of the 'insulator' is to separate either of the brushes which collects the currents from the commutator, from both segments during a certain interval, and twice in each revolution of the commutator. During these separations, the two bobbins of wire on the armature which are connected with the pair of segments are not only out of the general circuit, but are often circuited themselves, so that no current can circulate in them.

"Each pair of bobbins on the armature is thus provided with a commutator ring, and the segments of this ring occupy the same angular position with regard to other segments that its bobbins occupy with regard to bobbins attached to the said other segments.

"It will now be seen that only one pair of armature bobbins is out of the general circuit at one time, and this is made to occur when the said bobbins are at and near the neutral points of the armature, and are not in a condition to contribute to the general current. Now, if it were not for the 'insulators' above described, the idle bobbins would afford an easy passage for the current from the active bobbins, and thus destroy the efficiency of the apparatus." Mr. Brush follows with a comparison between his own and the Gramme commutator.

THE LAMPS.

The peculiar features of the lamps are fully described as follows: "These are, very great simplicity of construction, insuring ease of management, safety against internal derangement and securing great regularity of working; the double magnet circuit conveying currents of opposite direction, by means of which any number of lamps may be operated in a single circuit without any irregularity of action; the short circuiting safety attachment, by which any lamp offering an abnormally great resistance, owing to the final consumption of its carbons or other cause, will, without any change of strength in the main current, automatically short circuit the said lamp, and thus preserve the integrity of the general circuit; the multiple sets of carbons, burning successively, without the intervention of any switching or other special mechanism, and yet securing the maintenance of the light for any desirable length of time without requiring attention; lastly, the absence of any adjustment to be made by the attendant, other than placing the carbons.

"These lamps contain no clockwork or similar mechanism of any kind. The movement of the upper carbon, actuated by gravity, is controlled by a simple annular clamp which surrounds the rod carrying the carbon. When the lamp is in operation, one side of this clamp is lifted by magnetic action. This causes it to grasp and raise the rod, and thus separate the carbons. As the carbons burn away the magnetic action diminishes, and the clamps and rod move gradually downward, maintaining only a proper separation of the carbons. But when the tilted annular clamp finally touches the supporting floor from which it started, any further downward movement will at once release the rod and allow it to slide through the clamp until the latter is again brought into action by the increased magnetism due to the shortened arc between the carbon. In continued operation the normal position of the clamp is in contact with its lower support, the office of the controlling magnet being to regulate the sliding rod through it. If, however, the rod accidentally slides too far, it will instantly and automatically be raised again, as at first, and the carbon points thus maintained in proper relation to each other.

"Each magnet helix is first wound with a few layers of coarse wire, through which the main portion of the current operating the lamp passes. Over this coarse wire is wound a very much greater length of fine wire, having its ends connected with the terminals of the lamp, but in such a manner that the electric current shall pass through it in a direction opposite to that in the coarse-wire helix. Thus the fine wire forms a secondary current of high resistance through the lamp, which circuit is independent of the arc between the carbons, and is always closed. It follows, from the difference in direction of the current in the two helices, that the fine-wire helix will constantly tend to neutralize the magnetism produced by the coarse-wire or principal helix. The number of convolutions of the fine-wire helix and its resistance are so proportional to the number of convolutions in the principal helix and its resistance, together with that of the normal voltaic arc, that the magnetizing power of the latter shall be much greater than that of the former. Notwithstanding the small amount of current which passes through the fine-wire helix (about one per cent. of the whole current) its magnetic power is very considerable, owing to its great number of convolutions.

"Now, when a number of regulators provided with these double helices are operated in a single circuit, great uniformity of action will be maintained, owing to the peculiar function of the recording helix. Thus, when any lamp gains more than its normal arc, the resistance of its main circuit is thereby increased, more current is consequently shunted through its secondary helix, and the resultant magnetism is diminished, allowing the carbons to approach. On the other hand, if an arc becomes too short, its resistance is reduced and less current is shunted through the corresponding secondary helix; consequently the working magnetism in that lamp is increased, and its carbons are drawn further apart. Thus it will be seen that, although the general strength of the current operating a large number of these lamps does not vary, each lamp performs its regulating functions through the agency of varying magnetism precisely as though it were the only lamp being operated. * * *

"The shunting or short-circuiting device in each lamp consists of a small magnet core surrounded by a coarse and fine-wire helix similar to those of the working magnet. No current passes through the coarse wire until the magnet which it surrounds has raised its armature. The latter, together with the coarse wire, then form a part of the short circuit established through the lamp. The fine-wire helix of the shunt is put in the circuit of the fine-wire regulating helices before described. During the normal operation of the lamp this fine-wire helix exercises a magnetizing influence on its inclosed core, which thus attracts its armature with a certain degree of force, but not *enough to lift it. But* when, through the exhaustion *of the carbons in* the lamp, or *from their failing properly to feed together*, the arc between them becomes *considerably* lengthened, thus *developing an abnormally* great resistance in the lamp, *a greatly increased* current will be shunted through the fine-wire helix. *The iron core of the latter will raise its armature and thus establish a circuit of low resistance through the lamp, independent of its carbons. Evidently, when the short circuit is closed as above, very little current circulates in the fine-*

The Edison Electric Illuminating Company of New York
65 Fifth Avenue.

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Elektrisk belysningsanläggning.

Elektriska belysningsanläggningen å Stadsteatern kommer att utföras på följande sätt: Ångmaskinen, hvilken kommer att användas härstädes, är af 80 hästkrafters storlek och naturligtvis mobil, så att den kan flyttas från ställe till ställe. Den kommer att stå på Gustaf Adolfs torg och Norrbro samt förses med elektriska lampor, hvarjemte de medelst kablar, gående under jorden, förbinda med det nedanför rådhuset uppförda elektriska strömmen skall passera, förelöpande, i hvilket elektricitetsmaskinen finnes uppställd. Vi lämna nu Dagens Nyheters följande beskrifning öfver det nya belysningssystemet:

I skjulet finner man en lokomobil af 15 nominella hästkrafter, en stäfvo elektricitetsmaskin, en mindre sådan färdig att lysa, 24 st elektricitetsmätare samt en mängd lampor af olika storlekar. Så vill elektricitetsmätare som lampor tillhöra amerikanen Brush's patent, och det den mätare som med så stor framgång blifvit försökt i London City. Att beskrifva denna, hvarpå strömmen genereras, är för tillfället af tekniska vara föregifvit möjlig. Vare det nog sagdt, att Brush's maskiner äga förmågan intensse med bäkeye till den ovanligt höga tonsiffran lika väl som styrkan hos den strömmen de genererar. Kablarne äro af bredvid hvarandra lagda kopparstänger af omkring ¼ millimeters tjocklek och äro omgifna af en ledarmassa, tjocad hampväf. Lamporna äro groom-en mycket slarmik apparat, som fästats, att de dela lemna obehindrad passage åt strömmen, fall de icke äro tända, dels att regleras med hänsyn till lampornas inverkan, den afsäkrar. Skall en lampa tändas, löker strömmen passera genom spiralformigt virdan kopparstråd, som omgifva öfre delen af ett stålfjäd likaväl strömmen sakna och upphäfva uppstår mellan kolspetsarna. Två par kolstift ger lampa i hvarje lampa. Endast den öfre tändningen förbrukas. Då den ena, efter omkring 40 timmars förlopp, är uppbränd, omkastas strömmen af sig själf, så att den andra tändgen samma. 10 timmar utan att vårdnen af monnlarband. At Brush's lampor äro uppsatta 6 på Gustaf Adolfs torg, 6 på Norrbro och 4 framför nord västra slottsflygeln, tillsammans 16 lampor, som motsvara från samma maskin. Lysstyrkan hos hvarje lampa är, beräknad till 2,000 normaljus, d. v. s. öfver 120 vanliga gaslågor. Dessutom finnas mindre lampor, bestående af små hattformiga glödgkroppar, i hvilka är gupnen strömmen införaren. Skulle lampor derstad lära förut lemna ett stadigt ljus. Förslyftning.

Samtlig maskiner och ändtrådar för den elektriska belysningen förskaffas af fyra dugtiga engelsk-amerikanska ångbåtsbolaget, som redan tagit hufvudstaden.

Brush's electric light, which will commence in Gustave Adolf's square, that the electric which the lamp cables strong from a shed (shed) the ele are placed (of Stockholm) for shed is a Brush large electric several lamp Electric engine

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THE SANITARY ENGINEER. Oct 1881

authorized by the police court of Lambeth to demolish certain houses belonging to a Mr. Munn, which projected beyond the authorized building line unless the terms of the Building Act were complied with. As Mr. Munn did not conform, the surveyor freed him from the necessity of doing so by pulling down the houses.

ELECTRIC LIGHTING—ITS FIRE RISKS AND THEIR REMEDIES.

BY HENRY MORTON, PH.D.,

President of the Stevens Institute of Technology.

Some very lamentable accidents have strongly directed public attention to the question of danger possibly accruing to life and property through the rapidly increasing employment of electricity as a source of light, and as the actual conditions of this danger, like the true properties of the agency from which it may arise, are but little known, a brief explanation of some simple facts related to this subject will be at this time acceptable and perhaps useful.

I would propose, then, to treat this subject under two general heads, namely: 1st, The sources of danger; 2d, The conditions of their prevention, or of security.

The sources of danger in the use of the electric light are essentially two; from the conducting wires and from the electric lamps.

As long as the electric fluid or electric energy, is conveyed by a sufficiently good conductor it is perfectly harmless, resembling a river flowing in its natural channel, and powerless to rise above its banks; it is only when some easier channel into surrounding objects is offered or some partial obstruction of a certain character impedes its regular flow that trouble may arise.

The conditions of these difficulties are, moreover, very peculiar.

Thus, for example, if two electric conducting wires, forming the outgoing and returning paths of a powerful current are placed near each other, but are separated by a bad conductor, as, for example, when both are tacked on to a board partition, the current will follow the wire from end to end, with no development of heat in the same, or tendency to leave the conductor or pass into any adjacent object. If, however, between the two conducting wires we introduce some imperfect conductor, such as a small wire, some metallic dust, or a film of water containing mineral matter in solution; then a portion of the current will be diverted into this "short-cut" from wire to wire and may heat the fine wire or the metallic dust or the wood wetted with the aqueous solution, so as to cause the ignition of inflammable matter.

Accidents of this nature have already occurred. Thus a telegraph or telephone wire having fallen across one or more of the conductors used for street lighting purposes has been fused, or, itself escaping, has caused the fusion of finer wires connected with it.

Again, two wires being the outgoing and return circuits of a powerful current, have been nailed side by side, without other insulation, on the same board of a floor, partition, or ceiling; and though used safely for a long time, while the wood was in its normal state, have developed a very dangerous activity when the wood between them was wet with dirty or impure water. In that case the water offers a circuit through which a cross current is established which first heats the damp wood, then chars it, and finally establishes a series of minute arcs or electric sparks along this charred surface, which would soon develop a conflagration if left uncorrected.

Again, two such wires as above, insecurely attached near each other, may be brought into momentary contact and then separated, in which case an electric arc with its intense light and heat, will be established between them. In like manner a conducting wire itself may be inaccurely connected at some point, and if the abutting ends are separated slightly during use, a similar "arc" with its intense heat may be there developed.

These examples will give a fair idea of the dangers arising from the conducting wires, as they are manifestly to be guarded against by proper separation and insulation of the wires themselves. Of this, however, more anon. At present, I would only further point out that there is no risk whatever of any heating or other injurious action arising in or from the conductor itself when an adequate one is used, as must be the case from motives of economy; since an inadequate conductor would involve ruinous expense in the use of the electric current.

Electricity is not to be regarded as a set of fluid fire passing along the conductor; and the popular notions on this head are as absurd as were similar ones which prevailed in referen to illuminating gas, at the time of its first introduction, and which caused rules to be made in places that no gas pipe should be allowed come in contact with any wood-work.

Turning next to the dangers which might be expected from the electric lamp, it is to be remarked in the first place, that these in the case of the arc lights depend much upon the number of lamps operated on the same circuit. Thus if thirty or forty lamps are operated in series, the electro-motive force of the currents must be sufficient to maintain a correspondi number of arcs; and, therefore, if by any mea many of these arcs are closed out the elec motive force of the current available for t maining ones would be so excessive that the arcs might become excessively long, and ev the metallic carbon holders and other parts the lamps constitute poles between which arc would spring, melting the metal work establishing a very dangerous course of ex bustion.

To avoid this class of dangers two provisio should be made.

In the first place some arrangement in t lamp itself by which, whenever the arc exce certain safe limits, the current will be aut matically diverted from it and through a strong a good and sufficient conductor; and, in t second place, some simple apparatus in connectio with the electric generating machine by which the electro-motive force of its current should be varied automatically in correspondence with the resistance of the circuit, so that any diminutio of such resistance, as by the closing out several arcs, should cause a correspondin diminution in the force of the current generated

Numerous contrivances for both of these purposes have been already carried to greater or less perfection and efficiency, and it is manifestly possible by such means to secure immunity from risks of this sort.

The securing of adequate insulation for the conducting wires in view of the endless ramifications of telegraphic and telephonic systems, to say nothing of the other conductors found in all buildings is a problem of no small difficulty.

One important general principle would seem to be the equal insulation of the return as well as of the outgoing wires, as also of the machines, and the avoidance of all ground connection for any part of the circuit. Another general rule would be the separation of outgoing and return wires as far as possible from each other; and yet another, the continuous insulation of conductors leaving no vulnerable places even where danger would not directly result from accidental contact.

Fully to discuss all the details of this subject would be impossible within the proper limits of such a note as the present, and I will therefore only say in conclusion that, with well matured plans and skillful and intelligent provision, these dangers may be provided against and electric lighting may be made as safe as that obtained by gas or by candles; but without such care and judgment the use of electricity on the grand scale either for lighting or for transmission of power, would involve serious additions to the risks which accompany so many of the conveniences which constitute a large factor of our modern civilization.

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From Nya Dagligt Allehanda
Stockholm Sept 16th 81

The Electric Light.

The trucks with the electric light, which we have previously mentioned, will commence this evening - As known, it is on the Fastorne Adolphus Square and the North Bridge, that the electric lights are placed. The poles on which the lamps are placed, are connected with cables through which the electric current passes from a shed by the side of the City Hall in which (shed) the electric engines (generator a steam engine are placed - We are indebted to the "Daily News" (of Stockholm) for the following description — In the shed is a Locomotive of 15 nominal Horse power, one large electric engine (generator) one small ditto and several lamps of different sizes - Both the Electric engines as well as the lamps are of the American Brush system, being the same which

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THE SANITARY ENGINE

authorized by the police court of Lamb demolish certain houses belonging to a Mr. which projected beyond the authorized l line unless the terms of the Building A complied with. As Mr. Mumm did not c the surveyor freed him from the neces doing so by pulling down the houses.

ELECTRIC LIGHTING—ITS FIRE I AND THEIR REMEDIES.

BY HENRY MORTON, PH.D.,

President of the Stevens Institute of Technology.

Some very lamentable accidents have st directed public attention to the question o per possibly accruing to life and property fr the rapidly increasing employment of elec as a source of light, and as the actual con of this danger, like the true properties agency from which it may arise, are bu known, a brief explanation of some simpl related to this subject will be at this time sible and perhaps useful.

I would propose, then, to treat this s under two general heads, namely: 1st sources of danger; 2d, The conditions o prevention, or of security.

The sources of danger in the use of th tric light are essentially two; from the co ing wires and from the electric lamps.

As long as the electric fluid or electric is conveyed by a sufficiently good conducti perfectly harmless, resembling a river flow its natural channel, and powerless to rise its banks; it is only when some easier ch into surrounding objects is offered or some tial obstruction of a certain character im its regular flow that trouble may arise.

The conditions of these difficulties are over, very peculiar.

Thus, for example, if two electric cond wires, forming the outgoing and returning of a powerful current are placed near each but are separated by a bad conductor, example, when both are tacked on to a partition...wall, the current will follow the

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Elektriska belysningen.

Det ena af förra tvenne stallarna, som blifvit ombyggda till elektrisk belysning, hvilka komma att användas i närvarande skola, derest ej naturhinder möta, tagas början i afton. Såsom bekant är, det på Gustaf Adolfs torg och Norrbro samt Bron emellan, kommo att användas. De stolpar, som för några 16l sedan på dessa platser upprestes, hafva nu blifvit försedda med elektriska lampor, hvarjemte de medelst kablar, genom hvilka den elektriska strömmen skall passera, förenats med det nedanför rådhuset uppförda trånskjul, i hvilket elektricitetsmaskinen finnes uppställd. Ytterligare upplysningar beträffande följande beskrifning öfver det nya belysningssystemet:

I aftonen äger man en lokomobil af 15 nominella hästkrafter, en större elektricitetsmaskin fullt monterad, en mindre eldad ångpanna, uppställdes samt en mängd lampor af olika storlekar. Så väl elektricitetsmaskiner som lamper tillhöra amerikanen Brush's system, hvilken det samma som med så stor framgång blifvit vid förra London City. Att beskrifva dessa sätt, hvarpå strömmen genereras, skulle utan tillhjälp af teckning vara försöket värdt. Vare det nog sagdt, att Brush's maskiner äga till synnerliga interesse med hänsyn till den ovanligt höga tensionen lika väl som styrkan hos den stadin de genereras. Kablarne bestå af 7 hvarandra lagda koppartrådar af omkring ½ millimeters tjocklek och äro omgifna af en isolerande, tjocklagd, lampen förenas genom en nyckel stenrik sprängning så inrättade, att de dela lemna obehindrad passage åt strömmen, ifall de icke äro tända, dels af sig själfva, d. v. s. genom strömmens inverkan, reglerne med hänsyn till kolstavarnes tändlängd. Skall en lampa tändas, låter man strömmen passera genom spiralformigt vickad koppartråder, som omgifva öfre delen af ett ankare, vid hvilket öfre kolspetsen är fäst. I följd häraf uträtbaras ankaret och upplyftes öfre kolstången, så att en elektrisk fjunkbåge uppstår mellan kolpetsarne. Två per bolaltiga äro lampor i hvarje lampa. Bestå den öfre ättogen förbrända. Då den ena, förbrukad, tänna lampan förloppa, är upptänd, enkastas strömmen af sig själf, så att den andra lampan antändes. En Brush's lampa kan således brinna 10 timmar utan att vårdnas af maskinskund.

Af Brush's lampor äro uppsatta 9 på Gustaf Adolfs torg, 8 på Norrbro och 4 framför nuvarande slottsflygeln, tillsammans alltså 16 lampor. Alla metalla äga samma maskin. Ljusstyrkan hos hvarje lampa skiftar vara lika med 2000 normalljus, d. v. s. öfver 100 vanliga gas-lågor. Ljuset är dagsljus. Dagarna finnas tanken kommande att små luftstorma glasglober, i hvilka en konst elektrokemisk metallrid bringas till glödgning i egenom strömmens inverkan. Sådana lampor inuti de fästa för belysning hos hus. Förut-nämnda dermed lära först komma att anställas å Norrmalm och Ryssbacken.

Samtliga maskiner och materialier för den elektriska belysningen förskrifva sig från den engelsk-amerikanske Brush-bolaget, som redan beskrif öfvan nämda belysningsföretag i den engelska huvudstaden.—

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succeeded so well in London. To describe how the current is generated, would be impossible except by aid of a drawing — It will be enough to state, that the Brush system is particularly noticeable on account of the high tension of strong current generated. The cables consist of seven copper wires of ¾ Millimeter thickness, which are carefully isolated by tared hemp. The lamps are very well made so that the current passes through them when not lighted and also automatically regulating the distance between the points of the carbon candles of a lamp is to be lighted the current is allowed to pass through spiral shaped wire which surround the upper parts of an anchor by which the upper electric candle is fastened — In consequence there of the anchor is attracted and the upper candle lighted. Two kinds of carbon candles are used in every lamp, only the upper is burnt. The current is automatically conducted to the other candle part of

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the lamps a Brush Lamp can therefore burn 10 hours without any help from Man. Of Brush's Lamps, 6 are on Fürstrans Adolphus Square, 6 on the North Bridge, and 4 in front of the N. W. Wing of the Royal Castle, together 16 lamps fed from one engine. The power of the candle is said to be equal to 2000 normal candles or 150 common Gas flames. There are besides smaller lamps, consisting of glass globes that are free from oil, in which a horse shoe formed metal thread is brought to white heat by action of the current. Such lamps are meant to be used indoors. Trials with them is expected to be made in Hotel Rydberg. All the engines are worked by the English Brush Company which have already made trials with the electric light in London.

$2 Sunday Engineer Oct. 1881.

Under the title "Real Workers in Electric Lighting," the *Tribune* quotes from the *London Electrician* the following statement, which well expresses the exaggerated degree to which, in some quarters, the public has been led to expect impossibilities in electric lighting:

The non-technical papers, totally ignorant of the scientific aspects of the case, have introduced into the popular mind ideas altogether erroneous, yet so abiding that they still exist. The divisibility of the electric light is what the misery and slow say the inventors are endeavoring to find, and think that, to a certain extent, success has been achieved. It is impossible to drive away the illusion and to enforce the doctrine that on this direction nothing new has been or is likely to be done. Mathematicians know years ago as much about resistance, lamps in "series," or in "multiple arc," as they know now. It was not in this direction that science was working at all. The men who have developed the properties of electric lighting are those who have worked at the perfecting of the steam-engine as a motor for the dynamo-machine, who have improved the dynamo and magneto machines, so that the current is more economically generated, who have experimented in every direction, and added minor improvement after improvement to the arc and incandescent lamps—these are the men who have made electric lighting not only practicable, but the light of the immediate future.

ACCORDING to *La Lumière Electrique*, M. de Pezzer has made some important modifications in the Planté pile. Instead of the thick lead plates usually employed he uses very thin plates, the negative electrode being ½ millimetre in thickness, and the positive 2½ of a millimetre. Moreover, he makes the positive plate but one-half the size of the negative. M. Pezzer claims that with these modifications he can store the same quantity of electricity as with plates of greater thickness constructed in the ordinary way.

Record

Journal Oct. 1881

ELECTRIC LIGHT NOTES.

It is reported that Mr. Brush, of Cleveland, has invented a storage battery which he claims is far superior to that of M. Faure. The details of its construction will not be made public until patents have been issued.

A portion of the Junior Carlton Club, London, is lighted temporarily by incandescent lamps, the electricity for which is furnished by Faure's secondary batteries. There are 40 of them sufficiently charged to maintain 15 lamps for six hours.

The Brush Electric Light Co. have commenced the lighting of the towers in Union and Madison Squares, but the results are by no means encouraging to the company, or agreeable to the people. The difficulties, however, will doubtless be remedied entirely or in part after further trial.

There are sixteen electric lamps in the Laboratory Department of the Woolwich arsenal. The workmen while appreciating the purer atmosphere resulting from this method of illumination, complain of the shadows cast upon their work, and also that the intensity of the light impairs their eyesight.

Mr. Edison has constructed a dynamo machine of sufficient power to operate 1,000 incandescent lamps. It contains twelve magnets, each weighing about 685 pounds, and cost $6,000. It is intended for a station at Charing Cross, London. It is stated that Mr. Edison is constructing some dynamo machines of very large size for use in lighting the district in the lower part of this city.

A correspondent of the London *Times*, writing of the Paris Exhibition of Electricity, mentions several novel applications of the electric current as a motive power. The plowgliding machine of M. Menier, the circular saw three feet in diameter, a stone cutter and electrical hammer of M. Pint attract considerable attention. There are machines for pumping water, and rock-drilling, besides a number for sewing and embroidering.

At the meeting of the British Association at York, Mr. J. H. Wigham, of Dublin, read a paper on the use of gas for lighthouses, in which he claimed that gas could furnish the great volume as well as the great intensity of light which would be desirable. Of late years the system of lighting by naked gas flames in connection with the ordinary dioptric apparatus, has come to be fully recognized as of great importance. The advantages possessed by longer gas flames over flames of the ordinary focal size were pointed out as being equality to be found in revolving and flashing lights as in fixed lights." The penetrating effect of the gas flame in foggy weather is far greater than that of the electric light of even greater power, for the simple reason that the former contains a greater proportion of the red rays than the latter, and it is the red rays which are least obscured by fog.

In our last issue we referred to the opinion of Prof. W. Thomson on the possibility of utilizing the water-power of Niagara Falls in the production of electricity to be conducted to a distance and there converted into light and heat. It seems there is a plan being discussed for making the experiment, but on a small scale as compared with the suggestions of Prof. Thomson. It is proposed to form a company, place dynamo-electric machines at the Falls, to be operated by the very large water-wheel recently constructed there, and to convey the electric current to Buffalo, there to be used for the purpose of light or motive power as may be desired. The experiment will certainly be a most interesting one, and it well managed will help to settle the question as to how far it can be put to the immense power of the Falls can be economically utilized at a distance. Prominent electrical engineers consider that the thing can be done, but the real question to be settled is—will it pay?

and payment of the dividends, the same was carried unanimously"; as also the re-election of Messrs. Henry Wood and Henry Willis as Directors, and Mr. George Willis as Auditor.

Mr. Cuthbert Quilter, in seconding a vote of thanks to the Directors for their past services, expressed a hope that they would see their way to reducing the price to furnish the Shareholders with copies of the accounts and report.

After a vote of thanks to the Secretary and Officers of the Company the meeting separated.

LEICESTER CORPORATION GAS AND WATER SUPPLY.

A Quarterly Meeting of the Leicester Town Council was held last Thursday—Mr. MARTIN (Alderman) J. Bennett presiding—when the following report of the Gas Committee was submitted and read:—

The Gas Committee have to report that the accounts of this undertaking for the half year ending the 30th of June last have been audited by the Borough Auditor, and that the results are by no means encouraging to the company, or agreeable to the people. The difficulties, however, will doubtless be remedied entirely or in part after further trial.

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The Committee have further to report that about the middle of last year they received a communication from the Corporation Surveyor, Mr. Paget, calling their attention to the fact that the Corporation Surveyor had been instructed by the Council to prepare plans for the purpose of erecting the abutments to the Freer Law Estate; and subsequently Mr. Joseph Firth, the Borough Engineer, had been instructed to prepare plans for the widening of the bridge. The latter work was first carried out. The Committee subsequently superintended the various portions, and £21,311 19s. 7d. in February last was paid to the contractor, Mr. Thomas Firth, of Sheffield, on account of the widening of the bridge, and which completed the contract price to £24,200, exclusive of £1035 1s. 6d. duties of superintendence, engineer, and subsequently interest, and £1,888 19s. 5d. duties of engineer, surveyor, auditor's fees, and incidentals, which will be paid in the present half year's accounts, making the total cost of the bridge £27,124 0s. 11d., which will be payable to the general account fund at the close of the present half year.

The reduction in the price of gas, as approved by the Council in March last, has not yet been carried into effect, the necessary alterations, as they took effect from the 1st of July last, having been delayed.

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Your Committee have further to report that they have had under consideration the question of the electric lighting of the Town Hall, and have had several interviews with Mr. Swan, and they have also had the advice of Mr. Preece, the engineer to the Post Office, as to the best mode of lighting the Town Hall by the electric light

Journal of Gas Lighting &c. Oct. 1887.

The Expenditure of Energy in Incandescent Electric Lighting.

At the York meeting of the British Association, Sir W. Thomson and Mr. Hottenley gave the results of some experiments carried out by them in order to determine the illuminating power of incandescent vacuum electric lamps with various strengths of current. Every lamp was tried with higher and higher potentials until the carbon broke. The electricity was obtained from a number of Faure's cells, of which 20 were first put in circuit, developing 0·003-horse power, and others were added until the lamp was destroyed. Three lamps only were tried, the first of which broke down after fourteen experiments; the second lasted through fifteen tests; and the third broke before the third reading could be completed. With 20 cells the first lamp gave the illuminating power of 11·6 candles; four more cells then brought it up to 25 candles; with 32 cells it showed 42-candle power; and successive additions of cells forced the light up through a very irregular scale until, when giving the maximum of 114-candle power, the carbon gave way. The next lamp was first tried with 40 cells, affording 0·27-horse power, and giving the light of 19 candles; and the lamp broke when connected with 70 cells, when the light would have been over 200 candles. The irregularity of all the records is very striking, the power of the batteries and the light given by the lamps being very uncertain and by no means increasing in any common ratio. For example, the first lamp gave the light of 81 candles, with the expenditure of 0·217-horse power from 56 cells. The next lamp, with the same number of cells, gave only 49-candle power in one instance, and 32 candles in another, although the energy of 0·27-horse power was recorded, or nearly the same as before. Again, the second lamp gave 186-candle power with 66 cells, while the addition of 6 more cells, instead of increasing the light, brought it down to 180 candles. Much of this variation is said to be caused by the blackening of the interior surface of the globes by the deposition of volatilized carbon, when high powers were applied. The photometric method employed by the authors consisted of directly comparing the depth of shadows thrown by a pencil on a piece of white paper, and the candle employed was the usual standard sperm article, assumed to burn at the normal rate, but not weighed, as the object of the experiments was simply comparative.

Art and the Electric Light.

It may be remembered that when the announcement was made in the spring of last year, that the electric light was about to be adopted for illuminating the Paris *Salon*, a good deal was said, both in the English and the French Press, as to the superiority of the intensely over gas for the lighting of picture galleries. After a few preliminary difficulties had been overcome, the light was brought into use, and the public—influenced, probably, by what they had read in the newspapers—were loud in their praises; and, judging from the public prints, there appeared to be for once a general and mutual feeling of gratitude to the authorities for the adoption of the new system of lighting. This happy state of affairs, however, did not last. After the electric light had been for a short time in operation, a protest against its use was raised by some of the artists whose pictures were being exhibited. They complained that the light was not a good one for showing off their productions, and urged its discontinuance. But the remonstrance came too late. The contract with the electric light company had been signed, the necessary appliances were all fixed, and the light was allowed to illuminate the *Salon* for the remainder of the season.

It would have been thought that the action taken by the artists last year would have led to a repetition of their remonstrances when the determination of the authorities to again employ the electric light this year in the *Salon* became known; but we are not aware that any steps were taken. At any rate the light was once more brought into use, and was heralded with much the same flourish as on the previous occasion. It may be presumed, however, that the artists, though silent, were not altogether enraptured with the new illuminant; and so far as may be gathered by the remarks contained in a characteristically French article, emanating from the pen of M. Charles Kurner (which appears in the current number of *La Cour*, gentlemen of the brush will not be inclined to regard its introduction as an unmixed blessing. The writer of the article in question is of opinion that the light will in time entirely supersede the employment of gas for the lighting of picture galleries, but he believes that it will cause some trouble to artists in the mixing and employment of their pigments. "This superb invention, the electric light," he writes, "will upset our ideas, depreciate our *chefs-d'œuvre*, and convert our masterpieces into patterns for paper-hangings." All this is, he says, owing to the colour of the light, which, according to the statements of the electricians, should be pure white, but is in reality—at least, so M. Kurner says, speaking of that used for lighting the pictures in the Electricity Exhibition—"pale and wan, bluish, violet, and lilac;" and consequently when it is employed certain colours produce effects which are not exactly in accordance with artistic notions. He then makes special reference to several pictures which were exhibited in the *Salon* this year, and are now on view in the eastern gallery of the Palais de l'Industrie—of course, illuminated by the electric light; and with very few exceptions his remarks are altogether condemnatory of the light. One exception is in the case of the painting representing the meeting of Dante and Matilda—

> A lady all alone, who, singing, went,
> And culling flower from flower, wherewith her way
> Was all o'er painted.

The picture is composed of figures, phantoms, and flowers, over which the electric light throws a strange, unearthly pallor, which rather heightens the effect of the artist's work.

It is needless to follow M. Kurner in his remarks on the various paintings exhibited, as viewed by him under the electric light; or to indicate those points where he considers the effects intended to be produced by the artists have been perverted, if not entirely marred, by the medium employed for the illumination of the gallery. He confesses to being somewhat hard in his remarks; but he assures his readers that they are made in all sincerity. He is one of those who approve of innovations in the arts; but in the present case he says he is in a dual between the arts and the electric light, and the question is, which is to give way? The electric light will not; therefore it will remain for artists to arrange their subjects and prepare their colours to suit the new illuminant—in other words, to abandon the old order of things and adapt themselves to the new. Are they prepared to do this? M. Kurner answers emphatically, "*Jamais!*"

Journal of Gas Lighting &c. Oct. 1887.

The Utilization of Water Power—A New Discovery.

In the dull season, which is now at its nadir, a very small item of news only is required to form the motive for a column of commonplace in the daily newspapers. The broad sheets must be filled somehow, and since sea serpents and gigantic gooseberries have become suspected by the general public, other curiosities have to be sought for. The wonders of electricity have for some weeks been largely drawn upon by hard-pushed leader writers, whose sublime ignorance of scientific truths is balanced by the possession of imaginations untrammelled by considerations of fact. The Paris Electrical Exhibition having been worked out as a theme for similar amateur utterance is available. The *Daily Telegraph* had a long leading article, on Friday last, on the apparently insignificant circumstance that an fledgling an electric lighting experiment is being carried out, the motive power for the generators being a water-wheel, instead of the usual steam or gas engine. A reader of our somewhat sensational daily contemporary, unless previously instructed to the contrary, would be induced to believe that the institution of water-wheels is a novel and startling innovation, for which the Godalming millwrights deserve infinite credit. We are told in the scholarly article in question, how the stoker and collier are to be in a great measure dispensed with if the Godalming example be followed. The contagion is said to be already spreading, and that Guildford also "is to be illuminated by the brilliant ray of the electric vibration." The same well-informed writer also reminds us that "Sir William Thompson (*sic*) has long ago lighted his mansion in Scotland by a stream of the burn which wimples near it." The mis-spelling of the Glasgow professor's name is a trifle to the *Daily Telegraph*, but this error might be still less important if the story were otherwise correct. As a matter of fact, most people interested in the subject are aware that to Sir William Armstrong, in Northumberland, is due the credit for the idea of lighting his house by the power of a brook. To proceed, however, engineers and others do not require to be told that water power is liable to the three elements—a flood, drought, and frost, all which cause total stoppage of the machinery. These things are conveniently ignored by the *Daily Telegraph*; but those who saw us remember last January, and the annoyance caused even to Gas Companies and their customers by the fearful frost, we cannot regard the coming winter as being devoid of the possibility of troubles to the wise men near Guildford. We may be tolerably certain that if the water-power scheme of electric lighting breaks down there, the *Daily Telegraph* will have its columns too full of other matter to report the fact. For the present, our reflections on the "all talk" of our contemporary may be thus expressed: Whereas it was once the remark of a keen observer, "With some spirit exclaim, "Soo what little knowledge is required to compose a quasi-technical article for a newspaper which boasts of the largest circulation in the world!"

Electric Lighting in America.—In the matter of electric lighting, America would certainly appear to be far in advance of this country. Englishmen are oftentimes disposed to, view with doubt and suspicion accounts of what is done on the other side of the Atlantic, and there can be no question that in regard to this subject of electrical illumination doubt and suspicion have been freely expressed, when the doings of the Americans are referred to. We are bound to confess, however, that if the reports which reach us from time to time are at all to be relied upon, and in most instances they emanate from sources which we are prepared to accept as thoroughly reliable, the old country has in this matter a long way to go, so far as the use of electricity for ordinary interior lighting is concerned, by no means taken the lead. We have always regarded with undigested satisfaction the steps that have been taken, chiefly at the risk of Frenchmen, partly of English speculators, towards lighting parts of London and some other towns by electricity, and also the adoption of this mode of lighting in numerous private business establishments, &c.; but neither in England nor on the Continent have there yet been established general lighting stations, to supply the electric light after the fashion of gas-works. We are of course aware that some enterprising firms are now seeking to establish central stations of this character, but nothing at all practical in this direction has yet been accomplished here. In the United States, however, we are told that "no considerable city is without such an institution." At Salt Lake city an arc-lighting system has for some months supplied electric light to subscribers' customers. In Denver, Colorado, a city of 35,000 inhabitants, above 200 arc-lights are supplied to shops, hotels, &c., by a company; the light in each case being furnished at from 20 per cent. to 30 per cent. below the price of gas, as well as being much greater in quantity. The Salt Lake company is said to have been the first in the world to supply electric light in direct competition with gas. The returns to the proprietors are stated to be lucrative in the extreme. The system referred to has been attacked in America precisely as, thirty or forty years ago, the manufacture of gas was introduced into our smaller towns. A local company having been formed, a concession from the patentees of the system chosen is arranged for; ground is bought, buildings are erected, and engines, boilers, dynamo-machines, and the whole light-producing apparatus are purchased and erected. Powerful engines are employed with fly-wheels weighing from 8 to 10 tons, in order to have steadiness and uniformity of motion, the absence of which (so one informant writes) is evinced by that flitting, fleshy-like pulsation of light with which we have become familiar on the banks of the Thames. Wires are conducted either under or over the streets, to be supported where required, in the same manner as gas-mains. Automatic contrivances, for the purpose of turning light on and off at pleasure, are supplied with the lamps, which are visited and kept in order by the servants of the company. The result appears to be the advance of electric lighting all along the line. The use of masts or towers of the height of 250 ft. for the lighting of squares and streets is also becoming general. The city of Denver is lighted from lofty towers, and for the price formerly paid for gas four times the area is now lighted by electricity. In the city of Albany gas-electric lights, placed on alternate blocks, have replaced some 2,000 gas and oil lamps. Akron, in Ohio, is lighted from towers; and Wabash, Ohio, by four lights on the steeple of the Court House. In New York there are competing companies, one of which is now supplying 1,000 lights to shops, and is prepared for 4,000 more. Most original of all is the application of this source of illumination at New Orleans, where the companionship of the night is now selected for running the races of the Jockey Club by the light of electricity. We could add instances innumerable of the adoption of electricity as a practical and commercial means of lighting not only the public streets and large buildings, but ordinary interiors. This probably we have already alluded sufficiently to what is being done by the Americans to show that, beyond doubt, they are in advance of us in the matter; and to show, further, that the steps that are now about being taken in this country for the purpose of rendering the electric light available for every-day use in hotels, theatres, business premises, and even in ordinary dwelling-houses, are not, as some persons so persistently assert, a part of any impossible or impracticable scheme, but are, on the contrary, measures shown by experience to be capable of yielding a fair return to the parties adopting them, and calculated to prove of the greatest advantage to the community.

THE METROPOLITAN.

NOVEMBER 26, 1881.

Gas, Water, and Electricity.

The Paris Electrical Exhibition, which finally closed its doors on Monday, would appear to have proved as great a success financially as in every other respect. It is now stated to have realised a net profit of over £20,000. An immense crowd besieged the Palais de l'Industrie on Sunday, admission being free. In the evening, when the exhibition was illuminated for the last time, there was scarcely standing room either in the main hall or the galleries, most of the visitors being of the artisan class. The total number of closing exhibitions by a general letting loose of all the noisy elements contained in the show was observed on this occasion with an almost deafening effect. Shortly before eleven the whistles of all the steam-engines and every electric bell in the building were set going, making such an inharmonious din as was certainly never heard before. Fortunately for the hearing powers of the audience, the scene lasted but a few minutes, and had the desired effect of clearing the palace of its thousands of visitors.

Edinson's System of Electric Lighting in the City.—Londoners will shortly be afforded an admirable opportunity of judging for themselves of the practical value of the Edison system of electric lighting as a general and economical means of illumination for both exteriors and interiors. The Edison Electric Light Company recently applied to the City Commissioners of Sewers for permission to light at own cost, for a period of two months, "all the existing gas lamps on the Holborn viaduct as far as the subway extends, and also the bridge and the four towers," they undertaking that the light shall be as good as and not to interfere with the gas. The Commission have decided to allow the company to make the experiment, and the necessary preparations are to be proceeded with forthwith. We believe, however, that the Edison Company do not intend confining themselves to the lighting of the roadway of the Viaduct, but will be prepared to supply and maintain any number of lamps in houses or business premises in the immediate vicinity. In a future issue we hope to be able to furnish our readers with further particulars of this interesting installation; but, as an illustration of what is aimed at, we may, perhaps, state that the Edison System, according to its promoters, contemplates universal lighting of exteriors and interiors. Every detail of a comprehensive system, it is asserted, has been worked out, and is ready to be put into practical operation for the purpose of demonstrating its efficiency. All questions affecting the substitution of electric for gas light have received due consideration, and a degree of economy of production, distribution, and consumption is said to have been attained which will prove of successful commercial competition with gas.

Corporations and Gas Profits.—The question of the disposal of profits realised by Corporations and Local Boards in respect of their gas-works is one which very frequently arises in those cities and towns where the gas supply is in the hands of the public authorities, and varied in the extreme are the opinions expressed as to how gas profits should be appropriated, directly or indirectly, in relief of rates, or indeed to any outside purposes. There seems every probability that in the ensuing session this question will be brought specifically before Parliament. The Paddiham and Haydon Local Board have announced their intention to apply for an act for the following among other objects:—"To authorise the Board to supply any artificial light within their district, and to apply profits from the gas-works for redemption of water annuities." We hear that steps are being taken in order that in connection with this Bill the general question of principle shall be considered in all its bearings, regard being also had to the position of one or two other towns of a typical character, and an authoritative decision obtained.

The Storage of Electricity.—This was the subject of the lecture on Wednesday at the Society of Arts, the lecturer being Professor Sylvanus Thompson, of Bristol. Professor Adams presided, and the room, which was crowded, was lighted during the lecture by two groups of suspended Edison lamps connected with 40 Faure cells brought to the building ready charged. Professor Thompson said the electric storage of energy must not be mistaken for the storage of electricity itself. Electricity, like heat, was a kind of work done was as much chemical as electrical.

J. P. Thomson, Bristol.

AN ELECTRICIAN'S VIEWS ON ELECTRIC LIGHTING.

Mr. Ellershausen Hodges' practical knowledge of electric lighting should peculiarly fit him for writing a small book on the subject, intended for general readers; although his well-known personal and professional interest in a part of the matter as which he treats would naturally lead us to refuse him the position of an unbiased arbiter of science. Hodges' book has now arrived at the dignity of a third edition, the first having been published in 1878. In his preface to the third edition the author refers to the period of four years which has elapsed since his work first appeared, and states his conviction that electric lighting having in this time "passed out of the hands of the experimentalists, has taken a recognised position as the illuminant of the nineteenth century." In the first edition Mr. Hodges apologised for saying little as to the cost of different systems of electric lighting; and in the present edition this branch of the subject will be found to occupy a chapter to itself. In regard to incandescent lighting, which the author elsewhere acknowledges to be the system in which public opposition is principally directed, he candidly states that it "is because the success in practice believe it will, it is still doubtful whether it will ever be sufficiently economical to warrant its superseding gas in all cases;" and that, "although Mr. Edison says to the contrary, it is a question whether heat for cooking purposes could be practically produced at all; and even if it were, the cost would be enormous." Mr. Hodges says, however, that arc lighting should be one-third cheaper than gas; but as he appears to rate gas at about one-third of its actual luminous value, when employed in the most powerful flames necessary in comparison with arc light, the comparison is not so advantageous to electricity after all. The author gives tables of the cost of some of the best installations of arc lighting, by which he seeks to prove that when used in large centres, electricity is cheaper than gas. He confesses again that the case is reversed with incandescent lighting; and, as usual with gentlemen of his way of thinking, he begs the whole question of distribution by asserting, without a shadow of evidence, that this will be altered when "the current is generated at a central works, and supplied like its either fluid." With regard to street lighting, Mr. Hodges confesses that gas must still be employed for the narrow thoroughfares, but asserts that the electric lighting of the City is a success "except in the material one of cost." In respect of lighting-power, the author quotes Professor Morton, of Hoboken, New York, who states that the power of an electric arc lamp is equal by day to that of an oil lamp, which is ordinarily rated in the proportion of 10 to 1. Mr. Hodges kindly devotes a few paragraphs to the purpose of reassuring fluid gas-shareholders as to the continued value of their property. He acknowledges that the present position of the gas industry in this country is due to the continued exercise for 70 years of the most praiseworthy enterprise, and believes that the results of this enterprise will remain valuable. This little work is, on the whole, a well-compiled account of facts, accompanied by a fair and interesting commentary, and is calculated to impart much valuable information to unprofessional readers.

LA PERSEVERANZA DI MERCOLEDI'
non esce se, 22 PEGHRAIO
Ecco un altro esempio riguardo ai treni-lampo
Partì l'espresso dell'Indiano-Continentale di un vagone ner mezzo dell'elettricità. Fischi esso rivoci, un treno intero, rischiarato con lampade Edison ed interamente composto di vetture di lusso, percorsi ora un grande tratto senza l'effluenza del viaggiatori è sempre grande.
Il nuovo treno di Brighton è un vero albergo in circolazione.
In questo treno capidifonne, fornito di tutta una serie di salotti e di camere, elegantemente ammobigliati e rischiarati di luce elettrica, il viaggiatore può passeggiare a proprio agio da un capo all'altro del convoglio. Se desidera cenare, può ordinare un bello pollastro in mezzo ad una sala speciale; se vuol dormire, havvi un apposito vano dove le sedia sono disposte cosa in un vero ristorante; vi sono inoltre gabinetti di toeletta, ecc.
Ma la meggior attrattiva è ancora quella dell'illuminazione elettrica durante la notte.
Declamando Edison giungo a farci prevere il gas sia ora che già si poteva la cennia al segno — un mezzo di illuminazione antiquato.

Il Sole-Luna
Mercoledì, 27 Febbraio 1882

La luce Edison a Milano. — Il distinto prof. cav. G. Colombo terrà fra breve una conferenza sopra l'illuminazione elettrica, sistema Edison, introdotta in Milano, con tanto prove di esperimenti riusciti a meraviglia, dall'egregio ed infaticabile James Shepherd, il quale volle in questi giorni fare un dono all'istituto tecnico di S. Maria e all'istituto tecnico superiore di quattro lampade Edison a incandescenza.

La conferenza sarà tenuta nelle sale del Ridotto al Teatro della Scala, le quali verranno come le sere precedenti, illuminate da lampade Edison di un sistema semplicissimo e proiettanti una luce tanto limpida e chiara da confondere qualsiasi altra luce.

La lampada Edison infatti da una luce calda, vivida, fissa, che non altera i colori del viso, nè delle vesti; il blu, il rosa, per esempio, restano blu e rosa, e non paiono, come col gas, verde e vermiglio.

La prova del Ridotto della Scala persuaderà della superiorità di questa luce non solo una sala, ma tutto un teatro, compreso il palcoscenico; poichè, data la facilità, come è il caso di questa luce, di moderarla a piacimento e di darle anche le tinte che meglio converranno; parrebbe risoluto il problema delle esigenze degli spettacoli, e tutto il fatore e il toglierlo dal lumi della ribalta sarebbe un notevole vantaggio per gli attori e i cantanti), vien tolta la causa principale d'incendio.

L'impressione che è esperimento ha prodotto in me e tutti i presenti è che il sistema dell'Edison, introdotto fra noi dall'egregiare Shepherd, fa entrare nel campo pratico l'applicazione della illuminazione elettrica negli ambienti chiusi e negli usi comuni della vita.

Anzi il signor Shepherd, che si è assunto con ferrea volontà il difficile compito di diffondere la luce Edison in Italia, colla perizia nacia del suo volere riuscirà senza dubbio a rimuovere alle nostre difficoltà che gli si oppongono, e l'Edison non poteva trovare un più intraprendente, operoso e tenace rappresentante.

James Shepherd ha già iniziato la via Stella una Stabilimento in cui farà l'applicazione del nuovo sistema di luce elettrica e l'Edison visitando l'Italia e Milano, farà senza dubbio stasio al suo carattere fermo e perseverante.

Attualmente si trova a Londra una esposizione d'elettricità ed in tutte le Compagnie sono rappresentate, e, quantunque l'installamento sia incompleto, vi funzionano 2000 fiamme. Ebbene l'Edison vi alimenta 2 4 giobi con una macchina a vapore d'una forza di 25 cavalli ed il suo sistema porta la palma su tutti gli altri e siamo certi che anche a Milano l'illuminazione elettrica con questo sistema farà, stante la sua eccellenza, continui progressi e verrà giorno in cui tanti privati, pubblici stabilimenti, istituti, negozi, caffè e case private vorranno illuminati con la luce elettrica di Edison.

L'Edison, il genio di Menlo-Park, può dirsi il Promoteo moderno, ed ha trovato in Italia un apostolo fervente, e piano d'abnegazione nello Shepherd, che non risparmia nè cure, nè fatiche, perchè la luce elettrica trionfi.

LA PERSEVERANZA Dio. par.
DOMENICA, 12 FEBBRAIO

La luce elettrica Edison alla Scala.

L'infaticabile signor James Shepherd, rappresentante in Italia della Società Edison, per far apprezzare degnamente il sistema, ha con questi illuminato il salone del ridotto della Scala, venerdì sera, in prima delle esperimento, che durerà quindici sere, la Commissione municipale incaricata di studiare l'applicazione della luce elettrica ai teatri, in questo vedere e giudicare come piccolo lampade del celebre inventore americano.

Il successo non poteva essere più bello e completo, tanto più che risaltava il confronto colla luce dei lampadari a gas delle sale attigue.

Come si sa, il salone del ridotto ha tre lampadari con 50 becchi a gas, complessivamente. Ebbene, precisamente su questi 50 becchi che il Shepherd ha infisso 52 lampade Edison, della forza di 8 candele ciascuna, oltre ad una trentina comuni a gas.

La lampada Edison di una luce calda, vivida, fissa, che non altera i colori del viso, nè delle vesti: il blue, il rosa, per esempio, restano blen e rosa, e non paiono, come col gas, verde e vermiglio.

La lampada Edison sono di tre categorie, della forza cioè di 16, di 8 e di 4 candele, il secondo per tutti gli usi, anche per i più modesti di servizio domestico, se ne può regolare, moderare, attenuare, come e quanto, la forza, e sono indipendenti l'una dalla altra. Quelle applicate ai lampadari del ridotto sono, come abbiamo detto, della forza di 8 candele.

Un altro vantaggio del sistema sta nella facilità della sua colazione, in quanto che alle lampade Edison possono servire di sostegno gli stessi apparecchi dei gas.

La prova dell'altra sera persuase alla opportunità di illuminare non solo una sala, ma tutto un teatro, compreso il palco scenico, poichè, data la facilità di moderare a piacimento la luce e di darle anche le tinte che meglio convengano, parrebbe risoluto il problema delle esigenze degli spettacoli, e tutto il fatore e il toglierlo dai lumi della ribalta sarebbe un notevole vantaggio per gli attori e i cantanti, e tolta la causa principale d'incendio.

In questo esperimento l'egregio J. Shepherd fu assistito dal sig. Cabenon, perito elettricista, allievo di Edison.

I lili sono riusciti di una maestria inconcepibile, che ora si possono vedere, perchè trattasi di un esperimento, e che diversamente sarebbero mascherati.

Nel sistema Edison si completano a vicenda la lampada, la macchina dinamo-elettrica e la canalizzazione co' suoi commutatori, regolatori, contatori.

La lampada — frutto di perdinet studi e di molteplici prove — è un globo chiuso, di vetro, grande come una grossa pera, contenente un filo di carbone in fibra di un diavvocalato, ottenuto da una lima di carbone a della grossezza di un crine. Agli estremi è collegato a due fili di platino, che vi conducono la corrente.

Il globo, vuoto d'aria, è chiuso da un disco di materia isolante, attorno a cui sono calati due anelli in rame, per mezzo dei quali la corrente passa dal filo esterno agli interno. Questo filo di carbone, sottile le lampade, durano da 300 a 1200 ore.

L'impressione che l'esperimento ha prodotto in me e in tutti i presenti è che il sistema dell'Edison fa entrare nel campo pratico l'applicazione della illuminazione elettrica negli ambienti chiusi e negli usi comuni della vita.

Ieri sera, il pubblico che assisteva allo spettacolo della Scala, ha veduto questa nuova illuminazione nel ridotto, e tutti, ammirandola, constatavano la bellezza della luce e la mirabile semplicità del sistema Edison. Fu un vero successo.

ENGINEERING NEWS.
JAN. 14, 1882.

ELECTRIC LIGHT VS. GAS.—Judge Wilson, Jan. 7.—Judge Gibson, in the Circuit Court to-day, announced his decision in the Gas Light Company of Paul du Lac against the City of Fond du Lac, the United States Electric Light Company and the Eagle Tubular Iron Works Company, granting a perpetual injunction restraining the defendants from erecting towers and purchasing machines for lighting the city with electricity. The court continued the injunction against the Electric Company, on the ground that the contract with the city in question were illegally made, that the city has no right to enter into such contracts, and that the city has no power under its charter to manufacture its own light.

IL SECOLO
Giovedì-Venerdì 23-24 Febbraio
CORRIERE SCIENTIFICO

La luce elettrica Edison. — Si pretende che l'anni celebre e popolarissimo romito di Monte Pork abbia avuto un dì ad una dei suoi fanciulli chierici: « Ogni volta che la teorie l'analogia ed il calcolo mi dimostrano l'impossibilità di trovare quel che cercavo, io era sulla via di una nuova scoperta. » (*L'Electricien, 15 février 1882*).

Conviene dire che ciò sia vero e che quella frase sia proprio di Edison, altrimenti come si potrebbe spiegare i successi ottenuti? Due anni fa, quando si parlò per la prima volta della luce elettrica prodotta dall'incandescenza di un pezzo di carbone carbonizzato, il mondo scientifico non dissimulò il suo scetticismo ed il suddivisamente nel tempo che la prova era fatta, e nell'apprendere che anche l'invenzione era spacciata, il grande Edison poteva andare una distanza.

Due grandi elettricisti, Price in Taghttrem, Du Moncel in Francia, dimostrarono con gran pompa di scienza, che così doveva essere, e che forse la preziosa scoperta si sarebbe concretata fra un centinaio d'anni e più di lì, e ci augurarono di comparo quanto basiasse per assistere al trionfo delle idee della scoperta americana. Così e loro se quel voto fosse stato esaudito! Ma Price e Du Moncel non sono due monumenti viventi che temono degradarsi, confessando il loro errore, sono due onesti ingegni, due uomini coscienziosi che per i primi ridono del giudizio che emisero, ed oggidì schierano fra i più caldi fautori del sistema Edison.

E questo sistema infanti presenta la soluzione completa del grande problema dell'illuminazione elettrica.

Diatrico, generatore dell'elettricità, sistemi di distribuzione per la via e per l'interno degli edifici, apparecchi regolatori e moderatori, apparecchi di sicurezza, contatori dell'elettricità consumata, tutto sorti dalla mente di quell'uomo straordinario, o tutto è mirabilmente ideato dal punto di vista della pratica, della semplicità e della solidità.

La luce ora emana dalla lampada, prodotta dall'incandescenza di un filetto di carbone di lampion, che brilla nel vuoto entro un vaso di vetro, o sinibio, dolce, inoffensiva e sopratutto gradita alla vista perchè non ha quel colore bianco-lunare che rende antipatico questo genere di luce.

L'esperimento, che per opera del valente ingegnere signor James Shepherd, rappresentante dell'Edison in Italia, si va facendo di più sera nella sala del Ridotto del nostro massimo teatro, ha convinto i più restioni della superiorità del sistema Edison.

Il pubblico milanese, che sino ad ora non si mostrò mai molto tenero in fatto di luce elettrica, questa volta dovette smettere la freddo. ammiratore che decidere di volerla prendere sinbilo dimora almeno nel massimo e nei minori teatri.

ENGINEERING NEWS.
JAN. 14, 1882.
ELECTRICITY.

ELECTRIC LIGHT.—Allegheny, Pa., is considering the cost of electric lights in place of gas.

ELECTRICITY from water power has been generated in the town of Godalming, Eng.

LOCOMOTIVE HEAD GATE.—It is probable that a bill will be presented to Congress for an appropriation for light Hell Gate by electricity. The Light-House Board estimate the cost of plant at $20,000.

Scientific American.
MARCH 11, 1882.]

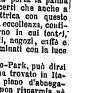
Electric Lights in Philadelphia Post Office.

A Philadelphia paper says that there are seventy-five small incandescent lamps at present in use in the City Post Office, supplied by the Maxim Electric Light Company. Each lamp is run to twenty-four candle power, though the power can be more than doubled. When the lamps were first placed some trouble arose in the machinery, in breaking globes, and in the carbons burning out; but the two latter difficulties have been overcome. The carbons are supposed to burn from six hundred to seven hundred hours. Theoretically there is no reason why they should ever burn out, but experience demonstrates, in the Post Office at least, that the carbons rarely last over three hundred or four hundred hours of actual service. The lamp of the Maxim lamp is of vulcanite rubber and metal, and the work of removing the exhausted carbon and substituting a new one requires but a few minutes. Postmaster Huhlekopf expresses himself very much pleased with the lamps. When they were first introduced some of the employes thought the light hurt their eyes and they wore shades, but, with two or three exceptions, these protectors have been discarded.

THE ENGINEER.
FEB. 17, 1882.

2020. INCANDESCENCE IN ELECTRIC LAMPS. *Gower, and H. Eyre, London.*—28th June, 1881.

This consists in maintaining the points at which an incandescent carbon rests in contact with the terminals supplying the current, by, e.g., wires, as shown in Fig. 1, twisted, say about half an inch. They are then inserted in a paper or other tube, Fig. 2, of thickness to bind with the insulating material. When this is



burnished, the end of tube secured, the contained carbon rubbed down to a point, and the whole then inserted in a socket with the rebellion wires if required round them. The wires are then connected by a plumbago line, the lamp placed in circuit with a galvanometer, and the resistance of the lamp determined. The carbon is then withdrawn, and the tube with the wires cut off as at A and B, Fig. 3. Finally the tube is inserted into a fine carbonizing the fine composition.

On the road we THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT, Published. The returning thanks having

[FEB. 21, 1882.

SOME NOTES FROM AMERICA.

[FROM OUR OWN CORRESPONDENT.]

Jan. 23, 1882.

The period that has elapsed since my last letter has had its usual quota of accidents chargeable to the electric light. In Denver, Col., an employé of an electric light company was adjusting a lamp over the entrance of a store, and happening to take hold of the wires, received a severe shock. The man fell to the pavement, and was picked up insensible. In Philadelphia, where the electric light is being experimented with for street lighting, a couple of architects have occurred owing to the wires coming in contact with telephone wires. In another case was there any serious damage done, although the fire alarm was rendered useless for a time.

It is reported that Mr. Edison has nearly completed, at Menlo Park, an electric railroad, three miles in length, which is to be used to demonstrate practically the economy of electric over steam railroads. If he perseveres in his attempt to light part of New York with his licensed-secret lamps, it will certainly be curious to watch how the current used by the several consumers will be measured to the satisfaction of the contractors. At present, the system in vogue is to measure the current by the use of what is, I presume, so called, the *voltameter* of which is that a certain part of the current supplied to any building is caused to pass through a couple of cells containing zinc plates, which are removed at stated times and their increase in weight noted.

The United States Illuminating Company claim to have produced a more agreeable light than any other in use. The advantage claimed, is that the absence of the unpleasant violet rays in the light produced, which is more provided by lessening the distance between the carbons, thus having a steadier light.

There is the usual amount of cheap talk going the rounds of the daily press throughout the country relative to the probable formation of companies to supply electricity for the lighting of dwellings, &c. A prominent Boston paper recently stated that electricity could be supplied for lighting, by the licensed-secret lamps, at a no competing gas company at the price of the latter were the former not per 1000 cubic feet. Of course such a low price is impossible, and would not pay the companies. The figures were it not for the fact that it is just such items that remache timid and uninformed holder of gas stock to sacrifice his investment. One of the most recent electric light schemes is the proposition to light one of the entrances of New York Harbour, popularly known as Hell Gate. Already a bill has been introduced in Congress appropriating 30,000 dols. for the erection of the necessary electric lighting plant. It is, however, hardly possible that the bill will be passed.

THE ENGINEER.

FEB. 17, 1882.

FILE-BARING BY ELECTRICITY.

SIR,—At the present time any successful application or transmission of power by means of electricity cannot fail to interest many engineers.

On Thursday last I visited Bartlett Park to inspect a sufficient trade across a portion of the river Lea, which is to be worked with electricity driven by the power of a water wheel situated at a distance, which power was transmitted by two dynamo machines to the couple of wires in passing connected to a pile-driver of ordinary construction. These were erected on a large floating in the river, and the work of driving rather rapidly constructed by the employés on the adjacent bank very well, lifting a daily weighing about 4 cwt. with ease and driving the piles to full depth. Should this system of transmission prove successful, the largest size could be driven by the same means successfully. Such an adaptation may prove of much value in certain situations.

Great merit is due to the energetic clerk of works, Mr. Skillin, Bartlett of skilfully arranging and carrying out the scheme. The Harrods of Salisbury, who takes a lively interest in electric lighting, as well as in the application of other mechanical improvements, has also been under the tuition of the foreman of Mr. Skillin, succeeded in lighting by means of the same dynamo both the principal rooms and corridors in the old mansion at Hatfield. The incandescent lamp is used, and the dynamo is about one horse-power, and superior from the house. I hope shortly to communicate details surthy the attention of those interested in electric lighting.

St. Alban's Ironworks, St. Albun's, February 11th.

ENGLISH MECHANIC AND WORLD OF SCIENCE.

No. 868 Dec. 16, 1881.

A "note for the festivity" — is it simply here, so that they may be safely handled. According to Dr. Lees, two connecting wires are attached to a lamp-cord, and the ends are rendered inactive by about 20 minutes, while no bad results follow chance awakening." The Germans are credited with the application of electricity to the living of bees.

ENGLISH MECHANIC AND WORLD OF SCIENCE.

No. 868 DEC. 16, 1881.

[46403.]—Electric Light.—A Faure, or a series of them, will not help you in the least; better get about 40 quart Bunsen cells; these would give a good light for one hour, or less, or more. You can make a bunsen light for less than quite extensively, and you can depend upon nothing else. Any battery will attempt to use 20 or 30 Faures to go for three or four hours, you will find them to be no endless source of trouble, and at the least almost a failure.

—W. J. LANCASTER.

THE METROPOLITAN.

DECEMBER 31, 1881.

Gas, Water, and Electricity.

Electric Lighting at the Savoy Theatre.—On Wednesday afternoon last, for the first time in this country, the electric light was alone employed as the illuminating medium of a theatrical representation. For some time past the electric light has been in use in the new Savoy Theatre, but until the present week gas was retained upon the stage. On Wednesday, however, the building was entirely illuminated, both before and behind the curtain, by electricity, and we are glad to be able to record that the experiment proved completely successful. As the public are aware, the electrical lighting is carried out by means of Swan's "incandescent," which are supplied by Siemens' Brothers' generators. Of these lamps there are about 1,200 in front of the house. Behind them are 1,000 8cp lighting the stage and 30 the numerous dressing-rooms. Each lamp burns only in vacuum. On another occasion we hope to be able to furnish our readers with full particulars of this very important and interesting installation. The general effect is certainly very pleasing. The light is singularly soft and pure, and altogether free from the glare and shiftiness which used to be considered indispensable from its employment. But the great thing in connection with this mode of illumination is the absolute security from fire which, as its inventors claim, is afforded by its use. If a lamp glass is broken the air rushes in, with the effect of putting the light out instantaneously. It is asserted, further, that no sort of danger can by any possibility arise from the heating of surrounding wires, or in any other way. The importance to a public place of entertainment of this character of being able to dispense with gas, and all its dangers, discomforts, and inconveniences, cannot be over-estimated.

ENGINEERING NEWS.

JAN. 28, 1882.

ELECTRICITY.

COMBUSTION.—The inventors of electrical torpedoes have long formed a combination of all their interests, there will be no similar obstacle to contend with in America. The question may easily be put to the test, and will possibly be established near New York.

STREET LIGHTING.—The Select Council of Philadelphia the ordinance giving the use of certain streets to the National Underground Electric Telegraph Company was reported by the committee on public accommodation. He reported with a favorable recommendation.

ELECTRIC LIGHT EXTENDED.—The Grand Trunk Railway Company is introducing the electric light at their Point St. Charles workshops with great advantage. The superiority of electric lighting, in this instance, at least, over gas is not to be disputed.

NEW COMPANY.—Articles of association of the Fisher Electric Company, of Tiffin (O.), Ind., were filed with the Secretary of State on the 20th. The capital stock of the company is $5,000,000, and the object is to manufacture, sell and lease electric lights for private use.

ENGLISH MECHANIC AND WORLD OF SCIENCE.

No. 868 DEC. 16, 1881.

[46403.]—Electric Light.—A Faure, or a series of them, will not help you in the least; better get about 40 quart Bunsen cells; these would give a good light for one hour, or less, or more. You can make a bunsen light for less than quite extensively, and you can depend upon nothing else. Any battery will attempt to use 20 or 30 Faures to go for three or four hours, you will find them to be no endless source of trouble, and at the least almost a failure.

—W. J. LANCASTER.

THE METROPOLITAN.

DECEMBER 24, 1881.

Gas, Water, and Electricity.

Electric Lighting.—This method of illumination is getting a former hold every day upon the public. It has never met with that degree of virulent opposition and ridicule that attended the early days of gas, and it is rapidly receding from the confidence of impossibility. While it is fast to be expected that gas will cease to be manufactured and sold, or even used, it might be almost safely asserted that for lighting on a large scale, electricity will, before another decade has passed, take the place of all other media. As a proof of this, we need only turn to the proceedings in many of the local Boards this week, examples of which we give below.

The Electric Light for Millwall.—On Wednesday, at the Vestry meeting, a letter was read from the Vestry of St. George's East, stating that the House having of opinion that the time has arrived when the question of the further introduction of the electric light into the public streets should be considered, have referred the subject to their Lighting Committee for a preliminary report. "It has been suggested that it might be thought desirable to select the City of London for the purpose of experimenting, and as the position of this vestry, it is suggested, should be used for the purpose, is partially within the borders of Mile-end, I (Mr. Harrison, the Clerk) have been requested to ask your Vestry whether they are also prepared to join and take part in the experiment, and if so, to suggest the advisability of their instructing Mr. Knight (Mile-end surveyor) to meet our surveyor and prepare a full report for the latter." [Some of our representatives, as Mr. Ward, have reported that this matter be referred to the Committee of Works, with power to act with the St. George's East Vestry.—Ed.] Having been duly seconded, Mr. J. Rush said the matter of gas was of serious importance, and not to be treated hastily. He (Mr. Rush) would certainly object to entering on a partnership with another local Board for the proposed purpose. (Hear, hear.) If the Vestry were to do anything, they should do it for themselves; and, as regards sites for an experiment, they possessed a finer road even than the Commercial-road. (Hear, hear.) Whitechapel had already considered the matter of electric light, and have given permission to one company to enter the district. But this case was not one to be followed lightly, for these were other companies whose claims for lighting should be impartially examined before giving away public rights. (Hear, hear.) St. George's Vestry was, no doubt, anxious to get everything to help with the expense of the experiment; but to this he objected, for several reasons, and especially because the electric light was treading down the Whitechapel-road, and it was difficult to get rid of. He wanted the Mile-end-road. (Hear, hear.)—Mr. Hall objected to anything being done in an important a matter until they had seen the economical and other results of the experiments in the City by the several rival electric light companies. To spend public money in Mile-end at present would be premature, and might prove very wasteful.—Mr. Giles, on the other hand, urged that Mile-end should not be lagging behind other public districts, and even the municipality of London, in this matter. Ample sufficient was known of the new light to justify the Vestry's immediate action, and this would be a splendid field. Mile-end-road practically required special lighting more adequate to its proportions than gas could afford. The Mile-end-road was the finest one in the world they should have the best of lights.—Mr. Jupp explained Mr. Giles's references to the matter by attributing it to a desire for his own shop should be illuminated as that he could reduce his personal expenses for gas, and do it at the public cost. A prospect so gratifying to Mr. Giles would not arouse similar feelings in the back streets, and the ratepayers would not assent to any such use of the experiment would have to be drawn.—Mr. Glass indignantly denied the justice of this analysis of his motives, and chimed—what in a person of Mr. Jupp's habit of mind must be difficult to him—a patriotic note in favour of the whole metropolitan area. He advised Mr. Rush to withdraw his objection that "from a building they could expect only a small or a barbarous light."—Tuckwell counselled a cautious movement in the matter of the electric light, for he felt assured the advance of discovery and invention would be so rapid that in a short time they would be able to see at all their lamp posts and plant for the desired purpose, without rushing into large expense.—Eventually the subject was referred to the Committee of Works.

Electric Light in Whitechapel.—On Monday, at the meeting of the Whitechapel District Board of Works, by the minutes of the Committee of Works it appeared that they had considered a letter from the agents of the Brush Electric Light, stating that they were contemplating laying down an electric light main along the Whitechapel and adjoining roads, with the object of letting out electric lights to private consumers, and asking permission to carry the wire underneath the roadway. "Many of the inhabitants of the immediate neighbourhood of the High-street are very anxious to have an

experimental trial of the lights by Christmas, and we have consented to meet them on Wednesday [that is, last week].—The time being very short, it was suggested that the Board would allow the agents to take the wire for this trial underground. It was added by the writers that the best insulated wire would be used, and carefully covered with gutta percha, so that there would not be the slightest risk of an accident of any kind.—A representative of the agents attended, and explained that it was proposed to light the premises of some of the inhabitants in the district in Whitechapel-road, Commercial-street, and also in Whitechapel-road.—The Committee of Works resolved to recommend that no objection be offered by the Board to an experiment being made by Messrs. Hammond and Co., agents for the Brush Electric Light, to light certain private establishments in the district, and for that purpose to carry their wires above ground from point to point as may be arranged by them with owners of private property, such arrangement on the part of the Board to be terminable at three months' notice, to be determinable at the absolute discretion of the Board at any time before the expiration of that period.—In moving this report, Mr. Lidyard, by the Board, Major Nimmo (Metropolitan Board of Works) said the Board would doubtless feel it their duty to give every reasonable facility to the progress of science in its application of light. (Hear, hear.) At the same time it must be clearly understood that the present resolution was only to permission only to cross public thoroughfares as an experiment, and temporarily, and that the Board exercised assented over the proposed individuals for the use of whose houses the agents would themselves have to negotiate. Neither did the Board accept any responsibility for any damage resulting from the breaking of wires.—Mr. Bass longer seconded the motion, and it was supported by Mr. Basham, both speakers urging that Whitechapel should not be behind the rest of the metropolis in this matter.—Mr. Harris strongly objected to cables being allowed to hang over public thoroughfares. The Board, of course, had no power to prevent owners of property making their own use of the electric light agencies, but he should be sorry to let any of his property for the purpose.—The Chairman said he expected that he could support the motion, and therefore some explanation of his sometimes resolved to deter a little the Board's consideration of the matter was necessary.—Mr. Harris moved to defer it for a week, because he felt that on a matter specially demanding prudent action. The impression of the Board's decision was a very good thing; but also was the question of the public rights and interests. Using the form of contract offered by the electric light agency, he showed that sometimes local boards themselves for three years, whilst the company puts itself in the position of voiding the contract if their application to the local authorities is refused. Further, what the company wanted as a permanency was to take a portion of the subsoil. Doubtless that was the better method, for the expedient of carrying cables overhead was both clumsy and dangerous; but it was nevertheless one to the public property for private profit. It might be said that this was a mere experiment; experiments were everything, and cases there were where the wires would have to be very difficult to get rid of. He wanted the Board to consider well the attempt to promote science, they might not be absolutely blocking the progress, because there was no question that they would have to deal with it in the course of a very short time, applications from three or four companies, and they would then require to be in a position to deal with the matter. He moved his previous amendment.—Mr. Lidyard, on the part of the Committee of Works, explained that the action of the Committee was carried by the addition of the clause, "as an experimental trial," and that the object was to secure the Board's power to withdraw its consent at the end of the term mentioned," and thus amended, it was adopted.—Mr. Ox, the Board's surveyor, explained that this term had the Board's consent would come too late for the purposes desired.

Reduction of Price.—At the meeting of the St. George-in-the-East Vestry on Thursday, the Clerk reminded the Vestry of their proceedings in 1878, when the Vestry resolved to go in for the operation of other Vestries, in seeking a reduction in the price of gas supplied by the Commercial Company to the public lamps, and he now read a letter from the secretary to the company, recommending a reduction of the price of gas from 3s 2d to 2s 11½ 6d. per 1000 per annum, making a reduction of 3s. 6d. per lamp per annum, or 350 cubic feet, making an aggregate reduction in the public lamps.—Mr. W. Walker said they here saw the effect of the Gas Referees' Act, which was a very good piece of legislation as it ought to be. Gas companies, and only amounting to £700 per annum in St. George's-in-the-East, whereas the lamps was not at all in proportion to that on private consumers.—The Chairman said he thought a considerable amount of credit was due to their Clerk for the consistent perseverance he had manifested in bringing the proposal to a successful issue.

Electric Lighting for Paddington.—On Tuesday, at the meeting of the Vestry, the following resolution, moved by Mr. Keeche, was carried:—"That it be referred to the General Purposes Committee to consider and report whether the time has now arrived to invite tenders for the purpose of lighting this parish with the electric light; or, if it be advisable and more economical for the Vestry, to make arrangement with one or more of the ratepayers to work it themselves."

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT. [Jan. 3, 1882.

SOME NOTES FROM AMERICA.

(FROM OUR OWN CORRESPONDENT.)

Dec. 13, 1881.

Accidents caused by electric light wires are now becoming so numerous that it is absurd to keep track of them, or to note them all, as it is nearly always the same story over again—either an electric light wire coming in contact with a telephone or telegraph wire, or else one of the wires becoming heated and setting fire to adjacent woodwork, &c. Thus, in Chicago, a man was on the point of taking up the ear-trumpet of a telephone, when he saw the instrument on fire in several places. In Cincinnati, the *employés* at the central office of the Telephone Company were recently treated to quite a grand pyrotechnic display, the sounding-boards shooting out flames from all sides, making necessary the disconnecting of several wires. Of course the explanation, in each case, was that an electric light wire had become crossed with a telephone wire. Perhaps, in time, means may be devised whereby such accidents can be in a great measure prevented; but certainly at present they are a serious obstacle to the use of this mode of lighting.

Mr. Edison is making some progress in his task of "piping" a section of New York City. The work does not go on so rapidly as it might, owing, it is said, to difficulty in procuring the copper mains. However, it has probably advanced sufficiently to convince the Edison Company that a diminished outlay in the distributing plant is *not* one of the advantages that electric lighting has over gas. I have so often referred to this scheme in my "Notes," that it is not necessary to dilate upon it at this time. Suffice it to say that the section being piped is in the down-town business portion of the city, where the incandescent lamps would doubtless find more customers than in any other locality, because the absence of excessive heat, which is the one good point in this mode of illumination, would be of great importance in the low, dark offices which abound in that part of the city. But the night supply of light would be practically *nil* in the district unless Mr. Edison turned his attention to lighting the streets. It is further to be noted that the great bulk of those who have agreed to use his lamps when his mains are laid, take the light on trial only. It is to be sincerely hoped that nothing will occur to prevent the scheme going forward to completion, so that the question of supplying electricity for the lighting of interiors may be practically tested.

A couple of novel actions against gas companies have been in progress recently in New York City. In one case, the Health Commissioners sued the Metropolitan Gas Company for allowing gas to escape into a sewer. The action was brought under a statute which prohibits any one permitting refuse matter from a factory to escape into the sewers; but it was apparent that the accidental escape of gas into a sewer could not be punished under the statute, so the action was decided in favour of the Company. In the second case, a well-known New York citizen is trying to get a permanent injunction against the Manhattan Company to restrain them from removing his meter. It seems that the gentleman went to Europe during the summer, and before starting thither had his gas supply shut off; but on his return he received a bill from the Company for a few dollars' worth of gas. This bill the gentleman refused to pay, and in consequence was threatened with the removal of his meter. A temporary injunction to prevent this was obtained, and now it is sought that the Company may be permanently restrained from carrying out their threat. The way in which the Company make out their bills is doubtless at the bottom of the trouble. The meters cannot all be read on the same day, but the dates on the bills are all alike; so that while, according to the gentleman's bill, he probably paid up to the time of his departure, yet, as a matter of fact, the meter was read several days previously thereto. The case is still pending.

Looking back over the year now rapidly drawing to a close, the gas companies throughout this country have much cause for rejoicing, for the epoch in question has been one of marked progress. Increased out-send and a more general use of gas have been the order of the year. Especially in the use of gas-stoves has improvement been marked. In the early part of last summer the gas-stove manufacturers had all they could do to supply the demand made upon them. Several gas companies, in order to foster this part of their business, have supplied the stoves to their consumers at cost price; and some have even gone so far as to sell at a reduced rate the gas used for cooking and heating purposes. This latter practice has been generally found to work well, though it does not seem to be based on sound commercial principles. Now, as the winter has set in, there is a good demand for heating-stoves, and the makers having, during the summer, added many new styles to their catalogues, are quite ready to meet everybody's wants in this direction. The progress made in the introduction of gas-engines has been fair.

While attention has been given to these auxiliary branches of the gas business, the main object for which gas companies are organized—namely, the supply of light—has been pressed forward with vigour. The electric light has engendered a demand for more light; and, as a result, gas has been burnt with greater freedom. The gas companies have shown their customers how to burn their gas to the best advantage; thus, improved burners and globes have been very generally adopted. Three years ago, globes with 5-inch openings on the top and 1½-inch openings below were almost the only kind used; the result being a flickering, disagreeable light. To-day, few gas-fittings manufacturers make globes with less than a 4-inch opening below, unless they are specially ordered. This is an improvement of no small moment. Nor does there seem to be any more chance of electricity supplanting gas than there was a year ago, perhaps not as much. If the whole truth were known, it would doubtless appear that the companies supplying electricity, especially those working the incandescent patents, are not so sanguine of success as they were twelve months since. The fact still remains, that with the small lamps only about 120-candle light can be obtained per horse power, and until this figure can be vastly increased the incandescent lamps cannot compete with gas, except in a few isolated cases where money is no object. Of course we hear a good deal about the improvements that are being made, whereby better results are to be obtained in the future; but there is one thing to be borne in mind in this connection—namely, if the electric light of the future is to be put in comparison with gas, it must be with the gas of the future. We must take the two industries at the same epoch. Granted that improvements may be made in the incandescent lamps; well, gas-burners may likewise be improved. The Siemens burners open up a vast possibility to which full weight must be given, if we are to begin and compare the illuminators of the future.

ENGINEERING NEWS.
FEB. 4, 1882.

ELECTRICITY.

UNDERGROUND TELEGRAPH WIRES.—An effort is being made in Louisville, Ky., to place the telegraph wires underground.

WESTERN UNION EXTENSION.—The lines from Corpus Christi to Brownsville, Tex., and from Matamoras to Tampico, Mexico, have been completed.

BRIDGE LIGHTED BY ELECTRICITY.—The Greenbush Bridge, Rensselaer County, N. Y., is to be lighted by electricity.

WILL CONSTRUCT A LINE.—The Trenton (N. J.) Common Council has given the Mercer & Burlington Electric Light Company permission to erect poles and wires in that city.

PUBLIC ELECTRIC LIGHTS.—The Belleville (Ill.) City Council is asked to give permission for electric lights on the streets.

ELECTRIC LIGHT COMPANY ORGANIZED.—The Brush Electric Light and Power Company, of Memphis, Tenn., has been organized with a capital of $500,000. The new company will have exclusive control of the Brush apparatus for all the nineteen counties of West Tennessee.

ELECTRICAL HONORS TO AMERICANS.—Edison has been made officer of the Legion of Honor, and our Consul-General, Hon. George Walker, is made recipient of the same favor. His son, Mr. Philip Walker, receives the grade of Chevalier for his services as Secretary of the American branch of the Electrical Commission. He is the youngest man but one who ever received this decoration.

A NEW TELEGRAPH LINE has been lately built across the mountains from Manchester to Saxton's River, Vermont, with ten offices on it, in as many country villages.

ELECTRIC LIGHT ABROAD.—The London *World* says: "The frightful calamity at Vienna—a combination of carelessness, misfortune and an unprecedented absence of mind—renders every step towards making a theatre more or less secure against danger of fire particularly interesting. Mr. D'Oyly Carte gave one day last week the first performance of 'Patience' with the whole stage lit up by electricity. It will, perhaps, less interest the reader to know that two separate engines provide 800 lights for the stage and the dressing rooms, and 120 lights for the auditorium, than to know that the incandescent lamp gives an agreeable, soft, not glaring light, advantageous for the colors, and—mind!—for the complexion; gives no heat, flickers not, smokes not, causes no dirt, and last, not least, cannot set fire to anything it comes in contact with, simply because the incandescent wire, heated white, is inclosed in a glass globe from which the air has been exhausted, this vacuum being one of the conditions of the burning. If, therefore, by any accident the globe should be broken and the flame exposed the mere rushing in of the air would destroy its vital conditions and extinguish it.' An *argumentum ad hominem* was furnished, after a clear and intelligent speech to that effect, made between the first and second acts by Mr. D'Oyly Carte, who, to illustrate his words, wrapped one of the globes in the most inflammable material, tulle gauze, and broke the glass; instantly, instead of burning the gauze, the flame was extinguished." With reference to the lighting of railway trains, a correspondent of a Sheffield (Eng.) paper, writing from London of the recent trial of electric lights on the Pullman train of the London, Brighton & South Coast Railway, says: "There is no doubt whatever on the point that this, apart from the question of cost, is a decided success. It is easily manageable, and diffuses through the train a pleasant, equable light, scarcely less agreeable than daylight. It is turned on and off with instantaneous effect as the train enters and leaves a tunnel, and of course is kept burning the whole of the time during the night journeys."

Dec. 20, 1881.] THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT.

THE ELECTRIC LIGHT AND ITS FRIENDS.

ANYTHING is good enough to hang an advertisement upon; and any advertisement of electric lighting is good enough to find ready admission into the news and editorial columns of *The Times* under the present management. This time it is the contractors for the electric lighting of Godalming who have found favour with *The Times*, and have also won notices in the *Daily News* and other London daily newspapers. On Friday last it was announced in the journals named that on the previous Wednesday evening the efforts of the electric lighting contractors to light the streets of Godalming, which had been in progress since the 1st of October, culminated for the first time in a completely successful test. It would be cruel to inquire whether this notable success took the form of a dinner to the representatives of Metropolitan journalism, who are, of course, eminent authorities on street lighting; but the culmination referred to must have had reference to something besides street lamps, since this part of the experiment has been on show for weeks, as testified by several communications which we have received from interested visitors to the town. That there was something done successfully in Godalming on Wednesday night is, from the press notices already mentioned, sufficiently proved; it is for us to show that the success was not in the lighting of the streets. From special inquiry we learn that on this auspicious occasion the electricians were on their mettle, having been given a week from the last previous meeting of the Town Council to improve the admittedly unsatisfactory state of the lighting. An extra impulse was therefore given to the test prepared on Wednesday night, which was to determine whether the experiment should be speedily discontinued or allowed to go on, and eventually blossom into a definite contract. On this occasion, according to the newspaper reports, four powerful arc lights were used in the main thoroughfares, which gave "every satisfaction." The remainder of the minor streets and lanes, to follow the same authority, were lighted by forty Swan lamps, all of which were estimated to give a light equal to fifteen-candle power. Our own information on the subject of these proceedings is to the effect that the principal arc lamp near the Town Hall would not light, and has ever since only given a flash at intervals. Instead of the forty Swan lamps, of fifteen-candle power, twenty-one only showed a light, of which three were apparently of about three-candle power each, and the remainder not averaging more than a single candle—some, indeed, merely glowing like a recently blown-out match. There is thus a grave discrepancy between the two records; but that the latter is correct is strangely indicated in the highly laudatory *Daily News* notice, wherein it is naively remarked that the inhabitants are not unanimous in admitting that the Swan lamp is equal to a good gas-burner, and, finally, that although the contractors had offered "to light "the borough with electricity, for a term, at nineteen per "cent. less cost than the ordinary gas contract," the contract had not been signed, and it was even considered "possible "that at the meeting to be shortly held it may be decided "not to proceed further with it." To close the subject, it may be stated, as the result of this meeting, that although the Town Council are naturally reluctant to abandon their hobby altogether, the Swan lamps at least are to be given up at the end of the year. So much for the value of professedly independent press notices of electric lighting.

At the last meeting of the Lambeth Vestry an extraordinary proposition to invite the Brush Electric Light Corporation to submit tenders for lighting the whole parish on the tower system was brought forward by Mr. Wiseman. We should rejoice to see the experiment tried, but not at the ratepayers' expense; and the Brush Company are probably too astute to undertake such an attempt on their own behalf. They know too well what have been the results of the tower lighting experiments in various towns of the United States and in France—results which somehow are hushed up as carefully in proportion as the initiation of the trials is noised abroad. Even Mr. Wiseman, of the Lambeth Vestry, has heard of the existence of the tower lighting idea, and was quite prepared to show that eight towers, 250 feet high, would suffice for turning night into day all over the parish, at a total cost of a little more than £3000 per annum, while the cost of gas consumed for public lighting is now £13,670 yearly. He has apparently never heard that the tower system of lighting is wrong in theory, and disastrous in practice. This delusion, indeed, is a good modern instance of the truth that persistent advertising will persuade people of the reality of the hollowest and most transparent fraud. The tower lighting device is a swindle; it has never succeeded with any description of electric lamps; it is not to be seen in action successfully anywhere on the face of the earth at this moment; and it never will succeed with any tower that man can build, or with any light of much less power than the sun. And yet it is being constantly brought forward by numerous wiseacres as a great fact!

* The death of a labourer at Hatfield House on Monday last week, from touching a presumably uninsulated electric lighting wire, has attracted considerable attention. It is not our purpose to unduly magnify the very real dangers of strong electric currents, or to discredit electric lighting simply because it is capable of causing damage. We desire to remark on the peculiarly insidious, or rather deceptive character of the principal risk in dealing with electricity in a state of high tension. It is simply impossible that any one should discover beforehand what would be the awful result of touching a pair of harmless-looking wires, which at the time may be conveying a tremendous amount of electrical energy. Escaping coal gas gives its own warning to the senses, and all that is necessary to avoid harm in such a case is to avoid striking a light. Yet this precaution, simple as it is, has not yet been fully taught to a careless public. What, then, will serve to warn them from wilfully or heedlessly touching an electric light line-wire? The recommendation of the jury in this instance was ridiculously insufficient to point the moral of such a case; but the time may be near when an electrician who, from economical motives, transmits a death-dealing force through an unprotected wire, will find reason to repent his criminal recklessness.

* Perils of Electricity.

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT.

[Dec. 20, 1881.

A local paper, commenting upon the abandonment of the proposal for the electric lighting of Dudley, says: "The negotiations for introducing the electric light into the town have broken down, as was only to be looked for when such conditions were asked for by the promoters of the light." The idea of adding a monopoly of 20 years to that which the period was simply in its infancy. The electric light was then only just coming into use, and it was clearly to be followed by improvements, but they could give us an indication of what may yet be done, and what will very likely be done in the years that are to come. Is it reasonable, therefore, that we should bind ourselves to a system for three generations, or even for two, which very likely, before ten years are gone would be looked upon as a thing of the past? Certainly not. Mr. Shackleton, Messrs. Hanson & Co. wished the Corporation to take up the electric light, and were willing to grant you one for the purposes of the town, by holding out to the Corporation, if offering to light underground from Crown to St. Edmund's Church, for one year, for the sum of £700. As the saying is, it was but "a sprat to catch a mackerel;" but the bait did not take. In introducing a novelty some risk must be run by the person who is introducing it, and some inducement given to those whose interests he seeks to disturb. Mr. Shackleton's offer was that the electric light should be tried and work satisfactorily, before there was any agreement to be entered into. This was all that could be reasonably expected in regard to the introduction of a novelty which as yet had not been sufficiently tested to render its adoption a matter of certainty."

THE ELECTRIC LIGHT IN BERLIN.—At the meeting of the Dublin Corporation on Monday last week, the Paving and Lighting Committee presented a report, in which it was stated that the Dublin Electric Light Company had withdrawn their application for the necessary powers to light for the purposes of public lighting certain streets proposed to be lighted by the Company, viz., Parkville Street, O'Connell Bridge, and South Great George Street. The object of this was, the report stated, to give the Council and the public an opportunity of testing the efficacy of the electric light. The Company offered, at their own expense, to lay their wires in pipes beneath the pavement, and they asked the Corporation to pay for the electric light is to be supplied the price they now pay gas for the lighting of the same streets by gas. The report, further stated, that the Company had not yet commenced to lay down any part of the mains which the Company proposed to light, and that May had not yet been lighted, did not recommend the Council to entertain the present application. Mr. Mulligan said that, as Chairman of the Committee, it was his duty to move the adoption of the report, but he disconcurred in its recommendation. Mr. Beasley seconded the motion. Mr. Shackleton moved, as an amendment, that the report be referred back to the Committee for further consideration. The amendment was not seconded, and the motion was carried. Mr. Lyons seconded the amendment, and it was agreed to.

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT.

[Dec. 20, 1881.

FATAL ACCIDENT WITH THE ELECTRIC LIGHT.—At Hatfield House, the residence of the Marquis of Salisbury, a labourer named William Dunmack, 28 years of age, was accidentally killed on Monday last week, by coming in contact with a live wire connected with the electric current which lights the mansion. Hatfield House is illuminated with 117 lights on the Brush system, worked by an engine of 16-horse power placed in a detached stable some distance from the house. From electric wires and a telephone wire connect the stewards with the mansion. For some distance they are carried on poles; but to avoid the unsightly appearance of the poles near the house, the wires are run along the garden wall, 3 feet from the ground, and are protected by a wooden casing. Deceased, with a fellow-workman, was in the garden assisting to lay a telephone wire, and was next to cross the wire at the corner of the kitchen-garden wall, on the left-hand side. While he was almost the linesman heard the wires shake, and on looking round saw the deceased lying on his back, and on going up found he was dead. The machine was at work at the time, some of the Royal Company's men being down from London repairing it, and it is supposed that the deceased, in crossing the wire, came in contact with it, and was thus immediately killed by the current. The linesman stated at the inquest that neither he nor the deceased knew anything about electricity, but the man in charge of the lighting arrangements said he told the deceased, if it, and had purposely sent him to work at the telephone wire 150 yards away from the electric wires. This witness said he did not think the shock would have been fatal if it had not been a wet day and the deceased's clothes saturated with wet. The medical evidence showed that death arose from shock to the system, causing paralysis of the heart. At the inquest the jury returned a verdict that the deceased died through touching the electric wire, and appended a recommendation that there should be a fence put round the wires, and that notice should be given of it to all persons engaged near the wires. It was stated that to avoid similar accidents in future the wires would all be conveyed either underground or on poles out of reach.

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The Electric Light.

A large number of interested citizens took advantage of the invitation extended them in Saturday's paper to call and investigate the Edison electric light for themselves, and all last evening a steady stream of ladies and gentlemen poured through the STATE JOURNAL building to see and be convinced. The verdict was unanimously in favor of the beautiful light, and all were astonished at the difference between all other known illuminators and the clear, pure brilliance which poured from the tiny loops of glowing carbon, inclosed in fragile glass globes. And just here a slight correction of an inadvertent statement in yesterday's issue is in order. The statement of carbon is the shape of a horseshoe, but it is inclosed in a pear shaped glass globe, exhausted of air, and hermetically sealed.

Last night thirty-six of these lamps were in action till nearly midnight, of which twenty-five were in the scanning room, editorial rooms and press room of the STATE JOURNAL, and the remaining eleven in the hallway and office of Mr. T. B. A. David, agent for the Edison Light, No. 49 East State street, in the next manner in which the spark apparatus was put in position, so that it was a pronounced success from the moment of starting. Electric engineer Mr. David and electrician Sergeant Nelson, Messrs. Charles Barnard and Charles Merrill, assisted.

ENGINEERING NEWS.

JAN. 21, 1882.

ELECTRICITY.

NEW CARLE.—An exchange says: Mr. Jay Gould has announced his intention of laying a telegraph cable between North and South America.

A PRACTICAL test of electric lighting is being made in Indianapolis by Ilg Electric Light and Power Company. Fifty-three lamps will be in operation next week.

ELECTRIC HEAD-LIGHT.—According to *Railroad Gazette*, Normandine has been placed on the Pennsylvania Railroad, which is called spring to an electric light which is placed in front and fed by the engine itself, and intended to illuminate the way for a long distance in front."

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT.

[Dec. 20, 1881.

THE BARNSLEY TOWN COUNCIL AND THE ELECTRIC LIGHT.

Last Tuesday a special meeting of the Barnsley Town Council was held at the Masons (Odgen Brady) to the consideration of the desirability or otherwise of extending the trial of the electric light.

The Town Clerk read the minutes of the Park and Lighting Committee, who met on the previous day, including a letter from the contractors for the electric light, stating they were willing to continue the trial for twelve nights more for 25s. This the Committee recommended the Council to accept. Mr. Hall moved the following minutes, which will be laid before the Council at their next meeting:—The Committee instruct the Town Clerk to apply to the Directors of the City of London Electric Lighting Company for providing and supplying the whole of the public lamps in the town for one, two, or three years from the 25th of June, 1882.—Mr. Hall, in moving the resolution, remarked the Council at once to give notice to the Gas Company to terminate the present contract with them.

Mr. Hall moved the adoption of the Committee, in moving that the trial of the electric light be extended, referred to the display which had already taken place, to the streets, and to the fact that the first night of the experiments owing to a defect in the machinery, and a few success which had since attended its working. He assured the Council and those interested in the Gas Company that all the Committee desired to do was to ascertain which was the best and cheapest light. Such being the case, he thought the trial should be extended to the dark nights, in order that they might be able to know what gaslights would be displaced, and what the cost of lighting the whole of the streets by the electric light would be. The Committee had had many opportunities of testing and proving the light, and therefore he could not see the use of throwing away £50 more. He moved—That as further money be expended on the electric light until better data and more facts are laid before the ground.

Alderman PRIEST, whilst agreeing with Mr. Taylor that ample time had been afforded for ascertaining the merits or otherwise of the electric light, said he could not second the amendment, and therefore it fell to the

Mr. WADE called the attention of the Council to the fact that a record of 250 had been offered for information as to who stepped to the chimney of the electric lighting station. He then, amidst great laughter and interruptions, explained that he visited the depôt where the electric light was stationed, and on the Friday afternoon, for which on the previous Friday afternoon, when he was taken out on the roof, being something to the chimney, after which he observed a man with a ladder, who ascended more plentifully. He was to the same boy, but he had no, and got a handful of what appeared to be dust. He took it to Sheffield and had it examined by a friend of his, who said it was soot and charcoal wood, which had blown off the fire, and nothing more. He thought the Council ought not to be taxed to further experiments in the electric light.

After other remarks, the motion was put and carried by a large majority.

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT.

[Jan. 31, 1882.

THE BARNSLEY TOWN COUNCIL AND THE ELECTRIC LIGHT.

At the Meeting of the Barnsley Town Council on Tuesday last the MAYOR (Mr. Charles Wood) presided. The minutes of the Park and Lighting Committee in reference to the street lighting of the borough were under consideration. The Town Clerk read a letter, which had been received from the Barnsley Gas Company, stating their willingness to continue the present contract for lighting the whole of the lamps in the borough, and to erect 100 additional lamps during the ensuing year, on receiving a reduction on the 30th of June next of the present price of 3s. per lamp per week.

Alderman PRIEST asked whether the Committee meant to dispose of the question of street lighting by the resolution. The Council were premised that the Committee would bring up a report as soon as many be thought the Committee ought to say whether or not they intended presenting such report.

Mr. HAWKINS (Chairman of the Park and Lighting Committee) said he had to ask the Council to rest satisfied with what they had. The Committee preferred for the present to keep back the information alluded to. They were timed by the Gas Company for what they had done, and they asked for a reduction of some 12½ per cent. Another reduction. The Alderman for the public house had been reduced to 42 each, and through the aid of the Committee the public had the price of their gas reduced 2d to 2d per yard. Having obtained this reduction, the best way was to pause for a time, and watch further matters.

Mr. WADE thought the Council were entitled to the promised report. He moved that the minutes be referred back to the Committee for them to make a full report to the Council.

Mr. WILSON, a member of the Lighting Committee, said they had worked out the question satisfactorily to themselves, and they did not wish to throw any difficulties in the Council—their cards. The electric light was not a failure, but it was a thing was a question of cost. He knew of nothing that if the shopkeepers were asked which they would have, they would vote for the electric light; but they had to take into consideration the private householders.

Mr. BEARDSHAW said when they found that the Gas Company were anxious to fulfil contract, such was developed. By a judicious expenditure of £70 the price of gas for the public lamps had been reduced from 42 to 42 each.

Alderman MARSHALL said he could not give the Committee so much credit as they gave themselves. The Committee had been 12 months in office 12 was no concession. This was the price when he moved the Council, and during the coal famine the price was advanced 6d per lamp per week. He thought after a time, when the coal famine was over, the Gas Company would have got back the price to the old rates. The Council remembered with thankfulness the reduction from 3s forwards, and now that they had got the price back it was not to be forwards only, but now that they when the charge with respect to the public lamps. He wished to know Mr. MAWHOOD explained that the contract had been commenced.

Mr. WILSON seconded Mr. Wade's resolution, but on being put to the vote the consideration of the minutes was agreed by a large majority.

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT.

[Feb. 28, 1882.

AN ELECTRICIAN'S VIEWS ON ELECTRIC LIGHTING.

Mr. KILGOURHORN HUNTER' practical knowledge of electric lighting should entitle his opinion to be taken in writing a small book on the subject, intended for general readers; although his well-known personal and professional interest in a part of the matter on which he treats would naturally lead us to refuse him the position of an unbiased man of science. Mr. Hedges' book has now arrived at the dignity of a third edition, the first having been published in 1878. In his preface to the third edition the author refers to the period of four years which has elapsed since his work was first published, and states his conviction that electric lighting having in this time "passed out of the hands of the scientific specialist, has taken a recognised position as the illuminant of the nineteenth century." In the first edition Mr. Hedges explained for saying little as to the rival of different systems of electric lighting; and in the present edition this breach of the subject will be found to occupy a chapter to itself. In regard to incandescent lighting, which the author chooses acknowledges to be the system to which great expectation is principally directed, he candidly states that if it "becomes the success its advocates believe it will, it is still doubtful whether it will ever be sufficiently economised to warrant its superseding gas in all cases;" and that, although Mr. Edison says in the contrary, it is a question whether heat for cooking purposes could be practically carried at all; and even if it were, the cost would be enormous. Mr. Hedges says, however, that arc lighting should be one-third cheaper than gas, and he appears to rate gas at about one-third of its actual luminous value, when employed in the powerful flames necessary to compete with an arc light, the comparison is not so advantageous to electricity after all. The author then takes up the question of the subdivision of arc lighting, by which he seeks to prove that when used in large centres, electricity is cheaper than gas. He confesses again that the case is reversed with incandescent lighting; and after a consideration of the cost of lighting, he says the whole question of distribution by accumulators, without a number of evidence, that this will be altered when "the current is generated at a central works, and supplied like the older methods." With regard to arc lighting, Mr. Hedges confesses that gas must still be employed for the interior thoroughfares, but asserts that the electric lighting of the City is a success "except in the material one of cost." In respect of Holborn too, the author says that the experience of Dr. Barnard, of New York, who states that the power of an electric arc lamp is reduced by the to that of an oil lamp, which it ordinarily exceeds in the proportion of 10 to 1. Mr. Hedges kindly devotes a few paragraphs to the purpose of reassuring timid gas shareholders as to the continued value of their property. He acknowledges that the present position of the gas industry in this country is due to the continued exercise for 50 years of the most praiseworthy enterprise, and believes that the results of this enterprise will remain valuable. This little work is, on the whole, a well-compiled account of facts, accompanied by a fair and interesting commentary, and is calculated to impart much valuable information to unprofessional readers.

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT. [Dec. 13, 1881.

THE DANGERS OF ELECTRIC LIGHTING.

An esteemed correspondence has favoured us with the subjoined account of facts in connection with electric lighting and its dangers, which appeared in an American trade journal—*the Scientific and Mechanic Repository*. In reference to it he writes: "An extract from it in the Journal would, I venture to say, be read with much interest by your subscribers." The article is as follows:—

In a former number we pointed out the unreliable and unreliable character of electricity as applied to illuminating purposes, and showed that even when the electric current was found to exercise a direct control over the action which would make it, at all times, a safe and reliable agent, a rival is already available substitute for gas or oils. We cited cases where a fire had been kindled, without any reasonable cause, and in cases had been consumed to fall back upon the less brilliant but more trustworthy coal gas. It now seems that the drawbacks incident to the use of electricity as an illuminating medium are not confined merely to the temporary loss of light, and the consequent inconvenience to persons in such application; but that serious injury to property and even loss of life, not to speak of numerous minor accidents, are resulting from its use.

In Boston a few days ago, at the Bowditch' Fair building, a man who was making a connection of the wires was knocked senseless by the field. Another man on Tremont Street, in the same city, suffered severe burns from a similar agency. A serious fire occurred in Chicago lately from the fact that the electric light wires getting in contact with a telephone line; and on the same occasion the wires of the Chicago Music Company, on State Street, was damaged to the extent of $5,000 by the burning of the roof melting the lead, and the induction rush could also being heard. In New York, a week ago, a fire occurred through a wire for illuminating purposes crossing the telegraph wires. On Oct. 21 one of our chiefs of the New York fire department saw flames and smoke issuing from the roof of a building in the vicinity of Germania Theatre in Thirteenth Street. He found the fire was caused by the wire of the Electric Illuminating Company, which led to the electric light on the roof of the house. This wire had become partly burned off, and, coming over a sheet of tin which covered the top of the arch, made the latter red hot, thus setting fire to the woodwork.

Just by far the most melancholy result of the use of this new light has been a distressing accident which occurred lately in Philadelphia, where nearly a dozen people were killed outright, the existence of peculiar terror, and many more injured and disabled for life. The circumstances of this affair may be called, it will be seen, more than ordinarily distressing, and the lesson they are intended to teach is one which cannot be too carefully considered.

It appears that in a certain factory in the above named city, which is devoted to the manufacture of fireworks, and which is lighted by the electric light, a number of persons were engaged in filling cartridges with powder, when suddenly a terrific explosion occurred, which shook the whole building to its foundations, and was heard for a considerable distance around. Fortunately, the explosion was not followed by a fire, but the scene which presented itself to the eyes of the people who rushed to the spot was one of the most appalling character. Dead and dying were lying in all directions, and the floor was covered with the mangled remains of human beings. Of the number employed in the factory at the time, it is said that only a few escaped without injury, and the list of killed and wounded is a very large one. The cause of the explosion is supposed to have been the ignition of some of the powder by the electric light, which was suspended immediately over the table at which the workmen were engaged.

Now, this is a case which, we think, should be carefully considered by all those who are using the electric light, or who contemplate doing so. It is evident that the danger of fire is not the only one to be guarded against, and that the electric current is capable of producing results which are as much to be dreaded as those which are caused by the agency of fire. Of course, it is impossible to say whether the explosion in the above case was caused by the electric light or not, but the fact that it was suspended immediately over the table at which the workmen were engaged, and that the explosion occurred at the moment when the current was turned on, would seem to point to the conclusion that it was the cause of the disaster. Whether this be so or not, however, it is evident that the electric light is capable of producing results which are as much to be dreaded as those which are caused by the agency of fire. Of course, it is impossible to say whether the explosion in the above case was caused by the electric light or not, but the fact that it was suspended immediately over the table at which the workmen were engaged, and that the explosion occurred at the moment when the current was turned on, would seem to point to the conclusion that it was the cause of the disaster. Whether this be so or not, however, it is evident that the electric light is capable of producing results which are as much to be dreaded as those which are caused by the agency of fire.

THE SANITARY ENGINEER.

DECEMBER 22, 1881.

ELECTRIC LIGHT NOTES.

An electric light company has been organized in Louisville, Ky., with a capital of $150,000.

Dr. Siemens has succeeded in melting five pounds of steel in 25 minutes, by means of the electric current.

It is stated that the substitution of the electric light for gas in the Philadelphia post office has effected a saving during the past year of over $6,000.

The Patriote states that the fires which so frequently occurred at the electrical exhibition are all due to one of two causes—this wires or contact of wires.

The Inspector of Public Lighting of Bristol, Eng., after visiting the Paris exhibition, thinks that a liberal use of gas will give results as effective as those of electricity.

The Mutual Electric Light and Supply Company have applied to the Board of Aldermen for permission to put up electric lights on Eighth Avenue, from 14th to 34th streets.

It is reported that the experiments with the electric light at Scarborough Spa, near York, Eng., which have been continued for about one month, are to be discontinued and a return made to illumination by gas.

The lavatories, cloak-rooms and gas-ages of the British Museum are now lighted by Swan's incandescent lamps, and it is expected that eventually the system will be introduced into other parts of the Museum not now artificially lighted.

The Cincinnati *Gazette* says that the Brush electric Lights in Middletown are a complete success, and that every one who has seen the illeni nation "must acknowledge that for street lighting nothing yet accomplished by man approaches it."

A corresp-ndent of the *Metropolitan*, London, gives figures to show that the illumination by incandescent electric lamps is more economical than by gas. He puts the cost of lighting 20 houses for 2,000 hours per annum by the incandescent lamps at about $2,060, while the same done by gas would cost $4,160.

The resolution which was passed by the Board of Aldermen granting permission to the Metropolitan Telephone and Telegraph Co., to lay wires in the streets of the city, was objected to by the mayor and returned to the Board with his veto. The Board have passed the resolution over the veto, and doubtless others will ask for similar privileges since they are bad for the asking. Indeed, the United States Underground Telegraph Co. now comes forward and reopens the privilege "upon payment of two cents per foot of street opened." It is difficult to see why matters of this kind cannot be conducted as business transactions, and it is certainly the duty of any Board of Aldermen to consider first the interests of the city they are supposed to represent. At the present rate our streets in the future are likely to be in chronic state of eruption.

St. Joseph, Mo., has an electric light company employing the Brush system.

The Brush Electric Light and Power Company of Niagara has been incorporated with a capital of $250,000.

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT. [Dec. 20, 1881.

THE TOWER SYSTEM OF ELECTRIC LIGHTING.

AS IT IS PRACTICALLY AND TECHNICALLY CONSIDERED.

At a recent meeting of the Sheffield Town Council, one of the members (Mr. W. T. Wiseman) moved that—"The Brush system of electric lighting, by fixing lamps on towers, is a nuisance as to cleanness and power, the Anglo-American (Brush) Electric Light Corporation, lighting them in consequence of the failure of the Yeaty of the said Corporation's own report and in the light of the experience of this parish for one year from the 1st of January, 1882, to June 30th, 1882, and that the contract dated Dec. 31, 1879, and also the agreement dated Dec. 31, 1881, be cancelled for a period to be fixed by the Corporation—such tenders to be accepted as approved by the Yeaty at the said Corporation's own cost and risk." He said he thought the time had come to improve the lighting of the parish, and he was glad to see that they had adopt the electric light. One years ago on account of the long evening September last came to £10,000, Lighting towers might be erected there at the rate of £1,000 per mile, or half a mile from each boundary, in all directions. The area of the town was 3653 acres, and eight of these towers would light the whole of it, at a cost of about one-sixtieth of the present rate. Each tower would have a two-power night to read at a distance of half a mile from the light. The cost of the Brush system would be about £3000.

Mr. Wiseman believed. The experience of those who have tried the electric light on the tower system gives, however, a direct negative to his belief. The correspondence to which reference was made in our editorial columns of the 26th ult., furnishes particulars as to the failure of the system in the only places where it has been tried.

The Sheffield Town Council resolved, as noted many says, "a well-built, well-found, substantial, and workmanlike manner, at about £1,000 per mile." The electric light was started on Sept. 3rd; and on the 5th the Council met in the local newspapers the following day. The four electric light towers situated at the four points of the compass, and hardening upon the northern district, were in full blaze with the light for the first time. The test was not very encouraging. But it surely must not be presumed that these four towers were to light the whole of the city." Our correspondent writes: "I can vouch for the accuracy of the above statement. Entering the city by rail, on the evening of the 5th inst., the absence of light, as seen from the plains adjacent, was a brilliant point, diffusing light in the upper air—suggestive of a lighthouse guiding the distant steamer to port, rather than of an approaching dwelling. It was a dark night for the benefit of its immediate surroundings.

The *Electrical Light Correspondent* of the 2nd ult., wrote: "The Sheffield Electric Light Company have put up four towers, 150 feet high. On three of these they placed six lights—and on the fourth seven lights. The apparent intention was to effectually light the city, but for the space of one month endeavoured to operate them. *They made a most magnificent failure!* Some were abandoned [as we have mentioned] as a total loss. A postscript to his letter, the correspondent says: "One tower, with six lamps, is now in full blaze, and is a most disagreeable object to the inhabitants of the circle of light it is said to illuminate at 150 to 200 feet distance."

The *Denver Tribune* was less complimentary in its notice of the other local paper—the *Denver Republican*—was not a whit better account of the matter. On Oct. 1 they said, "The electric lights from the four towers which are supposed to illuminate the whole city, are heard forth their sickly glares every alternate night for whenever the conditions are favorable for the most effective work they are an intolerable nuisance. Every similar locomotive will not light the city," And again, three days later, "The electric light is a failure as well as a humbug, and they are utterly useless."

From Akron a gentleman writes: "There has been an attempt made to light—not my city by electric light from tall towers or masts; but it has proved far from satisfactory. I might say that lighting by this system is completely a failure. The masts are standing, taken from out of the city and scattered as follows: [giving the names of 3 places.] How much did it cost? It is all gone, and the fund is largely overdrawn if the late contract to erect six more masts is not set aside. The money was squandered, and the city is worse off for light than it ever was. These are the 'cold' facts of the case. The people who are supposed to be benefited by this statement, that the people what the electric light found his cost per year, and when we were in darkness it cost us nothing. If the company has reaped a little glory to himself, the people's money has been squandered, and we have for it all the most transparent swindle and consummate humbug that was ever attempted to be used lighting any people anywhere."

A long and interesting letter from an inhabitant of Salt Lake City gives details of the above there and in the neighbouring town of Ogden. Some extracts from it we may publish at some future time; but we will now conclude the record of failures by giving the words of a resident in New Orleans, who writes as follows, in regard to the electric light: "In most large cities in the United States, electric light companies are established, and a system which requires a large number of lamps to be run, at a fixed price per lamp, is the economy or final success of the system is said not yet satisfactorily determined. No dividends have been declared; nor has the consumption of gas been materially affected by competition. An attempt was made here last spring to run one Jablochkoff more by the light; but it failed completely. The Judges could not distinguish the horses or riders at the half-mile post; and after the first race the experiment was abandoned."

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT. [Jan. 3, 1882.

THE PUBLIC LIGHTING OF CHESTERFIELD.

(From the *Derbyshire Times.*)

The town of Chesterfield was plunged in darkness on the 31st of August last, owing to a dispute between the Gas Corporation and the Gas Company, since then the inhabitants have been conducted to all the lessened annoyances which are inseparable from deprivation of gas-light, but for a long time there was little sympathy suffering, for light is a necessary of life as at the like taken by the Gas Company, and were disposed to treat the matter as a joke, but in what they considered was a breach of contract, and by and others at the time, that the quarrel was an absurd one, and that the public would be the sufferers. Happily both sides have adhered to terms of peace. Then than this, the public were misled, by a local coach-company, into believing that they could get adequate public lighting by electricity at a saving of about *the cost of gas*; and, as a consequence, they have had no system of lighting at all. But we have now a better state of affairs, and a system of lighting, and we have a heavy bill.

Just now the electric lighters have made a great spurt as yet their large electric lights started on Saturday night, and the public are pleased, and brighter nights they have not seen for months. The number, after allowing the town to remain in darkness week after week, was considered somewhat over, however, they have only provided the lamps on lights in the open streets, and these are separated by long intervals of darkness. Not a single lamp appears to have been provided for the side streets, nor is there any apparent intention to erect them. The present state of public lighting in Chesterfield may fairly be described as follows:—There are now a few large electric lights in the main thoroughfares at long distances apart. These lights burn in a most disappointing manner. They never give out a steady light, but

ACTION OF THE ELECTRIC LIGHT ON VEGETATION.

M. Deherain, Director of the Paris Museum of Natural History, carried on a series of experiments at the recent Electrical Exhibition to ascertain the action of the electric light on vegetation. A small conservatory was built in the exhibition building, and in it the experiments were carried on, although the conditions were not the most favorable. M. Deherain's report has been published in the *Revue Scientifique*, and an abstract of it in *Engineering*. The author concludes "that the electric light produced by the voltaic arc has only a feeble and uncertain action on vegetation." In the experiments of Mr. Siemens, the useful effect of the light was much more marked, but the conditions were more favorable.

M. Deherain says the inability of the plant to mature under the electric light, is due entirely to its being so heavily charged with moisture. The heat radiated from the electric light is almost nothing as compared with that from the sun, and consequently the plants must be heated in other ways to supply the loss.

ELECTRIC LIGHT NOTES.

The Birmingham, Eng., Town Council have decided to ask Parliament for powers to supply the electric light in addition to gas.

According to the *Electrician*, M. Tellier proposes crossing the English Channel, from Boulogne to Folkestone, in an 18-foot boat propelled by an electric motor.

At a recent exhibition of the electric light at Barnsley, Eng., the lamps went out several times, and it was found that the engine had been tampered with by stepping up the chimney.

The electric light experiment in Liverpool, Eng., has been very unsatisfactory, principally because of the unfinished condition in which it was left. The city council seem very willing to drop the matter.

A correspondent of the *Journal of Gas Lighting* says that "while Mr. Swan is a resident of Newcastle, and daily exhibits his light to the public, there is not, he believes, a single other person in the town using it. The corporation, who did some time ago try the light for street purposes, have now given it up."

The Philadelphia Board of Fire Underwriters have notified owners and occupants of buildings desirous of introducing electric lights that application must be made to the companies for permission, stating the number and kind of lamps to be used, the work to be subject to the approval of the inspector of the board.

The Philadelphia *Ledger* is of the opinion that the experiment of electric lighting in that city, although gratifying to the eye, does not warrant the council in granting the privilege asked by the Electric Light Co., to carry their wires without the city generally. The most complete success would not justify the extension of a system which involved carrying the wires on posts.

The Board of Aldermen of Boston have decided to introduce the electric light in street illuminations. The number of lamps is not to exceed 250, however. The *Advertiser* does not anticipate that this step will diminish the use of gas. Permission has also been given to certain private parties to construct continuous lines of pipe in many of the streets for the reception of telegraph and telephone wires.

An Englishman, commenting upon the electric lights in Broadway, does not not consider them satisfactory. "The powerful glare of these lights make it somewhat difficult to walk the streets, the comparative darkness between them adding very much to the danger of colliding with those walking in the opposite direction."

Mr. W. N. Preece, in a paper on Electric Lighting, read before the Society of Arts, said that the Paris Exhibition sounded the knell of all forms of electric excite, as well as those of the Wenderman type. He thinks "the rising favorite is the incandescent lamp, pure and simple;" and that of these the Edison lamp is the most efficient.

PROVINCIAL PUBLIC LIGHTING AUTHORITIES AND THE ELECTRIC LIGHT.

THE question of electric lighting is treated very differently by various corporate bodies in the United Kingdom, and while some of them deal with the subject in a spirit of wise discretion, neither despising nor admiring it, others act as though in this matter the common considerations of everyday business were to be cast aside. The prudent way is undoubtedly that indicated in the report, given in another column, of the Gas Committee of the Birmingham Town Council, who have sought and obtained the consent of the Council to the preparation of a Bill to be submitted to Parliament in the session of 1883, if considered desirable, which will include provisions for the supply of electric lighting by the Committee. It is stated that this action on the part of a body which has hitherto looked askance at the electric light, has been decided upon in consequence of the intended application by various parties to Parliament, during the coming session, for very extensive powers to introduce electric lighting generally throughout the country, and consequently to interfere for this purpose with the roads and property of the Birmingham Corporation among others. It is intelligible and commendable that the Corporation should desire that these powers, if proved to be of any value, should be taken by themselves in preference to any speculative Company; and the Gas Committee, with the consent and opinion of the Council as their authority, will be quite justified in watching the proceedings of the general electric lighting legislation of next session, in order to protect their own interests, and to gain information for use in respect of their intended Bill for the following year.

The Manchester Corporation are going to Parliament for electric lighting powers next year; as a preliminary to which we are informed that a Sub-Committee, composed of a few active members of the Gas Committee, paid a visit to the Paris Electrical Exhibition, with a view to satisfying themselves of the present state of electrical science. It would be cruel to speculate as to the results of the task laid upon the persons thus selected by the energetic gentlemen who undertook this onerous duty. It is, however, open to remark that whatever may have been the mental impressions of the several members of this deputation, which we would naturally influence their after action in committee, the net result of their observations, as expressed in their printed report to their colleagues, is not of great apparent value. The report, indeed, consists in the main of a string of paragraphs intended to describe the peculiarities of the various exhibits to which the attention of the deputation was directed; but, as may be suspected, the deputation were not in a position to pass any technical opinion respecting the merits of the different systems, and their report therefore reads much like a facile annotated catalogue of the show. A description of the exhibits, intelligible to a stay-at-home colleague, a selection from the notices published in our leading engineering contemporaries would have been more satisfactory, and a great deal cheaper. It is only fair, however, to notice that the deputation have expressed themselves in a more definite manner with the "advantages which must necessarily result from their visit." After this declaration it would be ungracious to criticise the opinions of the deputation recorded at the end of their report, which may perhaps be nothing more than faint hints relating to some portions of the "large amount of general information" which is not included in the published report. One remark, however, must not be passed over. It is stated that "one of the greatest problems—that of subdividing the light without loss—has been practically worked out." We are not able to tell what this statement means, unless it refers to the division of electric energy for producing small lights for domestic purposes as cheaply, in proportion to the power required, as the larger lights. As to this claim, however, the deputation should have stated their authority, which was probably that of Edison's or Swan's agent, since it is entirely unfounded; and its adoption, without explanation or qualification, is extremely unfortunate. In making these remarks, we do not wish to reflect upon the action of the Gas Committee in sending a deputation to Paris, but rather to complain that they did not take steps to make their report of some independent value, by obtaining professional assistance to explain the meaning of the appliances which were there shown to the Sub-Committee.

Meanwhile electricians have gained another market at Dudley, where, by the casting vote of the Mayor, it has been decided to allow a firm of electric lighters to erect their plant to put up lamps, and to keep them going for a year, for a total charge of £180, being £30 per lamp per annum; which the contractors admit will result in loss, although the charge is in excess of that made by the Gas Company for the street lamps which will be temporarily extinguished. We notice that the example of Cockermouth was cited in support of the new system; but, as we showed in our last issue, this instance should rather have been brought forward on the other side. It is said that the electric lighting contractors want a "concession" for 99 years of the right to supply electric lamps in the town, which is a somewhat curious demand to make of an English Corporation. We shall see what the Dudley people think of the new method of lighting after the "experiment" has been going on for a few months.

At Barnsley, where the Local Authorities had arranged for an eight days' trial of the Brush lamps, by way of frightening the Gas Company into reason, the result has been precisely of the kind desired. The Gas Company met their rivals on their own ground, and, much to their opponents' disgust, prepared a brilliant display, at short notice, of high-power burners, which were fixed in a position to compare directly with the work of the electric lighting contractors. The electricians worked hard for some weeks to get things in order for their grand attempt; but, as fate would have it, their lamps could not be set to work satisfactorily, either on the opening night or since, and the preference shown by the populace for the brilliant and steady display of the Gas Company is so galling to the new comers, that they have endeavoured to account for the failure, which is certainly not unique, by imputing foul practices to some person or persons unknown. This disgraceful excuse has actually been followed up by the offering of a reward for the discovery of the perpetrators of the imagined outrage; but, it is needless to say, without result. While the failures at other places, which we have lately recorded, remain unexplained, it is too ridiculous to expect even a population not altogether ignorant of the meaning of the term "rattening," to ascribe a very common disaster to a cause which had not been thought of as an excuse in other localities where it might have been equally applicable.

THE ELECTRIC LIGHT IN LIVERPOOL.

The Electric Light Experiment.—At the meeting of Liverpool City Council on Wednesday last—the Mayor (Mr. J. Hughes) in the chair—Sir James Picton asked the Chairman of the Watch Committee (Alderman Cleveland) to give him some information as to the progress of the electric light. The experiment had, he said, been carried out in a very perfunctory and lengthy way, and he wished to know whether there was any prospect of the Watch Committee's recommendation to the Council adopting the plan underground, but there were very great difficulties in the way of this proposal. Alderman Chambers said the experiment had not been a satisfactory one, and the Committee were waiting for a communication from the Electric Light Company who had the contract in hand, before any further steps were taken. Then his experience of the light in America it was a great advantage to Liverpool that the plan it had not been proceeded with. Mr. Rathbone said he thought the Council could very satisfactorily get rid of the contract that should some taken they took any further steps in the matter. The subject then dropped.

American Gas Light Journal.

Jan. 2, 1882.

Danger from Electricity.

Another illustration has been given of the wisdom of our wi
the needless exposure of the wires used in electric lighting.
in Philadelphia last Friday night was one which may have im
petitions, if its cause has been correctly given. It is said tha
of a telephone wire with a wire used for electric lighting surch
mer, so that an action like a stroke of lightning was the resu
filled the room in which the discharge took place, and they w
culty extinguished. It is possible to protect wires used in ele
so that such accidents will not happen, and the proper preca
be taken at the very beginning of the introduction of electric
tical use.

In cities of Europe the wires for electric lighting are put und
it is evident that they should not be strung upon poles in Ne
the companies make no mistake in this matter. It will be b
expensive to sink the wires than to hang them upon poles, and
better in the end. The thorough insulation of wires laid in
electric lighting is also a subject calling for the attention of
Their pecuniary loss will be very heavy if their neglect to tak
cautions results in a destructive conflagration. They must no
city to the flames by the improper use of wires for electric lig
in the streets or in buildings.—*Mail and Express*, Dec. 27.

ENGLISH MECHANIC AND WORLD OF SCIENCE: No. 874

Dec. 23, 1881.

The deposit of metallic layers of different colours by means of electricity is now effected by M. Weil (*Comptes Rendus*). He can coat any metal or alloy instantaneously, at ordinary temperatures and by means of a single copper bath, with an adherent bright layer of various suboxides of copper, whose chemical nature is not yet studied. The same bath gives the whole series of colours at will, according to the mode of exposure of the pieces. There is no battery, properly so called. That the colours are not due to suboxides of copper and not an effect of thin plates, M. Weil proves thus: Any metallic piece, polychromised by his process, is covered at once with a layer of pure copper, of fine red colour, when treated with nascent hydrogen.

ENGLISH MECHANIC AND WORLD OF SCIENCE.

Dec. 16, 1881.

A curious application of electricity is described in *La Lumière Electrique*. It consists in a device to prevent military conscripts practising fraud as to their stature by bending their knees. When the youth stands erect against the measuring post, the hind parts of the knees press on electric contacts, causing two bells to ring; the ringing ceases when there is the least bending. The sliding bar which furnishes the measure has also a contact, which is pressed by the head, whereby a third electric bell is affected. For a correct measurement, the three bells should ring simultaneously. This system, the invention of M. Cazala, is now employed in the Spanish army.

THE METROPOLITAN.

December 17, 1881.

Electric Lighting at Godalming.—Water Power.—Several references have appeared in these columns in the course of the past few weeks to the works which for some time past have been in progress for lighting the town of Godalming, in Surrey, by electricity, generated principally by water power. On Thursday evening last these works were practically tested for the first time, with most satisfactory results. On a future occasion we shall endeavour to publish full particulars of this important experiment, which we know has been anticipated with considerable interest by those interested in the success of electric lighting.

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on Saturday, transferred from the Birmingham Corporation to the Oldbury Local Board, and the day was made the occasion of celebrating the opening of the new gas works at Brade's Village.

An alarming explosion of gas occurred at Brymbo-hall, near Wrexham, the seat of the Right Hon. George Osborne Morgan, on Wednesday morning, when two of the servants were severely burned.

With Monday night came the termination of the contract between the Edinburgh Town Council and the Anglo-American Brush Company for the lighting of Princes-street and the bridges with the electric light, and the lamps were at an early hour on Tuesday to be extinguished, not, for the present at least, to be lit again. Several important leakages have, it is stated, been discovered.

Mr. G. B. Smedley, formerly manager of the Birstal Local Board gas works, having been (out of 87 applicants) appointed superintendent of the Gravesend and Milton gas works, Mr. John Grayham (from Darlington) has been put in charge of the Birstal works.

The Gas Light and Coke Company have given notice of their intention to sell by tender, on the 23rd instant, £50,000 of new ordinary A Consolidated Stock of the company. The minimum price has been fixed at £170 per cent.

Exhibitions of gas appliances for lighting, heating, and cooking purposes were held recently at St. Mary Cray and at Sidcup. The exhibitions were promoted by the directors of the St. Mary Cray Gas Company.

The Directors of the West Kent Gas Company announce a further reduction in the price of gas of 3d. per 1,000 feet.

WANTED, READERS of a PAMPHLET—prepared for Gas Companies to distribute to Gas Consumers—on COOKING and HEATING by GAS, &c.
Copies, by post, Threepence, direct from the Author, Magnus Ohren, Assoc. M. Inst. C.E., Gas Works, Sydenham, S.E.

Public Health and Sanitary Work.

The Public Health.—A considerable increase has taken place in the death-rate of the country generally, it having risen from 24·1 to 27·3 per 1,000—a rise of 3·2. The lowest rate in twenty of the largest towns of England was 16·9 at Bristol, and the highest 32·2 at Nottingham. The highest annual death-rates per 1,000 from scarlet fever were 8·1 in Hull, 5·0 in Nottingham, and 2·2 in Sunderland; from whooping-cough, 4·1 in Salford, and 1·6 in Birmingham; from measles, 2·9 in Leeds, and 2·1 in Liverpool; and from "fever" (principally enteric), 1·4 in Oldham. In Hull 24 more fatal cases of scarlet fever were recorded, raising the number registered within this borough since the beginning of July to 642. The 42 deaths from diphtheria in the twenty towns included 18 in London, 13 in Portsmouth, 3 in Manchester, and 2 both in Birmingham and Liverpool; the annual death-rate from this disease in Portsmouth averaged 3·1 per 1,000 during the last quarter of 1881. Small-pox caused 37 more deaths last week in London and its suburban districts, and 2 in Salford; no fatal case was returned in any of the 18 other large towns. In London the annual death-rate from all causes, which in the two preceding weeks was 22·3 and 22·5 per 1,000, rose last week to 28·3. The births were 81 fewer and the deaths 424 more than in the previous week. Small-pox caused 32 deaths, against 23 in the previous week, and was 5 above the average. The number of patients in the hospitals was 11 more than in the previous week, but the new cases were 2 fewer. The deaths from whooping-cough rose from 96 to 124. With respect to diseases of the respiratory organs, the deaths, which had been 434 and 411 in the two preceding weeks, were 596 last week—a rise of 185, and were 52 above the average. With regard to other leading complaints, measles caused 61 deaths, against 72; scarlet fever caused 43 deaths, against 35; diphtheria 18, against 19; and enteric fever 25, against 33. In Greater London the death-rate was 26·8 per 1,000—a rise of 5·1. The total births were 56 fewer and the deaths 464 more than in the previous week. In the Outer Ring 5 fatal cases of small-pox were recorded, of which 4 were in West Ham, and 1 in Carshalton sub-districts; 15 deaths were also referred to whooping-cough.

A Year's Births, Deaths, and Marriages in London.—In the course of the 52 weeks that ended the 31st December last there were 132,674 births recorded as having hap

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THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT.

Jan. 24, 1882.]

THE VESTRY OF PADDINGTON AND THE ELECTRIC LIGHT.

On the 20th ult., the Vestry of Paddington referred to the General Purposes Committee to consider and report "whether the time has now arrived to invite tenders for the purpose of lighting the parish with the electric light, or if it be advisable and more economical that arrangements be made with one or more of the patentees to work it themselves." To assist the Committee in coming to a conclusion, Mr. George Weston (the Superintendent of the Works Department), who has charge of the public lighting, prepared a report upon the comparative cost of the electric light and gas in a certain main thoroughfare in the parish; and, in presenting the report to the Vestry, they say "that, owing to the large outlay which will have to be incurred in the purchase of plant, &c., they are of opinion that the time has not yet arrived for inviting tenders for lighting the parish by means of electricity; and, further, that it would be neither advisable nor more economical for the Vestry to enter into an arrangement of the kind mentioned in the reference."

Having briefly described the three systems of electric lighting in use in the City—the Brush, the Lontin, and the Siemens—the first of which Mr. Weston describes as "the lowest in cost, is considered the best light, and is the simplest in its action," the report proceeds as follows:—

It appears the Anglo-American "Brush" Company have undertaken to supply the Commissioners of Sewers with electric lights for 32 lamps, stated to represent 2000-candle power each, for twelve months, for the same sum which would be paid for gas consumed in 162 gas lamps superseded—viz., £660. This would equal £4 1s. 6d. per lamp; and to cover the expenses of laying the leading wires and alterations of the ordinary lamp-posts, the Company added £770, making the cost for the year's experiment £1410, or £44 per lamp. To obtain the electricity, two No. 7 dynamo-electric machines are worked at their Lambeth station, each machine making 800 revolutions per minute, and these absorb about a 28-horse power engine.

Taking the before-mentioned figures as a guide—no practical reliable results having yet been published—it follows that if 1900 gas lamps were superseded by 400 electric lamps, the expense for the first year would be something like £17,600; this amount being irrespective of money expended as capital for the purchase of land, engine-house, engines, generators, boilers, renewals, &c. In many cases, when the comparative cost between gas and electricity is considered, the amount expended for working plant appears to be entirely lost sight of; and this should form a principal item of expenditure. If a company were formed similar to a gas-making establishment, the necessary works erected, and electricity supplied to a parish, something of a definite nature might be arrived at as to cost, for purposes of comparison; but at present it is a matter of fact that the working plant necessary for driving the electric machines and all matters connected therewith, lamps, &c., with the exception of the copper wire, engines, and boilers, are all covered by patent rights, and involve a very large charge for capital. Engines making 160 revolutions and dynamo-electric machines driven at 800 revolutions per minute must be subject to great wear and tear, which must result in an enormous amount for maintenance.

The Vestry also desiring the Committee to report upon this subject, I beg to submit the following details as to the expense of displacing 76 public lamps and 4 Bray's "rest" lamps, between the junction of Edgware and Harrow Roads, and the eastern end of Westbourne Grove, including 30 lamps at the various intersections of streets running at right angles to such line of thoroughfare. My reason for selecting this line is with a view of utilizing the 20-horse power horizontal engine and boilers stationed at the Works Department, the distance being 1500 lineal yards. Supposing these lamps were superseded by 16 2000-candle power electric lamps, they would have to be placed about 100 yards apart, which I fear in practice will be found too far. The 76 ordinary street lamps are under the average meter system, and consuming 4·6 cubic feet of gas per hour of about 12-candle power, and the four Bray's lamps on refuges consume 30 cubic feet per hour of about 90-candle power; the annual cost for lighting these lamps being as follows:—

Ordinary Street Lamps—

Gas, 17,847 cubic feet per lamp per annum, at 3s. 2d. per 1000 feet	56·60s.	
Repairs and maintenance of meters, &c.	4·83	
Inspector's salary	2·89	
Wages—lighting and extinguishing	11·11	
Incidental expenses	0·25	
Total cost per lamp per annum	78·18s.	
73 lamps × 78·18s. equals per annum		£298 4 6

Bray's Rest Lamps—

Gas, 116,370 cubic feet, at 3s. 2d. per 1000 feet	368·12s.	
Repairs and lighting, &c., inspector's salary, and incidentals	21·88	
	390·00s. × 4 = 1561·20s. =	78 1 2
Total annual cost per annum as at present lighted by gas		£376 5 8

The following estimates will show the cost of first outlay, and the annual working expenses of electric lighting for 16 "Brush" lamps.

Estimated First Outlay to Prepare and Fix 16 Electric Lamps, under the Anglo-American "Brush" System.

Taking up paving, cutting trench, laying wires, including 4-inch cast-iron pipes, punning, restoring paving and making all perfect—say 2500 yards run.	at £0 7 0	£875 0 0
2500 lineal yards of insulated cable 7-16ths inch diameter	" 0 1 0	175 0 0
16 hanging lamps (double) to burn 16 hours	" 16 0 0	256 0 0
16 small weather protectors	" 0 5 0	4 0 0
16 hoods complete	" 5 0 0	80 0 0
16 albatrine globe glasses	" 1 0 0	16 0 0
16 alterations of lamp-posts, say about		50 0 0
16 boxes to each lamp-post	" 1 8 0	22 8 0
1 dynamo-electric machine, making 770 revolutions per minute, requiring from 9 to 11 horse power to drive the same, price without fixing		400 0 0
Driving belts, &c., for do., say		25 0 0
Provision for any incidental expenses		50 0 0
One tachometer (speed indicator for engine)		10 0 0
First outlay without extra details, or engine power		£1963 8 0

Estimated Annual Expenses working 16 "Brush" Electric Lamps.

Using the present 20-horse power horizontal engine, working 3879 hours per annum, allowing 6 lbs. of coal per horse power per hour, for coals only	£105 0 0
Oil for engine, say 3d. per night	4 11 0
Water for engine	15 15 0
Wages for driver or fireman, 365 nights, at 5s.	91 5 0
Proportion of rent of wharf and supervision	15 0 0
Depreciation and repairs of engine and boilers, say 10 per cent. on £400	40 0 0
	£271 11 0
Interest on first outlay, being portion of plant, £1963 8s., say 5 per cent.	97 8 0
Carbons for lamps, the Company say ¾d. per lamp per hour—burning 3879 hours during the year, equals £12 2s. 5¼d. per lamp, by 16	193 19 0
To two men adjusting and cleaning lamps, fittings, and carbons daily, say at 24s. per week	124 16 0
To one boy assisting do., at 12s. per week	31 4 0
To provision for ladders, repairs, glass globes, and incidental expenses, say	20 0 0
The annual working expenses would equal	£738 18 0

Or at the rate of £46 3s. 3d. per lamp per annum, 2·51d. per light per hour, or 2·25d. per horse power per hour.

The result of the before-mentioned estimates being that, taking gas at 3s. 2d. per 1000 cubic feet, the present annual cost for lighting the 76 "scale" lamps and four Bray's "rest" lamps in the locality in question will be £376 5s. 8d., as against £738 18s. for working expenses by electricity. To start the system, the first outlay will be £1963 8s., or a gross sum for the first year of £2702 1s. for 16 electric lamps. This sum does not allow for new engine or boilers, as it is presumed the present 20-horse power engine and boilers might be utilized for driving the electric machine; but at the same time it must be borne in mind that the engine is an old one, but quite capable of doing the work at present required of it on the wharves, though I fear it would not be steady enough in its action to ensure the lights being free from oscillation. Anyhow, additional duplicate details would have to be always in readiness in case of a breakdown, otherwise the streets might be left in darkness.

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT.

Jan. 17, 1882.]

The "London Correspondent," of a provincial newspaper last week wrote: "The Gas Companies are waking up to the importance of next year's parliamentary campaign, when a determined effort will be made by the promoters of the electric light to acquire parliamentary powers that will better enable them to compete for the custom of the public. I know of one wealthy Corporation that has already instructed Counsel to oppose the Bills of Electric Light Companies infringing on its district. I believe it is intended to call as witnesses a number of 'bus drivers and cabmen, who will with one accord testify to the inconvenient and even dangerous character of the light, as now in use in some of the Metropolitan thoroughfares. The light is all right when approaching it, but the shadows it throws are so black that it is difficult to see what is before them after they have passed the post."

The *Pall Mall Gazette* last week, referring to the dangers of electricity said: "The Philadelphia papers tell a startling story, which only supplies fresh confirmation of the warning we have repeatedly uttered as to the fire risks of electric lighting. On the last Friday in the Old Year an electric light wire was brought inadvertently into contact with a telephone wire. Instantaneously the latter was heated to whiteness at both its extremities, although one was a mile and a half distant from the other, and fires were occasioned which fortunately were discovered in time to be extinguished before much damage was done. If the accident had occurred at night time both premises might have been burnt down. It is quite on the cards that London may yet be fired simultaneously in a dozen distant centres at once by an electric wire coming into contact with the wires used for telephonic purposes. No one, however, seems to take any notice of this newest danger of civilization."

Metropolitan

January 7, 1882.

—The Electric Light.—Mr. Collyer asked whether any progress had been made with respect to the suggestion to have the electric light in the Commercial-road, and whether anything had been heard concerning the proposed arrangement with Mile-end.—The Surveyor said he had heard nothing officially.—Mr. Davis remarked that by the papers he gathered that in Mile-end they had considered it rather a cheeky thing for St. George's Vestry to want to co-operate with Mile-end, which claimed to have the finest road in the district.—Mr. Collyer said the reason that Mile-end had been asked to co-operate was that the Commercial-road happened to be in both parishes.—Mr. Coombe made a remark as to Mile-end getting advantage if St. George's alone went in for electric lighting in the Commercial-road.—Mr. Willey thereupon promptly rose to suggest that the experiment should be made in St. George's-street.—A few more cursory remarks closed the conversation.

ENGINEERING NEWS.
FEB. 11, 1882.

ELECTRICITY.

JOURNAL OF THE ARC AND INCANDESCENT LIGHT.—We have received a prospectus of Philadelphia as well as the agents of outside companies are considerably excited over a petition which they received from the Penn Patrol this morning stating that the Brush Electric Light Company, whose dynamo was run on parts of Chestnut street, had run a wire from the Chestnut street station to the burning property and were lighting the large store of Hood, Bushelgirl & Co. on Market street. The American Fire Insurance Company, which had given a policy on the Bidgood property, has refused to renew the policy on account of the property, stating that if the Brush wire was not removed at once from their building the policy would be cancelled. All the companies announce their determination to act in a similar manner wherever they find electric wires running over property which they have insured.—N. Y. World.

ELECTRIC LIGHT FOR PHILADELPHIA.—An attempt is being made by the authorities to light the city by electricity.

NEW YORK FRANKFORD TELEGRAPH COMPANY.—Articles of Incorporation of the Union Electric Lighting Company have been filed. Capital, $50,000.

THE METROPOLITAN.

JANUARY 28, 1882.

rates.

Anglo-American Brush Electric Light Company.—The first annual general meeting of the shareholders of the Anglo-American Brush Electric Light Corporation was held on Thursday at the City Terminus Hotel, Cannon-street, under the presidency of Sir Henry W. Tyler, M.P. The report of the directors and balance-sheet to 31st December last showed a profit of £34,064, of which amount £29,500, in cash and shares, had been derived from the sale of patent rights, concessions, and licenses, and £3,846 from manufacture. The whole of the former amount, £29,500, had been placed to reserve; and of the £3,464, a sum of £1,279, being at the rate of 2 per cent., had been written off as depreciation of plant and machinery. After providing for all preferential charges, £30,750 was available for a dividend of 12½ per cent., and the directors recommended, leaving a balance of £2,054 to be carried forward to the year 1882. In addition to the patents originally purchased for electric lighting on the one system, the directors had also secured the valuable patents of Mr. Lane-Fox for incandescent lighting; and a separate factory for the manufacture of the lamps and apparatus connected with this system had been established.

The CHAIRMAN, in moving the adoption of the report, congratulated the shareholders on the results of their working for the last year. As they might imagine, they had had many difficulties to contend against in a new business such as theirs, and any one who knew what it was to collect together appropriate machinery of a new description for a new market would be able to appreciate to some something of what they had gone through. It was desired in the middle of last year by certain gentlemen that a meeting should be held and accounts rendered, but in addition to their articles providing that the meeting should be annual, it would have been most unfair to hold a meeting and render the accounts of a concern which had been working only six months, during which it had been impossible to make any satisfactory progress. What they had done at the year, however, was most satisfactory, for in one sense they had accomplished, that period more than half the capital of the company, and had not come into full operation in their business, for many had many rivals who would be very glad to know a little more than what they were doing. They had sold some patent rights, licenses, and concessions in this country, but they had other patents under consideration for other countries, as well as for various parts of England, and it would very much embarrass the directors were they to state in detail everything they had done. Their net profit for the year had been £34,064, of which £29,500 had been realized—about half in cash and half in shares—from the sale of patent rights, concessions, and licenses, while £3,464 had been derived from manufacturing operations. They had resolved to divide all moneys arising from the sale of patent rights and concessions, and to transfer to a reserve fund the profits obtained from the sale of patent rights and concessions. He thought that would be a wise course, as in such a business they did not know what in-

ventions might be made in the future. As time went on, too, should they continue to prosper, it might be wise for them to reduce their capital, and thus enable them to earn dividends on the capital they would retain. The shares were taken up in three companies only, and they had estimated them at the value at which they had written off all preliminary expenses, and, although indeed it was hardly necessary to do so with new machinery they had written 10 per cent. off for depreciation of plant and machinery. They proposed to continue that in future, so that in ten years their plant would have written itself. They commenced taking their premises very cautiously, but they soon found it necessary to extend them, and, indeed, take additional and larger premises. At Belvedere-road and Portpool-lane they now had 456 men employed, and so rapidly was their system developing that before long they expected to have 1,000 men fully employed. They now had orders of the value of £46,000 in hand. In addition to the Brush system of dynamo machines and lamps, they had acquired the patents of Mr. Lane-Fox for incandescent lighting. They had carefully considered the question of central lighting and what they should do as to undertaking the lighting of towns, &c., and they had felt that it was hardly for their company to undertake all this business, on account of the large capital and the enormous staff and superintendence it would require. They had therefore, sought rather to sell their concessions for different counties in England to other companies, and they believed that in this manner, they becoming ultimately the manufacturing centre for a large number of affiliated companies in the United Kingdom and on the Continent, they would gain the largest profits. They had been difficult to spend money in a way which brought in no direct return, such as in advertising. At the Paris Exhibition they had a very fine display, which had been conducive to extending their business there, and they were spending a good deal of money in connection with the exhibition at the Crystal Palace. While he begrudged spending money in that way, he felt that it would be fill that the shareholders would allow them to do all they could to extend the operations of the company. Up to the present they had sold 250 dynamo machines, and 2,721 are lamps in England; but in the United States, where they had been longer at work, they had sold 850 machines and 21,251 are lamps. They heard sometimes that the are light was going out of fashion and that the incandescent light was taking its place, but he believed there was a great future for both. Are lighting was more adapted for open spaces, streets, and large manufactories, while incandescent lighting was more suited for domestic purposes theatres, clubs, and buildings of that description. He did not think it was wise to try and hide the few failures they had had, which had been principally owing to the difficulties they had had in the first instance, of getting a good staff of efficient men to carry out the work. In any new system of the sort they must learn by their failures, and seeing that they knew the reason of their failure they had no fear as to the system but the application of it which had been at fault. In manufacturing the machines and lamps they had really had great success. It was true that there were dangers about the electric light, and a man had been unfortunately killed at Hatfield House by putting his hand on a naked wire; but the wires ought to have been properly covered. Fires would not have been occurred in the accident, as they only last momentarie. They did not carry out the work. The wires would require to be properly insulated in houses and put down in a substantial manner, but the precautions to be taken in that respect were most simple, and perfectly well known, and if lighting, which he contended, was no longer wherever in electric lighting, which he contended, was no longer wherever in electric competed with other systems of lighting, as only sparks were at gas. Wherever new discoveries should be made they would be kept in the van in connection with electric lighting.

Mr. JOHN SCUDAMORE SELLON seconded the motion, and expressed his belief that the concessions, working in the electric light, would probably be obliged to give a better price for their cost. He contended that the criticism to which they had been subject was a proof of their success.

After a few observations from Mr. WILLIAM ANDREWS and Major ARLIE, the report was unanimously adopted.

Mr. Charles Denman was elected a director in the place of Mr. J. Montgomery, the two other retiring directors, as well as the auditor, were re-elected.

The Hampstead Vestry and Electric Lighting.—In question of installing the electric light in the parish of Hampstead, which has been once or twice ineffectually discussed in the Hampstead Vestry, was definitely brought under notice at the last meeting of that body by a recommendation of the Public Improvements Committee and a motion, of which Mr. Chamberlain, one of the members for Town Ward, had given notice. Upon the recommendation of the Public Improvements Committee a number of gentlemen were elected to act with Mr. C. H. Lowe, the surveyor, the Electrical Exhibition, the Crystal Palace, and to report for the next meeting of the Works Committee for consideration and adoption, such plans as they deemed the best. Mr. Chamberlain, in moving his motion, said he thought this was a very opportune time for the vestry to get themselves better informed on electrical lighting. He offered the time would come when they would have to consider the question of lighting the streets by electricity, and the information to be got by a visit to the exhibition would help them to avoid mistakes.—The motion, of which Mr. Chamberlain had given notice, was as follows:—"That for the better lighting of the parish the Vestry take into consideration the desirability of introducing the electric light, and that the various companies and firms be written to for information as to the cost and particulars, and that one or more be asked to experimentalize free of expense, and that the parish shall in High-street be lent for that purpose; and also that arrangements be made with Messrs. H. and J. Kelly for the fixing of their steam-engine for the electric lighting."—Mr. Finch suggested that this motion should be deferred till after the exhibition.—Mr. Chamberlain said he would bring it forward in a month's time.—The consideration of the subject was accordingly deferred.

CINCINNATI ARTISAN.
JANUARY 1, 1882.
Electric Lighting.

ITS FIRE RISKS AND THEIR REMEDIES.

BY HENRY MORTON, PH.D.,
President of Stevens Institute of Technology.

SOME very lamentable accidents have strongly directed public attention to the question of danger possibly accruing to life and property through the rapidly increasing employment of electricity as a source of light, and as the actual conditions of this danger, like the true properties of the agency from which it may arise, are but little known, a brief explanation of some simple facts related to this subject will be at this time reasonable and perhaps useful.

I would propose, then, to treat this subject under two general heads, namely: 1st. The sources of danger; 2d, The condition of their preservation, or of security.

The sources of danger in the use of the electric light are essentially two—from the conducting wires and from the electric lamps.

As long as the electric energy employed in any is conveyed by a perfectly good conductor it is perfectly harmless, like water flowing through a horizontal channel, and properties no rise above its banks; it is only when some accident causes it to overflow, or to be diverted or confined, or some partial obstruction of its course produces irregularities in regular flow, that trouble may arise.

The conditions of these difficulties are, moreover, very peculiar.

Thus, for example, if two electric conducting wires, forming the outgoing and returning paths of a powerful current are placed near each other, but are separated by a bad conductor, as, for example, when both are tacked on to a board partition wall, the current will follow the wire from end to end, with no development of heat in the same, or tendency to heat the conductor or gas into any adjacent object. If, however, between the two conducting wires we introduce some imperfect conductor, such as a small wire, some metallic dust, or a film of water containing mineral matter in solution; then a portion at the current will be diverted into the "short-cut" from wire to wire, and may heat the fine wire or the metallic dust or the wood wetted, with the injurious solution, so as to cause the ignition of inflammable matter.

Accidents of this nature have already occurred. Thus a fine copper conducting wire having fallen across one or more of the conductors and for want of proper insulation has been nailed side by side, without any fine partition, as the same board, or ceiling; and though used safely for a long time, and under circumstances in its normal state, have developed a very dangerous activity when the moisture of heavy rain has left with dirty or impure water. In that case the water offers a circuit through which a cross current is established which first heats the fine wire, and then chars it, and finally explodes it, a series of minute arcs or electric sparks along this charred surface, which would soon develop a conflagration if left undetected.

Again, two such wires as above, inaccurately attached near each other, may be brought into momentary contact and then separated, in which case an electric arc, with its intense light and heat, will be established between them. In like manner a conducting wire itself may be inaccurately connected at some point, and if the abutting ends are separated slightly during use, a similar "arc" with its intense heat may be there developed.

These examples will give a fair idea of the dangers arising from the conducting wires, and they are manifestly to be guarded against by a proper separation and insulation of the wires themselves. Of this, however, more anon. At present, I would only further point out that there is no risk whatever of any kind from any other injurious action arising in or from the conductor itself when an adequate cross section is used, as must be the case from motives of economy, since an inadequate conductor would involve a great expense in the use of the electric current.

Electricity is not to be regarded as a sort of fluid like passing along the conductor, and some popular notions on this head are so absurd as were similar ideas which prevailed in reference to illuminating gas, at the time of its first introduction, and which cannot rules to be made in some places that no gas pipe should be allowed to come in contact with any wood work.

Turning next to the dangers which might be expected from the electric lamps, it is to be remarked, in the first place, that those in the case of the are lights depend much upon the number of lamps operated on the same circuit. Thus, if thirty or forty lamps are operated in series, the electro-motive force of the current must be sufficient to maintain a corresponding number of arcs; and, therefore, if by any means many of these arcs are closed out the electro-motive force of the current available for the remaining ones would be so excessive that their arcs might become excessively long, and even the metallic carbon holders and other parts of the lamp constitute safe between which the are would spring, melting the metal work and establishing a very dangerous center of combustion.

To avoid this class of dangers two provisions should be made:

1st. That these some arrangement in the lamp itself by which, whenever the arc exceeds certain safe limits, the current will be automatically diverted from it and restored through a good and sufficient conductor; and, in the second place, some apparatus in connection with the electric generating machine by which the electro-motive force of its current should be varied automatically in correspondence with the resistance of the circuit, so that any diminution of such resistance, as by the closing out of several arcs, should cause a corresponding diminution in the force of the current generated.

Numerous contrivances for both of these purposes have been already created to greater or less perfection and efficiency, and it is manifestly possible by such means to secure the enemy from risks of this sort.

The securing of adequate insulation for the conducting wires in view of the endless ramifications of telegraphic and telephonic lines is to say nothing of the other conductors found in all buildings, is a problem of great difficulty. One important general principle would seem to be for the electrical workers of the future as well as of the engaging wires, as well as of the machines, and of a portion of all ground connections for any part of the circuit. Another general rule would be the separation of outgoing and return wires as far as possible from each other; and yet another, the centralization of conductors leaving no vulnerable places even where danger would not directly result from accidental contact.

Fully to discuss the details of this subject would be impossible within the proper limits of such a note as the present, and I will therefore only say in conclusion that, with well instructed and intelligent and intelligent provision, all danger from the use of the electric light may be made as certain and absolute by gas or by candles; but without such care and judgment the use of electricity on the grand scale, either for lighting or for transmission of power, would involve serious additions to the risks which accompany so many of the conveniences which constitute a large factor of our modern civilization.

What I have here written is but a fragment of the entire subject involved, and at some future time I hope to fill out and complete a preliminary sketch.—*The Sanitary En-*

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"Chronicle"
London Dec 16th 1881

ELE[illegible]RO.

At a crowde[illegible] of the members of the Society of Arts [illegible] night at Kin[illegible] at John-street, Adel[illegible] W.H. Preece, M.I.C.E., read a paper entitled "Arch[illegible]ting at the Paris Exhibition." Sir Frederick J. Bramwell, F.R.S., chairman of the Council, presided. The room was illuminated by the Edison-Swan incandescent lamps.

Mr. Preece said the present International Exhibition of Electricity in Paris, marked an epoch in the history of the practical applications of that science to arts, manufactures, and commerce. He proposed on that occasion to refer only to its application to artificial illumination. It was as an exhibition of electric lighting that it was principally attractive, and those who saw it for the first time would never forget the vivid impression that the great blaze of mid-day sunlight upon their minds on entering the building. The Palais de l'Industrie, in which the Exhibition of 1855 was held, was considered by many of the foreign exhibitors even then to present that terrible solution of lights that flooded the interior of the Palais de l'Industrie with great brilliancy, but with an intolerable glare, and consequent means of screening and dodging the unbearable expanse. For instance, at the forthcoming exhibition of electricity in Paris, the building—splendidly adapted for the purpose, it would be divided into sections, each section being lit by one, and only one system. He only proposed to select what appeared to him to be the most striking features worthy of keeping in their notice as steps in advance since the night of Aug. 29 there were in operation 227 arc lights, 24 candles, 41 arc incandescent lamps, 1,500 incandescent lamps, or a total of 1,837 electric light in all, at the Paris Exhibition. Towards the end of the year, during which the show was opened this number was to be considerably increased, and it was stated that the number reached 2,000 in the beginning of November. The exhibition of engines and machinery was extensive, although English manufacturers failed to do what they might have done had they thought of sending their machines at first or they did afterwards. The only extensive display was by Messrs. Siemens, of Berlin, and Messrs. Gramme, Sautter, and Lemonnier, which was not in full motion. The display of lamps was the display of the building. There were very few novelties some are known. The lamps relied, which led to an intense interference with the eyesight. The incandescent lamps made a very effective display in the Hillman gallery, where there were 25 lamps in a circle, and 25 in the centre, besides lighting up the recesses in Wonderland, and in a fixed, strictly circular lamp, giving a soft yellowish light. No one could deny that the Jablochkoff candle had a very pretty effect, as described by Mr. Preece, but he was afraid that the candle system in Paris had exceeded the hull of all former failures, even those of the Westminster type. The rising features in the incandescent lamp, pure and simple. The display was said by Mr. Preece, in the habit of the exhibitors of the Crystal Hall, and in the Pavilion at the Port of Paris, to be the most perfect of the kind. The arc soft, uniform, and pellucid. The incandescent light is totally free from those bright rays which are so injurious to the eyes, so unsatisfactory in the examination, and so irritating to the nerves; if they were not entirely absent they were sub-divided, and in so small under size that it became an almost impossible labour to explain it to the eye. In the hotel anywhere it can be worked from the fixed and detached pendants of a room, and it does away from the use of gas and all its inconvenient heats can be worked by either continuous or alternate current machines. The only drawback in favour of the Jablochkoff was this, that these lights were only fit for external illumination, and it could not be considered as one eminently adapted for internal and for domestic illumination. The lesson had been carried into practice in the Grand Theatre, where nothing could be more effective than the illumination of the auditorium—the soft and comfortable tone of, and, cast about a theatre, was perfect. There were several incandescent lamps shown at Paris besides those of Mr. Swan, notably those at Maxim and Lane-Fox; but that which received the greatest novelty, and was decidedly the most efficient, was that of Mr. Edison. The distinctive character of the Edison lamp is the remarkable high[illegible] fibrosity of the feather, and high-giving power. Many of the lamps were of extraordinary beauty. The quality of electricity concerned it was proved by electric trains; but that adopted by Mr. Edison, was undoubtedly simple and accurate for all practical purposes. The proper distribution of light was a problem that remained to be solved, and certainly enough nothing whatever was done in the Paris Exhibition to show that the question of artificial illumination in England by electricity up to the present time was, as a rule, a questionable success. It was true that those rooms lighted by electricity were better than those where gas was used, but the lighting by electricity was not one which what it should be if the lamps were properly distributed. What was wanted was a lamp which could be put in the centre of the room, so that the light should be properly and uniformly distributed. The question remained for discussion, how the electric light been brought within the region of practical domestics? He had no hesitation in saying that it had not whether it could be brought into commercial contact with gas, which was the question of the day. Gas could be electrically illuminated by its agency. Gas was produced, and on a future occasion he hoped to be able, from the experience of his own household to answer the question which everyone was asking, "How much is it to cost to light your house with electricity?" There was no use dwelling theirs ears to the fact that the electric light was the most perfect of all the lights, and that the light should be removed beside of the skilled it had less danger than gas, or even oil. In Paris there was a fire in the Exhibition four, from the wires coming in contact with each other in the Exhibition building. The insurance in New York were so concerned that the Board of Fire Underwriters had refused to insure the building, but an additional security was provided by Mr. Edison, by inserting in every branch wire a "safety catch," which is a short piece of wire that fuses at exactly melts if the strength of the car are exceeds a certain value, and thus prevents the excess stopping the flow of electricity, and preventing safety. The Edison lamp, which is the most perfect in the Exhibition, was extremely effective in the Hillman Gallery. Many skilled thought had been paid to Mr. Edison's lamp by his provisors; perhaps more so than anyone in this direction than by Mr. Preece] but. It was some gratifying for him, therefore, to be able to announce his belief that Mr. Edison had at last solved the problem that he had set himself to solve. It was taken as a rule that lamps, the resistant on the resistance of abnormal energy is certain to produce a more brisk blown. All of the lamps of personal interesting, and personal supervision At home, was a species of abnormal energy. This was the great secret of the success of gas. It was the cause of the slow progress of the electric light. He was glad to say that Edison's light promised to be as in this respect, and in such a future was open to it. He had no doubt that the Crystal Palace Exhibition would be as interesting as that at Paris, and at the former they would see some of those beautiful specimens of the Jablochkoff candles which he had shown in a way seldom, if ever, seen before.

Mr. Edward H. Johnson, the representative of Mr. Edison, said that Mr. Edison had devoted his manufacture of electric lighting on a large scale from central stations, and the distribution of that electric by throughout every portion of the area of a district to be used by the centralized and practicable public supply. Many thousands of experts in the country of the system. They proposed to put such lamps as might be used in that system. They started with such conditions as to make the use of gas as entirely unnecessary, and which might be placed within the reach of ordinary house servants, and in their hands, no matter how ignorant they might be, as to danger. They had to produce a lamp which the current into light might be used in connection with power by the electric motor, and a current into was electricity for any purpose for which electricity had hitherto been used. Mr. Johnson then explained the system with which the light could be reduced or extinguished and renewed and increased, and a portable lamp was handed round the room.

Sir H. Tyler, M.P., Mr. Crompton, and others, thought that more possibilities should have been given to other systems.

Mr. Johnson said that they had before them an excellent example of incandescent light, and if it could be introduced on the same cost as gas. He was sure they would willingly use it. If they could have electricity laid on to their houses was no doubts that the problem would be in a great extent, solved.

Mr. Preece, in replying to a vote of thanks, said it would have taken a week of time for him to have given a description of the lamps and processes that had been brought before the society more than once.

The meeting then separated.

THE EDISON ELECTRIC LIGHT.

Daily News 17th Dec 1881

A paper was read last evening at the Society of Arts, by Mr. W. H. Preece, F.R.S., upon Electric Lighting at the Paris Electrical Exhibition. Considerable prominence was given to the Edison incandescent light, and Mr. E. H. Johnson, Mr. Edison's representative in England, seized the opportunity to give an illustration of its use in artificial illumination as applied to the lighting of private houses. The hall of the Society upon this occasion was a fine example of a brilliantly lighted apartment. A number of tiny lamps shed their cold, but clear light from shelf, where they hung suspended upon slim connecting wires, while in one corner burned a chandelier of these lights, and several portable lamps were in use upon the platform. The lights were of the famous horse-shoe pattern and enclosed in small balloon-shaped glass globes. The horse-shoe, which is in a vacuum, is simply formed of a thin strip of carbonised bamboo wood, no thicker than a piece of ordinary sewing thread. The electricity which excites the horse-shoe to glow and shed light is turned on and off instantaneously by means of a switch with as little trouble as in the case of an ordinary gas jet. Mr. Preece, in his paper, made a complimentary notice by the electrical engineers followed, framed the progress of the application of electricity to lighting in every nation from the early machines made by Professor Pixii, of Hauxtare, in 1840, and by Signor Pacinotti in 1857. The new lamps, which were described in detail, and the steps found, which hold an intermediate position between the Jablochkoff candle and the Edison light, had done good service. The lighting was, however, was the brass-discord light pure and simple. At the Paris Exhibition was that the arc light was solely only for external illumination, while the incandescent lamps were eminently adapted for internal and for domestic lighting. The last been properly recognised at the Paris Exhibition, and the electric lighting in private houses interested to be more fully dealt with by the lecturer when he stated that gas was not the only available for producing the necessary power for producing the new light. Referring to devices for measuring the quantity of electricity consumed, he showed Mr. Edison's apparatus, as was best like a small gasometer, in which the electricity decomposed two copper plates which have been previously coated with sulphate of copper. A definite proportion of the electricity passing through a known piece deposited this coil, depositing finely upon one plate, and the weight of copper, or, deposited upon the second used, therefore, the light had been sold, said the lecturer, about 1s. per lamp per week, and the electricity supplied has been nearer to 1d. per lamp. Gas therefore was therefore more profitable for him to be able to announce his belief that Mr. Edison had at last solved the problem that he had set himself to solve. It was taken as a rule that lamps consuming the greatest amount of electricity were the most brilliant. The lamps were shown, and the lights, which were of 20 candle power, were lighted by electricity produced, were turned on and off at will. The Lecture closed or increased in brilliancy instantaneously. Mr. Johnson explained that Mr. Edison contemplated the manufacture of electricity on a large scale for distribution over a wide area. It could be used without any meter or apparatus, and could be applied in any portion of a house by merely attaching it to the ordinary sewing machine, &c. The cost of the lamps was so slight that his company intended to supply them without any charge beyond that made for the electric current. A discussion afterwards took place. Sir F. J. Bramwell, in bringing the to a close, spoke of the superiority of the new light over gas both as to its healthiness and its cheapness. He thought that we were near a practical possibility of applying it to the illumination of ordinary households. A vote of thanks to Mr. Preece was carried unanimously.

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FATAL ELECTRIC LIGHT ACCIDENT.—A fatal accident has occurred at Halifax, by the contact of the Electric Light Company's wires with those of the Telegraph Company. A young man named William Ackroyd, aged 17 years of age, [illegible] of mending a broken wire belonging to the electric light company for lighting the premises of Messrs. Crossley and Sons' Dean Clough Mills. The mills are lighted with 117 lights on the Edison system, worked by an engine of 16-horse power, and it is the new mills some distance from the house. Two wires are carried from the house to the mills, and two wires connect the new mills with the old. For some distance they are carried on poles, but for the last 200 yards they are carried underground in pipes. The pipes run along the garden walks, and at the Ground, and at the mills and the distance [illegible] of the pipes is [illegible] yards. The deceased [illegible] in the garden, assisting to lay a branch wire from the main wire to the house. He was not aware of the danger, and [illegible] getting out. While he was about it, [illegible] and [illegible] and [illegible] and

inner rings, however, instead of being on a level with the outer one, rise in the form of steps toward the centre of the burner. Each ring is supplied with gas by a separate pipe provided with a valve to control the quantity burned. The rings are of metal, and by conducting the heat downward present heated surfaces over which the air passes as it rises to the point of combustion. The novel feature of the new burner consists of several curved air deflectors which surround the burner and the lower part of the flames. The object of these deflectors, as described by Mr. Douglass, is "to force the outer flame or flames on to the inner flame or flames, and thus to condense the flames to the requisite extent, and deflect on to the internal and external surfaces of each of the flames the whole or nearly the whole of the ascending currents of air." An illustration of this burner which appeared in the "Register of Patents" of the *Journal of Gas Lighting* for August 9, 1881, shows three of these deflectors, the inner one having its upper edge nearly on a line with the top of the outer ring, while the outer deflector rises to the level of the inner ring. The burner is provided with a chimney—which, however, unlike the ordinary argand, is kept quite cool by the strong current of air, and does not require wiping oftener than once a week.

Of each of these burners having six rings and a nominal power of 600 candles, developed an illuminating power of 6.5 candles per cubic foot of gas. "Another and much smaller burner, giving about 80 candle power maximum, developed a power of 5.7 candles per cubic foot." A burner of 1600 candle power is reputed to develop from seven to eight candles per foot. "The combination of the gas is, of course, perfect and the design of the entire apparatus lends itself to the construction of ventilating pendants for apartments, in which there is a very wide field of utility awaiting a reliable appliance."

One feature of the burner, which is of especial advantage in the consumption of gas of high illuminating power, is the arrangement of valves by which the size of the flame from any ring can be regulated, and if necessary, one or more flames could be cut off entirely, thus adjusting the amount of combustible material to the supply of air. Properly the air supply should be made sufficient for the perfect combustion of the gas, but as most of these burners are designed for low candle power gas, it becomes necessary to diminish the quantity of gas or reconstruct the burner for the admission of more air.

THE SANITARY ENGINEER,

fourth } [FEBRUARY 2, 1882.
paper }

ELECTRIC LIGHT NOTES.

An electric light company has been organized at Lowell, Mass.

It is reported that St. Petersburg is to have an electrical exhibition.

The Maxim incandescent light is used for the illumination of a part of the Edinburgh Post-office.

It appears that the Brush company, of Boston, are to have a rival in the Weston Electric Light Co., which at present has 100 lights in operation.

It is announced that the experiment of lighting the Junior Carlton Club, London, with incandescent electric lamps has been discontinued, and gas burners substituted.

The Southwestern Brush Electric Light Co. have commenced operations in New Orleans, and the citizens are rejoicing over the illumination of some of their principal thoroughfares by electricity.

The Enterprise Factory at Augusta, Ga., has introduced the electric light in place of gas made from gasoline. In the weaving room seven Maxim "arc" lamps have replaced one hundred and thirty-seven gas burners.

We learn from *La Lumière Electrique* that the large silk factory of M. Dulac at Armentières, near Lille, France, is lighted by forty Jablochkoff candles. The weaving room, containing 300 looms, has twenty lamps, the adjoining rooms have sixteen more, while the bleaching room and dyeing basins are lighted by four lamps. The results are considered very satisfactory both by the owner and the workmen.

The *Metropolitan* states that the Brussels Telegraph Department is lighted by the Jasper Electric Lamps, and that this system is being largely introduced in industrial establishments in Belgium. Mr. Jasper believes that it is more economical to distribute the electric current from one centre, instead of placing a number of lamps on one circuit; and this arrangement is a prominent feature of his system of lighting.

According to the *American Architect*, a locomotive on a French railroad has been fitted up with an electric headlight, which is said to give entire satisfaction. As the ordinary arrangement of the engineer is the are light is not suitable for the purpose on account of the constant vibrations of the engine, the electrodes in the new apparatus are floated upon the surface of water contained in the two legs of an inverted syphon

Wires passing through walls or partitions must be surrounded by an insulating tube. Arc lights must be protected by glass globes closed at the bottom, and surrounded with wire netting if placed over combustible material. Wherever a current is used of such strength as to render possible the fusing of any part of the lamp, an automatic switch must be provided for throwing the lamp out of the circuit before the point of danger is reached.

Below and surrounding the arc be places a cylindrical reflector of ground glass which conceals the carbons, while above the arc is an umbrella-like reflector, which throws the luminous rays downward into the room, producing a soft and agreeable light. In the lighting of the Telegraph Department, the Gramme machines employed are driven by a gas engine. Previous to the introduction of these lamps, of which there are three, the lighting was done by 60 gas burners with a total consumption of 317 cubic feet of gas per hour.

The New York Board of Fire Underwriters have made some changes in the rules concerning electric wires. For arc lights the conducting wires must have a weight equal to that of the wires forming the main circuit of the lamp regulator or of the armature of the machine, if that is larger. For incandescent lighting the wires must never be unpleasantly warm by the passage of the current, and in no case must the wires be connected with the earth or with gas or water pipes. Exposed wires must be covered with two coatings, one of which must be water-proof if the wire is in contact with water. A switch must be provided at the point where the wires enter a building, to allow of its being "cut out" from the circuit in case of fire, and the two wires at this point must be at least one foot apart. Wires on walls and ceilings should not be nearer than eight inches to each other if for arc lights, and two and one-half inches if for incandescent lamps.

THE SANITARY ENGINEER.

[JANUARY 20, 1882.

ELECTRIC LIGHT NOTES.

The municipality of Turin have decided to try the electric light for illuminating the Royal Theatre and the Council Room, in place of gas.

It is reported that the party which Mr. Edison sent to Brazil to search for wood fibre suitable for his incandescent lamps has returned, and gives the information that the fibre desired can be obtained in any quantity.

The museum of the Louvre, which has had but one electric fire alarm, is to be supplied with six, to be distributed on the three floors. The alarms are connected with distinct dials which in turn are connected with the fire station. The cost will be about $1,500.

In Paris the work of establishing the large shops of the *Printemps*, the Boulevard Haussmann, and Rue du Havre is carried on at night by the aid of the electric light. The contractors and workmen express themselves as well satisfied.

A company is to be formed in Stromberg for the purpose of introducing the electric light into workshops, manufactories, and ship yards, at present lighted by gas. Similar companies already organized in Germany have met with success.

It is stated that the Paris Municipal Commission have decided to light the Council Hall by the electric lamps of five different systems successively. The one which proves most suitable and economical will be introduced permanently.

According to *La Lumière Electrique*, there is some talk of lighting the French senate chamber by electricity. A commission composed of M. M. Berthelot, Charles Robin, and Wurtz, and of a certain number of specialists is to have the experiments in charge. If they succeed, the electric light will be definitely used in lighting the session room and adjoining apartments of the Luxembourg.

The *Review of Gas and Water Engineering* states that the attempt to light the principal streets of Liverpool by electricity has proved a failure, the Brush Company having withdrawn from their contract after a considerable loss. The light was to have been introduced last spring, but several postponements followed, and only within the past few months have the lights been in operation. Even then no attempt was made to dispense with the ordinary gas lamps.

It is reported that the contract for electric lighting between the Council of Edinburgh and the Anglo-American Brush Company has been terminated, and that on account of the increased expense it will not be continued. The *Review of Gas and Water Engineering* gives the expense of ordinary lighting by gas as about $1,000, that by an improved method of gas lighting as $1,000, while the electric light costs about $5,500.

La Lumière Electrique states that the subject of lighting the port of Havre by electricity still continues the object of countless experiments and interesting study. Recently a meeting was held of the commission having the matter in charge, to receive the report upon the effect which this lighting produces and also upon the services which it can render to vessels entering the port. It was the opinion of several captains and pilots that the strength of the light was not sufficient for the purpose, and also that the lamps should be placed at about double the present elevation. It appears that changes are to be made.

THE SANITARY ENGINEER.

[JANUARY 19, 1882.

A NEW STORAGE BATTERY.

Whatever may be the practical value of batteries for the storage of electricity, the very general interest which the subject has awakened in the mind of the public makes every improvement or modification in the construction of such batteries worthy of notice. If, in future, experience shows that secondary batteries cannot be economically employed in the general applications of the electric current, certainly the study which the subject is receiving will add very much to our knowledge of the requirements and conditions affecting the storage of electricity by chemical means.

Mr. H. Sutton recently read a paper before the Royal Society giving the results of a long series of experiments on storing electricity. In one experiment the negative electrode was a sheet of lead placed in a solution of acetate of lead, and the positive one lead in dilute sulphuric acid. In charging this the acetate of lead was decomposed, metallic lead being deposited on the negative electrode, and acetic acid being formed. On discharging, the original solution of acetate is obtained. During the experiments it was found that the red oxide of lead is a very poor conductor of electricity, while the peroxide is a good one; and also that the amalgamation of the lead plates produces an increase in the polarization effects. The plates becoming more uniformly and rapidly peroxidized when used as positive electrodes, and lead action entirely disappearing."

Having satisfied himself that positive electrodes amalgamated with mercury were the best, he made further experiments to determine the best form of negative electrode, "having in view the conservation of the hydrogen." Metallic pellicles and spongy platinum were not considered on account of their expense. It was thought, however, that good results might be obtained by having as the negative electrode some metal whose oxide would be soluble in the solution, "and which could be re-deposited from the solution, or by having metallic solutions from which metal could be deposited, the resulting solution being such as should, on the oxidation of the deposited metal, combine with the oxide and again form the original solution. In this way it was hoped to obtain a cell which would not polarize itself during discharge, as is the case in both Plante' and Faure cells."

Zinc, iron and copper were tried as the negative electrode, the solution in each case being the sulphate of the metal experimented with. The results were both more powerful and more constant than with any other cell. Zinc was discarded, however, on account of the necessity of keeping the plate amalgamated in order to prevent local action. In the use of the iron plate in solutions when the cell was not in operation rendered the employment of that metal undesirable. "The cell having a negative electrode of copper, a positive electrode of lead amalgamated with mercury, and a solution of cupric sulphate" was adopted "as a thoroughly economical, lasting, and practical form of storage reservoir."

It consists of a sheet of lead, thoroughly amalgamated, and a thin sheet of copper, both of which are perforated with a number of holes and rolled in the form of a spiral, being separated by rubber bands to allow the free circulation of the liquid. The metals are then placed in a solution of sulphate of copper, and "the lead plate made the positive electrode of a suitable source of electricity." The chemical action results

proposed to employ plates of iron which have been made electronegative to lead like the carbon and the gas burner beyond their original use, and it is to be seen if the interest beyond their original use, and it is to be seen if the interest

The National Scientific Journal.

January 15, 1882.

Electricity and Chemistry.

MAGNETISM AND THERMO-ELECTRICITY.—There are facts on record which prove that the molecular structure of iron and steel, when submitted to magnetic action, generally undergoes a change which is different according to the direction of magnetization, and that, consequently, other properties depending on molecular structure, such as the conducting power for heat and electricity and the thermo-electric behavior of iron and steel, are likewise altered. With regard to the galvanic conductivity, it has been proved by Herr Beetz that in longitudinally magnetized wire there occurs an increase of the resistance; whereas in wires transversely magnetized, a change of resistance is not demonstrable. As to thermo-electric behavior, Sir W. Thomson found that a longitudinally magnetized wire is electro-positive, a transversely magnetized wire electro-negative.

This behavior of iron and steel has a special importance for the method proposed by Herren Stroubal and Barus, of measuring the degree of hardness of iron and steel wires. They have sought to do so, that is, by determining the galvanic resistance and the thermo-electric position. But if these properties are affected by magnetization, then this method of measuring hardness will only apply to unmagnetic, not to magnetic, wires. Now, the change of the electric conductivity in the case of transverse magnetization being found *nil*, and that in the case of longitudinal so small that a hardly perceptible difference of hardness was implied, Herren Stroubal and Barus have limited their attention to examining the change of the thermo-electric behavior through magnetization; especially as Sir W. Thomson's results were only qualitative, and quantitative results were necessary for the end in view.

The experiments (described in a recent number of Wiedemann's *Annalen*), were made with annealed iron wires, which, not magnetic, now non-magnetic, and called thermo-electrically with copper, at equal differences of temperatures, were examined as to their thermo-electric behavior. The observed electro-motive forces; copper with magnetic iron, and copper with non-magnetic iron afforded confirmation of Sir W. Thomson's result, that a longitudinally magnetized wire is more positive than one non-magnetized. The difference, however, were so small, that with slight differences of temperature the constants of a thermo-element of magnetic and non-magnetic iron could not be deduced. When the difference of the temperature was raised to that of ordinary temperature, and the fusing point of lead, the variation of the thermo-electric behavior by magnetization was found to be $= 0.017$.

Considering, over against the result, that the variation of the thermo-electric constants through hardening and annealing of steel reaches the value 13·6, it is clear that no objection can be taken to the use of thermo-electric constants as a measure of the hardness, even in the case of magnetic wires. The following circumstance, however, is noted as remarkable:—In change of the condition of hardness of a steel wire, its conductivity and thermo-electric position are varied simultaneously, and, with increasing resistance, the wire becomes thermo-electrically negative; in the case of magnetization, on the other hand, the resistance increases, but the wire becomes thermo-positive. Thus the thermo-current in the case of magnetic differences, flows in the opposite direction to that in the case of differences of hardness; which is explained by the different nature of the causes in operation.—*English Mechanic.*

ELECTRIC LIGHTING—ITS FIRE RISKS AND THEIR REMEDIES.

BY HENRY MORTON, PH. D.

Some very lamentable accidents have strongly directed public attention to the question of danger possibly accruing to life and property through the rapidly increasing employment of electricity as a source of light, and as the actual conditions of this danger, like the true properties of the agency from which it may arise, are but little known, a brief explanation of some simple facts related to this subject will be at this time seasonable and perhaps useful. I would propose, then, to treat this subject under two general heads, namely: 1st. The sources of danger; 2d. The conditions of their prevention or of security. The sources of danger in the use of the electric light are essentially two —from the conducting wires and from the electric lamps. As long as the electric fluid or electric energy, is conveyed by a sufficiently good conductor it is perfectly harmless, resembling a river flowing in its natural channel, and powerless to rise above its banks; it is only when some outer channel into surrounding objects is offered or some partial obstruction of a certain character impedes its regular flow that trouble may arise. The conditions of these difficulties are, moreover, very peculiar. Thus, for example, if two electric conducting wires, forming the outgoing and returning paths of a powerful current, are placed near each other, but are separated by a bad conductor, as, for example, when both are locked on to a board partition wall, the current will follow the wire from end to end, with no development of heat in the *same*, or tendency to leave the conductor or pass into any adjacent object. If, however, between the two conducting wires we introduce some imperfect conductor, such as a small wire, some metallic dust, or a film of water containing mineral matter in solution; then a portion of the current will be diverted into this "short-cut" from wire to wire and may heat the fine wire or the metallic dust or the wood wetted with aqueous solution, so as to cause the ignition of inflammable matter. Accidents of this nature have already occurred. Thus a telegraph or telephone wire having fallen across one or more of the conductors used for street lighting purposes has been fused, or, itself escaping, has caused the fusion of finer wires connected with it.

Again, two wires being the outgoing and return circuits of a powerful current, have been nailed side by side, without other insulation, on the same board of a floor, partition or ceiling; and though used safely for a long time, while the woodwork was in its normal state, have developed a very dangerous activity when the wood between them was wet with dirty or impure water. In that case the water offers a circuit through which a crosscurrent is established, which first heats the adjacent wood, then chars it, and finally establishes a series of minute arcs or electric sparks, whose fiery surface, waving and soon diffusing, excites ignition if left unarrested. Again, two such wires as above, insecurely attached near each other, may be brought into momentary contact and then separated, in which case an electric arc, with its intense light and heat, will be established between them. In like manner a conducting wire itself may be insecurely connected at some point, and if the abutting ends are separated slightly during use, a similar "arc" with its intense heat may be there developed. These examples will give a fair ideal of the danger arising from the conducting wires, and they are manifestly to be guarded against by a proper separation and insulation of the wires themselves. Of this, however, more anon. At present, I would only further point out that there is no risk whatever of any heating or other injurious action arising in or from the conductor itself when an adequate one is used, as must be the case from motives of economy; since an inadequate conductor would involve ruinous expense in the use of the electric current. Electricity is not to be regarded as a sort of fluid fire passing along the conductor; and some popular notions on this head are as absurd as were similar ones which prevailed in reference to illuminating gas, at the time of its first introduction, and which caused rules to be made in some places that no gaspipe should be allowed to come in contact with any wood-work.

Turning next to the dangers which might be expected from the electric lamp, it is to be remarked in the first place, that these in the case of the arc light depend much upon the number of lamps operated on the same circuit. Thus if thirty or forty lamps are operated in series, the electro motive force of the current must be sufficient to maintain a corresponding number of arcs; and, therefore, if by any means many of these arcs are closed out the electro-motive force of the current available for the remaining ones would be so excessive that their arcs might become excessively long, and even the metallic carbon holders and other parts of the lamps constitute poles between which the arc would spring, melting the metal work and establishing a very dangerous centre of combustion. To avoid this class of dangers two provisions should be made. In the first place some arrangement in the lamp itself by which, whenever the arc exceeds certain safe limits, the current will be automatically diverted from it and carried through a good and sufficient conductor; and, in the second place, some apparatus in connection with the electric generating machine by which the electro-motive force of its current should be varied automatically in correspondence with the resistance of the circuit, so that any diminution of such resistance, as by the closing out of several arcs, should cause a corresponding diminution in the force of the current generated. Numerous contrivances for both of these purposes have been already carried to greater or less perfection and efficiency, and it is manifestly possible by such means to secure immunity from risks of this sort.

The securing of adequate insulation for the conducting wires in view of the endless ramifications of telegraphic and telephonic systems, to say nothing of the other conductors found in all buildings is a problem of no small difficulty. One important general principle would seem to be the equal insulation of the return, as well as of the outgoing wires, as well as of the machines, and the voltmeter of all ground connection for any part of the circuit. Another general rule would be the separation of outgoing and return wires as far as possible from each other; and yet another, the continuous insulation of conductors leaving no vulnerable places even where danger would not directly result from accidental contact.

Fully to discuss all the details of this subject would be impossible within the proper limits of such a note as the present, and I will therefore only say in conclusion that, with well matured plans and skilful and intelligent provision, all these dangers may be provided against and electric lighting may be made as safe as that obtained by gas or by candles; but without such care and judgment the use of electricity on the grand scale either for lighting or for transmission of power, would involve serious additions to the risks which accompany so many of the conveniences which constitute a large factor of our modern civilization.—*Sanitary Engineer.*

St. Louis Daily Globe-Democrat,
Sunday Morning, March 5, 1882.

NEW YORK LETTER.

Edison's Inventions Put to a Practical Test in the Metropolis.

A Frank Account of the Adaptation of the Electric Light to Household Use—Point and the Holbrook Company —A New Star.

Special Correspondence of the Globe-Democrat.

NEW YORK, March 4.—From being one of the most lighted cities in the world, New York is now one of the most darkened. Gas and candles are not entirely out of use, but they are thought of lighting because by electricity as a thing that would possibly happen before I died, but I find that is has come to pass already, and as it is a fact that electric light can be furnished households cheaper than gas, it becomes a question of interest to everybody to know all about it.

Mr. Edison, the great inventor, has taken up his abode in New York City, on Fifth avenue, directly opposite the headquarters of his electric lighting bureau, and will remain until the head drives him back to his newly made seat at Menlo Park. I went down to the office the other evening with some friends, and we were kindly shown through the place. It is a handsome dwelling house, which has been adapted to the uses of the bureau of the Edison electric light. The rooms shown the different manners of using the light are:

The Bunsen light has a cold, steely glitter, which is painful in the eye when first thrown, but mixed on high as a street light, or in a room where the eye is not constantly affected, has the Edison light in use is only not painful, but restful to the eye, while shedding a soft and mellow radiance, which is very pleasing to see.

The incandescent Sawyer-Man burner is inclosed in a globe lamp, shaped somewhat like the ordinary gas burner globe, and the manner of burning of Sawyer-Man, a piece of the burner itself, until it brings two wires in contact with the platinum-iridium strip, when the light is turned on. The two wires then pass through the lamp one of colored and one of ground glass, and they never seem to wear. Gas burns super hot over the lamp to prevent the glass from cracking, and the light from these lamps is a great improvement to gas, with all the lamps turned downward, thus throwing the light on the ceiling, which is a soft reflector to shield the eyes, lamp lights are made, which have an insulated cord attached. The lighting of these lamps is done by a match, and they have private glass or porcelain stoples. They are just the thing for invalids or sufferers who hate the sulphur fumes. A lantern on the floor, in a corner, which contains a battery, is the source of the light, and the battery is charged in the morning, and then is lighted by means of a similar lantern. In appearance

THE ELECTRIC LIGHT IS HORRID.

when passing around from room to room are used, the lamps being attached to a handrail. A child, or even an ordinary servant girl, can light them, and there is no mess, no smell or danger whatever. One can take hold of the wires without getting a shock, for these wires can contain from a fifty pocket battery and upward, and the shock from them is not felt unless one embrace. There is a meter, by means of which the amount of electricity used can be measured, and the bill for it is sent in monthly. The meter is placed by a subject of interest, and in some manner beyond the power of consumption. Power for running sewing machines and other uses is furnished also at moderate rates, and can be furnished now at houses. Edison's system is the one to dispel all his square inches, and it only remains for the people to call for it, and the supply will be furnished for all the requirements of that district. Subterranean cables, wires inclosed in gutta-percha and lead, are laid under the streets to the houses and a half under the surface, and leading from these will be the wires that supply the interior.

It is hard to say the public to adopt any new thing, but if it is good, and there has been a great deal of talk about the electric light being injurious to the eyes. I am satisfied from what I have seen that it is a perfect success. Edison's people forward here ordered wires laid in many houses and offices.

In 1871, Alnar Smith is a factory in Connecti-

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ent, where an electric light was used, Mr. Edison determined to attack the problem of lighting by electricity at a rate lower than that demanded for gas, and of giving a purer, clearer, steadier and more reliable light. There were two systems to choose from—the voltaic arc and the incandescent. As a field for his operations he chose the latter, although it was beset with the difficulty that platinum, when subjected to intense heat of the electric current, was liable to melt, and that carbon might be dissipated under the combined action of gases and the current. Soon, however, he hit upon an ingenious contrivance to save the platinum, which shut off the heat from it when it had expanded to a certain degree, and by which he hoped to keep the incandescent metal below the melting point. This invention is described in the patent as follows:

"Electric lights have been produced by a coil or strip of platinum or other metal that requires a high temperature to melt, the electric current rendering the same incandescent. In all such lights there is danger of the metal melting. My improvement is made for regulating the electric current automatically passing through such incandescent conductor, and preventing its temperature rising to the melting point, thus producing a reliable electric light."

STILL ANOTHER INVENTION.

This device not proving satisfactory, the next regulator was in the form of a diaphragm, which cut off the electric current from the platinum whenever the diaphragm was pressed outward beyond a fixed limit by the heated air. As a further improvement, he used finely divided platinum incorporated with non-conducting material. This arrangement resulted in a very weak current, producing a good light, the non-conducting material becoming luminous. Then more light-giving surface was sought for, and one experiment followed another, and another another, until, at last, after becoming convinced that economy in the production of light from incandescence demanded that the incandescent substance used should offer great resistance to the electric current, and profiting by this conviction, he soon had the happiness of perceiving that the hour of his final triumph was drawing near. One by one he had overcome the difficulties that had lain in his way. He had raised platinum from a state of comparative worthlessness as a substance for illumination to one of all but absolute perfection. He had succeeded by a singular combination and improvement in air-pumps in obtaining a vacuum of nearly one-millionth of an atmosphere, and had perfected a generator of electricity that yielded 90 per cent of the energy it received from the driving machine. He felt that all the serious obstacles in the way of incandescent electric lighting had been nearly removed from his path. Just at this juncture happened one of those "accidents," as some people style them, and "direct interposition of Providence," as others look at them. One night Mr. Edison was sitting in his laboratory, busy thinking out details of his famous lamp and rolling between his fingers a piece of compressed lampblack, mixed with tar, for use in his telephone, as he thought, when, by an involuntary glance, he saw the black filament between his fingers, and instantly thought that might make a good burner. He tried the experiment instantly, and with the most satisfactory results. He took a piece of cotton thread, and placing it in a groove between the iron clamps, thrust the latter into the furnace. The light obtained from the tarred lampblack had convinced him that filaments of carbon of a texture not yet used in electric lighting would turn out to be important illuminating agents. In the course of an hour he drew the iron clamps from the furnace, and, removing the delicate carbon framework of the thread, placed it in a globe connected with wires leading from the machine which generated the electric current. He then extracted the air from the globe and turned on the electricity, when, lo! a beautiful, clear light greeted his eyes, the little filament withstanding a current that would have fused even a diamond, but finally giving way after having emitted a light equal to several gas jets. The microscope showed the filament to be highly polished, and the parts to be interwoven with each other. It was also found that the filament had attained an extraordinary degree of hardness, compared with what had characterized it before it was subjected to the electric current.

EXPERIMENTS FOLLOWED IN QUICK SUCCESSION,

the result showing that the substance best adapted for carbonization, and the giving out of incandescent light, was paper as thick as cardboard. A beautiful soft and steady light, reliability, non-fusibility of the carbon filament, and a proper and uniform resistance to the electric current being the only elements of true success, all the energies of the inventor were concentrated upon them. After countless experiments, involving alike intense labor and thought, it seemed to be decided that the best substance for incandescent lighting was the frame-work of a little piece of paper or thread. This medium is prepared as follows in the laboratory of the inventor:

From a strip of bristol-board there is cut a strip two inches in length and one-eighth of an inch in width, in the shape of a horseshoe. A number of these, separated from each other by tissue paper, are laid flat in a wrought-iron mold about as large as one's hand. The mold is then covered and placed in an oven, where it is subjected to heat of 600° F., when the volatile portion of the paper passes away. It is then withdrawn and placed in a furnace heated to almost white heat, after which it is allowed to cool gradually. On opening the mold the charred remains of the little horseshoes are found and removed with the greatest care. They are then placed in a little globe attached to wires from the generating machine, the air is extracted from this, and it is sealed up, the lamp is then ready for use. In making his pumps and other vacuum apparatus, Mr. Edison has secured the services of a glass-worker formerly engaged in the laboratory of the celebrated Geissler. Mr. Edison has so improved the Sprengel air-pump that high vacua may be produced in twenty-five minutes, instead of only with the enormous amount of time formerly consumed. Recent experiments have led to the adoption of horse-shoes made of bamboo fibers, carbonized in nickel molds. The fibers of bamboo undergo less waste and are more uniform than of paper.

Down in that section of the city by Wall street and the East River, the wires are all laid and the powerful generating machines are almost ready to begin operations. The work of laying wires is progressing up-town for lighting private residences, as fast as possible, so that in another year gas, as a light in houses, will be almost a thing of the past. It could not be otherwise when a light so superior in every way, and so free from the dangers that lurk in gas, is furnished cheaper than the gas. And, besides, what a relief it is to the hard-pressed householder to escape from the thraldom of the fiends that make their home in the gas-meter!

AMERICAN MACHINIST
NEW YORK, MARCH 18, 1882.

Length of Electric Arcs.

Editor American Machinist:

In your valuable paper of March 4th, in the article "Fire Protection Against Electric Lighting," there are two statements that certainly will be new to those who have used the electric light for years. Mr. Atkinson says: "If the wire is broken the electric spark will follow from one broken end to the other from one to six feet." There are very few persons who have seen an arc more than six inches, and, no doubt, many of your readers must have thought at the first reading that Mr. A. meant inches instead of feet, but, in another part of the report, he uses the words "several feet." The danger of fire from this cause is not considered great, and with wires put up as they should be, would not begin to compare with the breaking of gas pipes and the burning of the escaping gas.

So far as the damp wood is concerned, the wires must be of very poor copper and very near together to have a "cross arc," the law being that the current will follow the best conductor.

A glance at the tables will show that copper is among the best conductors, while salt is far down in the list.

CHARLES STOWELL,
Ausonia, Conn. Electrician.

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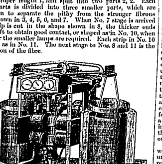
THE EDISON LIGHT.

In *Chambers' Journal*, and in some of the technical papers for July, 1863, there is to be found an article on the electric light. This article, like all others of its kind, is extremely interesting, dealing as it does with the history of the subject. The literature on the theory of the subject is interesting to another class of readers. In this article the work of Messrs. Greener and Staite, exhibitions of which were given in 1847 at several places in London, is discussed, and the following sentences are instructive:—"They devised a mode of enclosing small lumps of pure carbon in air-tight vessels, and rendering them incandescent or luminous by means of galvanic electricity." Other lamps involving a train of clockwork to keep the relative position of the carbon points constant were devised. Of such we read—"But these ingenious inventors, notwithstanding all their praiseworthy endeavours, could not obtain a steady light; it *would* flicker and intermit, and failed to become practically useful, although they fondly hoped—as they declared—that streets and buildings might thus be lighted at one-sixth the cost of gas." Even if the light had been steady, and thus have commended itself, the mathematicians with their cool calculating power, and to investors seemingly cynical results, soon showed that the burning of zinc to produce the electric light was far from economical, and could not because of its cost come generally into use. Time went on. Dynamo-machines replaced the galvanic battery; the electric current was cheapened by the combustion of coal as the first cause, instead of zinc; the electric world was moved to its vitals by certain successes; yet the old idea of incandescent lighting was pooh-poohed till Messrs. Swan and Edison showed us to be wrong. Swan experimented off and on for twenty years. Edison commenced, we believe, after the Eclipse expedition a few years ago, during which a sensitive instrument of his had been on trial. The Wallace-Farmer machine excited his inventive faculties, and he turned to test the possibilities of electric lighting. He passed through the ordinary course of experiments with the more infusible metal, and at length came to the conclusion, as every other experimenter before and since has come, that carbon, and carbon only, was the substance to be used. We wonder who will be the first to discover a real rival to carbon! Having decided to use carbon, the next question was the material from which the carbon should be obtained. A process of differentiation soon showed that vegetable carbon only was useful, and that obtained from grasses was selected. From north and south, from east and west, materials were obtained and tested. We illustrate, on page 118, specimens of bamboos brought from South America, Japan, &c., for the purpose of these trials. Each bamboo was exhaustively tested, till at length a certain one was selected for use. The following are the names of the canes illustrated in the figures:—(1) Hauchikee, from Japan; (2) Nebuchitakee, from Japan; (3) Shiho Jikee, from Japan; (4) Sugar Cane, from Venezuela; (5) Horteichikee, from Japan; (6) Kuraichikee, from Japan; (7) Matakee, from Japan; (8) Brazilian, from Para, Brazil; (9) Hauchikee, from Japan; (10) Shikakuakikee, from Japan; (11) Mountain Bamboo, from Japan; (12) Shikakuakikee, from Japan; (13) Brazilian, from Para, Brazil; (14) Shikakuakikee, from Japan; (15) Japanese, from Yokohama, Japan; (16) Torachikee, from Japan; (17) Chinese, from Hong Kong, China.

When the selection had been made, the method of manufacture was carefully considered and every detail arranged, so that the manufactured article should be produced at the lowest cost. Fig. 2 shows the processes of manufacture. The bamboo is taken of proper length 1, and split into two parts 2, 2. Each of these parts is divided into three smaller parts, which are pared down to separate the pithy from the stronger fibrous texture, shown in 3, 4, 5, 6, and 7. When No. 7 stage is arrived at the strip is cut in the shape shown in 8, the thicker ends being so left to obtain good contact, or shaped as in No. 10, when carbons for the smaller lamps are required. Each strip in No. 10 forms two, as in No. 11. The next stage to Nos. 8 and 11 is the carbonisation of the fibre.



EDISON WEBER METER.

Of course, the process of carbonisation is of somewhat a delicate nature, and care has to be taken, or the previous work might easily be spoiled. The filament, as we have said, is shaped before the carbonisation. The filament shaped as Nos. 9 and 12 is laid in a groove cut in a metal case—generally the metal used is nickel—which groove is covered to render it air-tight, and so prevent combustion. The filament so protected is placed in the furnace and raised to the temperature required.

To show how exhaustively Mr. Edison carries out his experiments, we give diagrams Figs. 3 and 4, showing tabularly how the information as to the better materials was obtained. Fig. 3 shows an example of a bad material, Fig. 4 of a good one. These diagrams are very instructive, showing as they do the time after which the carbon broke, under what current and at what points. The processes in the manufacture of the lamp itself are very simple. The lamp consists primarily of two parts, one the central stem, as shown in Fig. 5, No. 11, of glass into which are fused the conducting wires, to the ends of which the carbon filament is fixed as in Nos. 12, 13, 14, the other the globe proper. The lamp is exhausted from the top, and when exhausted sealed to prevent entrance of air. One conducting wire is in contact with the screw at the lowermost point of the lamp, whilst the other is in electric contact with a brass ring around the rim of what we may call the stem of the lamp. No. 4 shows how the exhausting tube No. 3 is fixed to the globe No. 2, whilst Nos. 5, 6, 7, 8, 9, 10, 11, show the processes undertaken to form two of the inner stems.

We have thus far followed what seems to be the natural order of things—we have shown in previous papers the arrangements made for the generation of the current, and for its safe conduction through mains to the houses. The lamp wires are so arranged that it seems almost impossible for any accident to happen. A strip of wood, say 3in. by ⅝in., has two grooves cut into it to hold the insulated wires, say to a lamp on a wall bracket. This lamp bracket may be of the design shown in Fig. 6, and hence movable around a centre. Sections of the joints at A and B are shown in Figs. 7 and 8. It should be

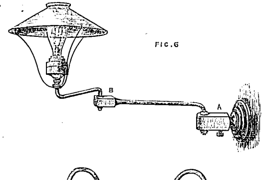


FIG. 6

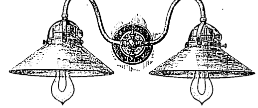


FIG. 9

understood that every lamp and every house is provided with a fusible conductor, so that should any mishap cause a greater current to flow into the conductors to the lamp, fusion at the safety point takes place and the current is absolutely stopped. The lamp is rendered useless; but who would care about a gas burner being temporarily useless if it automatically stopped a leakage of gas, and so prevented an explosion.

The current can be turned on or off the lamp by means of a tap, so that in many respects the householder who could go to sleep overnight with gas laid on, and wake up in the morning with the electrical connections made, would go about the work of getting his light just as he had always done. Figs. 9 and 10 show lamps adapted for pendants or to stand on the table, &c. A further similarity exists in the distribution of electricity and gas, inasmuch as the amount consumed of the former as well as of the latter can be measured. Fig. 11 shows the latest form of meter. The laws pertaining to electro-deposition of metals are herein utilised. It is well understood that a given quantity of electricity, whether passing in a shorter or a longer time, will deposit a certain weight of metal. The apparatus then consists of two cells placed in a shunt or branch circuit. The amount of electricity passing through this circuit in proportion to that through the main circuit is known, and hence the weight of metal deposited tells the quantity of electricity that has passed through the circuit. In practical use certain precautions are taken to counteract the effects of heat in the circuit, somewhat after the same fashion as in watches, two metals are used, expanding differently under the influence of heat. In the cell, for example, a rise of temperature decreases the resistance, and a compensating arrangement is therefore made in the circuit by inserting, say, a copper resistance, which resistance increases as the temperature rises. Another form of meter was described in our issue of November 4th, 1881.

With reference to this method of measuring electrical currents we may call attention to the admirable series of experiments undertaken by Dr. G. Gore, F.R.S., which supplies information regarding the degree of accuracy of such experiments when made by means of electrolysis of a solution of cupric sulphate, and states the conditions under which the degree of inaccuracy of measure is the least.

THE ROYAL INSTITUTION.

THE ABSORPTION OF RADIANT HEAT.—LONDON FOG.

On the 3rd inst. Dr. John Tyndall, F.R.S., lectured at the Royal Institution, Albemarle-street, on the "Absorption of Radiant Heat." Mr. William Spottiswoode, F.R.S., presided.

Professor Tyndall began by saying that some of the greatest superstructures of physical science depended upon a more or less ideal foundation. For instance, the undulatory theory of light could only be spiritually discerned, for the waves were far too small to be seen; it also required a mind of high ideality to conceive an ether filling all space, yet possessing the qualities of a solid. The ultimate atoms of matter stood upon the same ideal foundation. When several of these atoms were grouped together they were scientifically known as "molecules;" and the object of his address that evening was to explain the action of free molecules upon obscure radiant heat. By free molecules he meant the molecules in gases, vapours, and liquids. The invisible waves of radiant heat were longer than those of light, but inconceivably small; and there was a vast difference in the power of different kinds of free molecules to absorb these heat vibrations. They could do most in this way when they were chemically united. If a simple mixture were made of nitrogen and hydrogen gases, in the proportion of 14 to 3, and placed in a tube of wide diameter, through which a beam of obscure heat could be sent, scarcely any of that heat would be absorbed by that mixture. But if the same two gases were chemically united to form ammonia, they would stop a thousand times more radiant heat than before. It was the same with vapours. Some were as black as pitch towards radiant heat; others were highly transparent. If the number of molecules of the gas in the experimental tube were constant, the absorption of radiant heat was the same, no matter how the molecules were crowded together by the lengthening or shortening of the tube. But the molecules might further be so crowded together as to form a liquid. On trying experiments with a number of vapours, also of liquids from the same vapours, he found the mean absorption of radiant heat by the one to be 32·5, and by the other 32·9, the number of molecules being the same; so that the absorption by a liquid of its vapour is practically equal. The law is that the absorption of radiant heat remains constant through all changes between the vaporous and liquid conditions.

The speaker then stated that when impulses of light, made, say, by passing rays from the lime-light through perforations in a rotating disc, were allowed to impinge upon a small glass bulb containing vapour, sounds were given forth by the vapour, and the noise could be conveyed to the ear by means of an india-rubber tube from the mouth of the flask; the sounds were then like an ordinary organ peal, and were due to the absorption of radiant heat by each vapour tried. Some men of science had denied the accuracy of his discovery that aqueous vapour was such a powerful absorbent of radiant heat; he asked a bottle of aqueous vapour whether he was right as to its absorbent powers, and the vapour sent him a musical roar in reply. The sound was evidence that radiant heat had been absorbed.

The obscure radiation from the electric arc is eight times greater in heating power than the luminous radiation; the obscure radiation from the sun is twice that of the luminous radiation. A layer of water placed in the path of the electric light makes its radiation very much like that of the sun. Between ourselves and the sun is the aqueous vapour of the atmosphere, but at a height of 10,000ft. or 12,000ft. there is very little vapour in the air. Professor Langley, who was making observations in California at a height of 12,000ft., had just written to him saying that he found a great difference in the distribution of the solar radiation at that altitude; there was an enormous expansion of the ultra-red spectrum.

Last Friday night, in the course of a lecture at the Royal Institution, Professor Edward Frankland, F.R.S., said that the suspended matter in the atmosphere is mostly below the height of 5000ft.; probably half of it is below that level. The higher the position in the atmosphere, the smaller are the variations in solar intensity. The lower the latitude the greater might it be expected to find the intensity of the sun's rays, but this is not necessarily the case. In northern regions, coupled with the conditions of high elevation, light background, shelter, clear atmosphere, and a small quantity of aqueous vapour in the air, the solar intensity may be great. The chief evils of a town climate are—great heat in summer, gloom in winter, and so much dirt in the air, that the colours of new or freshly-painted houses soon change to a grimy hue. The darker the houses the warmer they are inside, and the cooler are the streets, and more especially is this the case in relation to the roofs; slate roofs sometimes became so hot in the sun that the hand can scarcely bear to touch them, but if they were made white outside they would be as cool as the external air. All the large towns in England are near the sea level—a condition which favours air warmth, but not direct solar warmth. The combustion of coal in towns results in the discharge into the atmosphere of vast quantities of soot, tar, and steam; the more perfect the combustion, the less tar and the more steam is given off. Mr. Robert Hunt estimates that eight millions of tons of coal are consumed annually in London, and that of these six millions of tons are consumed in the winter months, consequently the amounts of steam, soot, tar, and sulphurous acid discharged into the air are enormous. Steam supplies the basis of all fog; and the fog particles become covered with tar, which renders them more permanent; dirt in the air is necessary to produce fog. To illustrate these points Dr. Frankland took a large flask containing a little vapour of water, and with air deprived of dirt by being filtered through cotton wool; on chilling this air by expansion by means of a few strokes of an air-pump, slight mist was formed which disappeared in a moment. The effects were rendered visible throughout the theatre by means of a beam of light from the electric lamp, thrown upon the flask. The ordinary air of the theatre with its normal charge of dirt was then admitted into the same flask, and when the former experiment was repeated the fog was more dense and lasting then when air without dirt had been used. The presence of sulphurous acid in London air promotes fog, and the power of the acid to do so was proved by the lecturer by experiment. Tarry matter in the air renders fog more persistent by retarding evaporation. The power of tar to do so is recognised by some manufacturers, and used by them to economise fuel, while keeping water at the boiling point. Professor Frankland here exhibited one basin of water at the boiling point giving off its clouds of steam, and another basin of water at the same temperature giving off none at all, because the water was covered with a thin layer of olive oil, which the speaker stated to be the same in its influence under the circumstances as a thin layer of tar. Thus the products of combustion of our household fires, he said, furnish potent sources of fog, and it is a mistake to lay the blame on the discharges from the chimneys of manufacturers. If all manufactures were removed from London, no appreciable difference would be made in the amount of fog.

At the South Kensington Smoke Abatement Exhibition, he said were two great classes of grates for domestic use, namely, those which burn bituminous and those which burn anthracite coal. There are about 600,000 houses in London, and little good in the way of preventing fog will be done by improved fire-grates, he added, so long as householders use bituminous coal. There is one remedy and one only, and that is to stop the importation of bituminous coal into London. The price of anthracite coal is lower than the other, it is smokeless, and an ample supply of it and of smokeless steam coal can be had from Wales. Bituminous coal can also be rendered smokeless by coking; moreover, in the process of coking it gives off valuable commercial products. The difficulty in lighting anthracite or coke fires is overcome by Mr. Siemens' process; by an expenditure of two shillings each, every grate in London can be made to burn smokeless coal. He had proved this in his own home in spite of the grumbling of the servants at first, before they had gained experience in lighting the fires; the cost had been three shillings per grate, including blowers to facilitate lighting. The general adoption of such a system would do much to abolish the more injurious of London fogs, which always increase the death rate, more especially among persons suffering from bronchitis, asthma, and other diseases of the lungs. A cotton-wool respirator does much to prevent the choking sensation caused by London fogs, but it does not alleviate the smarting of the eyes. In any case, he added, we have little sunshine in this country, and need not make matters worse by throwing a dark unhealthy pall over ourselves.

over

THE MANUFACTURE OF EDISON LAMP CARBONS, AND LAMPS.

(For description see page 117.)

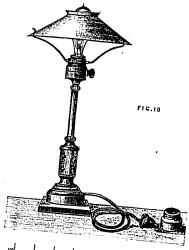


FIG. 10

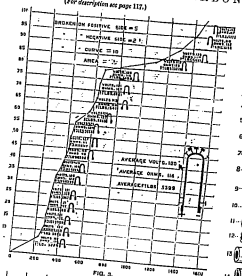


FIG. 3

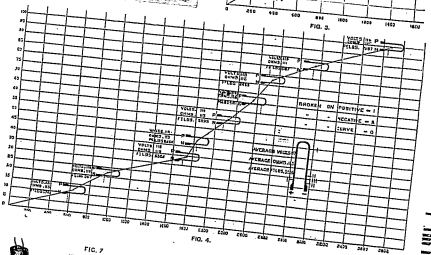


FIG. 4.

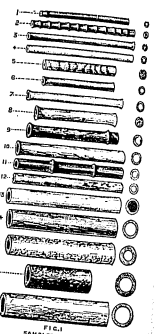


FIG. 1
SAMPLES OF BAMBOO

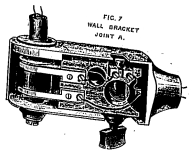


FIG. 7
WALL BRACKET
JOINT A.

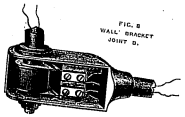


FIG. 8
WALL BRACKET
JOINT B.

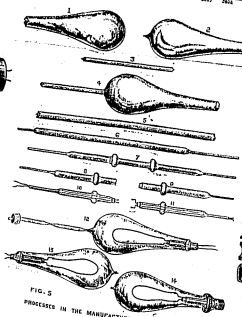


FIG. 5
PROCESSES IN THE MANUFACTURE OF THE LAMP

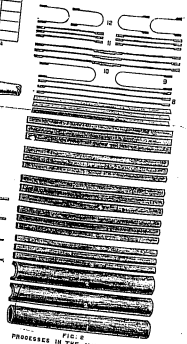


FIG. 6
PROCESSES IN THE MANUFACTURE OF THE BAMBOOS

THE ENGINEERING AND MINING JOURNAL.
Nos. 1 to 7 inclusive, 42
Oct. 22, 1881.

A series of Incandescent Electric Lamps.—Gradually we are obtaining what was so long needed—accurate data on the intensity and consumption of power of incandescent electric lamps. We have had occasion recently to give the results of some experiments, and may now add additional figures, which were published by Sir William Thomson and Mr. James T. Bottomley in a paper read recently before the British Association at York. The electro-motive force for the three lamps used, the number of which, however, is not given, was derived from Faure secondary batteries, the number of cells and horse-power of which are given in the tables:

No. OF EXPERIMENT.	Lamp No. I.			Lamp No. II.			
	Volts.	Horse-power.	Candles.	Candles per horse-power.	Volts.	Horse-power.	Candles.	Candles per horse-power.
1	50	0·093	22	235	48	0·127	49	381
2	50	0·120	30	250	48	0·163	70	427
3	50	0·126	32	253	48	0·175	76	435
4	50	0·170	50	294	48	0·233	101	396
5	50	0·180	54	300	48	0·233	101	396
6	50	0·187	60	320	48	0·245	112	457
7	50	0·197	63	320	48	0·245	109	445
8	50	0·224	75	335	48	0·280	116	414
9	50	0·233	80	343	48	0·280	116	414
10	50	0·238	84	353	48	0·293	122	417
11	50	0·252	90	357	48	0·310	135	435
12	50	0·267	96	359	48	0·327	140	428
13	50	0·282	103	365	48	0·327	143	436
14	50	0·296	110	371	48	0·327	147	449
15	50	0·310	114	368	48	0·327	151	461
16	50	0·324	119	367	48	0·327	151	461
17	50	0·338	124	367	48	0·327	151	461
18	50	0·352	129	366	48	0·327	151	461
19	50	0·366	134	366	48	0·327	151	461
20	50	0·380	139	366	48	0·327	151	461
21	50	0·394	144	365	48	0·327	151	461
22	50	0·408	149	365	48	0·327	151	461
23	50	0·422	154	365	48	0·327	151	461
24	50	0·436	159	365	48	0·327	151	461
25	50	0·450	164	365	48	0·327	151	461
26	50	0·464	169	365	48	0·327	151	461
27	50	0·478	174	365	48	0·327	151	461
28	50	0·492	179	365	48	0·327	151	461
29	50	0·506	184	365	48	0·327	151	461
30	50	0·520	189	365	48	0·327	151	461
31	50	0·534	194	365	48	0·327	151	461
32	50	0·548	199	365	48	0·327	151	461
33	50	0·562	204	365	48	0·327	151	461
34	50	0·576	209	365	48	0·327	151	461
35	50	0·590	214	365	48	0·327	151	461
36	50	0·604	219	365	48	0·327	151	461
37	50	0·618	224	365	48	0·327	151	461
38	50	0·632	229	365	48	0·327	151	461
39	50	0·646	234	365	48	0·327	151	461
40	50	0·660	239	365	48	0·327	151	461
41	50	0·674	244	365	48	0·327	151	461
42	50	0·688	249	365	48	0·327	151	461
43	50	0·702	254	365	48	0·327	151	461
44	50	0·716	259	365	48	0·327	151	461
45	50	0·730	264	365	48	0·327	151	461
46	50	0·744	269	365	48	0·327	151	461
47	50	0·758	274	365	48	0·327	151	461
48	50	0·772	279	365	48	0·327	151	461
49	50	0·786	284	365	48	0·327	151	461
50	50	0·800	289	365	48	0·327	151	461

The carbon of lamp No. I. broke during the 14th experiment, immediately after the measurement of the light was completed, while the carbon of lamp No. II. was ruptured by the application of 70 cells. A third lamp was ruined by the use of 60 cells, after having resisted 40 and 50.

The point of particular interest in the preceding table is the irregularity of the results, showing the effect of the blackening of the glass by volatilization of the carbon when too high electric power was applied. The durability of the lamps at any particular power must be tested by months' experience before the proper intensity for economy can be determined.

THE ENGINEERING AND MINING JOURNAL.
JULY 2, 1881.

PROGRESS IN SCIENCE AND THE ARTS.

Electric Lighting in Coal Mines.—On Thursday and Friday, June 9th and 10th, the Royal Commissioners upon Accidents in Mines witnessed some very interesting experiments on the application of electric lighting to coal mines. The plan selected for the experiment was the Pensby Colliery, near Hanwell. The pits are about 1800 feet deep, and the workings are very extensive; but in the present instance, the light was applied to three workings only, situated at a distance of about one third of a mile from the bottom of the pits. The Swan system was employed, the mines themselves were inclosed in lanterns of a very ingenious construction, which will be made by Messrs. R. E. Crompton & Co., which enabled the experiments to be carried about without fear of accident. The number of lamps used in all was ninety-four, which were worked by the current of an ordinary Gramme machine, driven by a portable engine placed near the top of the principal shaft. All the arrangements were carried out under the personal superintendence of Mr. Harold Thompson, of the firm of R. E. Crompton & Co. The commissioners, including Mr. Warrington Smyth, Professor Tyndall, Professor Abel, and others, spent two days in examining and testing in various ways the success of the experiment, and expressed themselves highly satisfied with the results obtained.

THE ENGINEERING AND MINING JOURNAL.
OCT. 8, 1881.

Portable Electric Light.—The Faure accumulator has been used in connection with a Swan incandescent electric lamp to produce a portable lamp of two candle-power, thus showing, theoretically, at least, the possibility of providing a light that will not cause explosion in coal mines similar to that of Edison, stated at the meeting of the British Association a few days since. The battery could keep the light going for six hours.

ENGLISH MECHANIC AND WORLD OF SCIENCE: No. 874.
DEC. 23, 1881.

Inventions of storage batteries for electricity are becoming rather common—there are several in France, Mr. Brush has one, Edison has one, and now we hear that Mr. Henry Sutton, of Ballarat, in Australia, has also devised an accumulator, which is reported to be superior to all the others.

THE ENGINEERING AND MINING JOURNAL.
JUNE 11, 1881.

Storing Electric Energy.—From a report of Sir Lyon Playfair's speech at the Institution of Civil Engineers, on the 31st, Sir William Thomson states that by measurement no appreciable loss was incurred in transmitting the last of stored electricity from Paris to Glasgow. He says: "The million 'foot-pounds' kept in the box during the seventy-two hours' journey from Paris to Glasgow was no exaggeration. One of the four cells, after being discharged, was recharged again by its laboratory battery, and was then left to itself absolutely unattended for ten days. After that, it yielded me 980,000 'foot-pounds,' or a little more than a quarter of a million. This not only confirms M. Planté's measurements, but it seems further to show that the waste of stored energy for time is not great, and that for days and weeks, at all events, it may not be of practical moment. I have already ascertained enough regarding its qualities to make it quite certain that it solves the problem of storing electric energy in a manner and on a scale useful for many important practical applications. It has already had in this country one interesting application of the smallest in respect to dynamical energy use, but not of the smallest in respect to beneficence, of all that may be expected of it. A few days ago, my colleague, Prof. George Buchanan, carried on a very heavy carry one of the leal cells, weighing about 18 pounds, in my carriage, and by it ignited the thick platinum wire of a galvanic cautery and bloodlessly removed a tumor from the tongue of a young boy in about a minute. The operation would have occupied over ten minutes if it had been effected by the ordinary knife, and screams, as it must have been had not the tongue of the boy been completely benumbed, the circumstances, the surgical dexterity with his accustomed use of voltaic battery to be set up beforehand, would not have been practically admissible. The largest useful application is waiting just now for the Faure battery, and I hope that a very nuisance thus will be allowed to pass until the battery supplied for this application is to do for electric light what a water cistern in a house does for an incomplete water supply. A little battery of seven dozen millions to give the incandescence in the Swan or Edison lights to the extent of one hundred candles for six hours without any perceptible diminution of brilliancy. Thus, instead of needing a steam-engine or steam-engine to be kept at work as long as the light is wanted, with the liability of the light falling at any moment through the slipping of the belt or any other breakdown or stoppage of the machinery, and instead of the wasteful inactivity during the hours of the day or night when the light is not needed, the engine may be kept going all day and stopped at night, or it may be kept going day and night, which undoubtedly will be the most economical plan when the electric light comes into general enough use. Another very important application of the accumulator is for the electric lighting of steamships. A dynamo-electric machine of very moderate magnitude and expense, driven by a belt from a drum on the main shaft, working through the twenty-four hours, will keep a Faure accumulator full, and thus, notwithstanding the irregularities of the speed of the engine alone, or the occasional stoppages, the supply of electricity will always be ready to feed the Swan or Edison lamps in the engine-rooms and cabins, or any lights for the mast-head, and red and green side lamps, with more completely safety regularity. I have not yet been achieved in the gas supply for any house on terra firma."

THE ENGINEERING AND MINING JOURNAL.
1881.

Oct. 8, 1881.

The Faure Battery and the Electric Light.—Mr. Keates, of the London Metropolitan Board of Works, has made some experiments recently in which the Faure accumulator was employed to feed electrically the electric light. Though they do not appear to have been intended for the value of the results, they are of some interest in other respects, and we reproduce the following account of them, given by the *Engineer*. The lamps used were those of Maxim and Swan, one of each kind being attached at a time. M. Faure states that his battery of 40 cells represent about half an available horse-power for three hours. The Maxim light being placed in connection with the accumulator, 39 cells were found to give the light of 16 candles. With the same number of cells, the Swan apparatus gave the light of 22·5 candles; with 35 cells, the lights became respectively 45·4 and 60·6 candles; and with 40 cells, the Maxim light rose to 101 and the Swan to 111 candles. Thus for the Swan light gave the greatest amount of candle-power. But with 45 cells the Maxim light rose to 228 candles, while the Swan only displayed 201. The capacity of the latter was evidently being overtaxed, for in about a minute the carbon loop broke. A power of 50 cells was then connected with the Maxim light, which then rose to 151 candles; but in about a minute the carbon loop shared the same fate as that of the Swan. The experiments are also interesting as showing the great increase of light by a comparatively small increment of power. Thus, in the case of the Maxim lamp, taking 39 cells as the standard, an increase of one sixth nearly trebled the light, an increase of two sixths augmented the light more than six times, three sixths increased it fourteen times, and four sixths twenty-one times.

The Times.
NEW BRUNSWICK, N. J.
THURSDAY, FEB. 16, 1882.

The Failure of Electric Lighting.

Some time since the Merrimack Woolen Mills placed sixteen 2,000 candle power electric lamps in its weave room, but after a thorough trial they have been removed for several reasons. It was found that they were twice as expensive as the gas manufactured and used on the premises, and though there was a sufficient volume of light it was too much diffused about the room, and could not be concentrated upon the looms in a satisfactory manner. The frequent flashing of the lights and the necessity of extinguishing all when any one was out of order was unsatisfactory, and moreover there was a possibility of the insurance company increasing their rates. The inflammable character of the dust arising from the work renders light of such intense heating capacity somewhat dangerous, and will do much to prevent their introduction in such places as the interior of a cotton or woolen manufactory. This action does not seem to be final, however, as it is added that a trial of the Edison lamp may be made some time in the future.—[Lowell (Mass.) Mail.

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT.
Jan. 10, 1882.]

The *York Herald* says: A correspondent writes that the electric light has failed at Newcastle-on-Tyne, at Edinburgh, at Dublin, at York, at Scarborough, and now at Leeds, and he asks what Leeds proposes to do. It is proposed to adopt the electric light in Coventry." Our correspondent remarks: "I save it. I have it would 'go to Coventry.'"

The Swan Electric Lights at the Savoy Theatre.—An esteemed correspondent informs us that the Savoy Theatre was lighted last Saturday week in the evening, when the electric lights in the auditorium were in use; but on the stage the proscenium, with four Bray lights, did the work. This arrangement, he has reason to believe, was in force except on the occasion of the much-hoped-for experiment the previous Saturday evening. On this night, too, notwithstanding all that has been said about the electric light always being ready for the audience at a moment's notice, the electric light failed, and "the electric light did not come well to the rescue when the last gas escaped, and the four Bray lights were kept going all the time."

With the failure in Liverpool—referred to in another column—before them, the members of the West Derby Local Board last week declined to appoint a Committee to collect information regarding the electric light. One member said that, the several systems of electric lighting that had been adopted by the Corporation of Liverpool had proved to be a complete failure, and therefore either the Committee or themselves, if it was proposed to attempt to light the West Derby district, a great part of which was green fields, with electricity. Another member said it would be far better for the Board to attend to work which was now neglected than waste their time on experiments. On being put to the vote, the proposal was lost by 7 votes to 5.

Hull and the Electric Light.—Yesterday week the Lighting Committee of the Hull Corporation met for the purpose of receiving tenders for the introduction of the electric light into Whitefriargate, the Market Place, the Pier, and the Town Hall. The tender of the Brush Company's amounted to £3000 for plant, and £966 6s. for working for twelve months; the subsidiary purchase being one of the conditions. Messrs. Siemens's tender—one, in which purchase was optional, was for £3228 for plant, and £750 for labor and coal, with £1000 for purchase outright, or £3978 for plant, and £750 for working. The first tender from Messrs. Siemens was, after some discussion, recommended to the Council for adoption.

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PRECAUTIONS TO OBVIATE THE DANGERS OF ELECTRIC LIGHTING.*

It is scarcely necessary to commend the following to our readers, as it is a subject in which we are all so interested that anything from such a source commands attention:

The committee, to whom was referred the question of "the dangers incident to electric lighting, if any, and the means of overcoming the same," specially report as follows, viz.:

That from a careful consideration of the evidence submitted they believe that the use of electricity as a means of illumination, when properly developed, is not attended with any danger to life, person or property, that cannot be reduced by the adoption of the precautions hereinafter set forth.

In order that the reasons which give rise to the necessity for these precautions may be more thoroughly understood by the general public, for whom they are designed, the committee believe that the following statements of the general principles involved in systems of electric lighting as now practiced, may not be amiss.

There are two systems of electric lighting now in general use, viz., the "incandescence system" and the "arc system."

In the "incandescence system" an electrical current, flowing through a thin wire of platinum, or other difficultly fusible metal, or through a thin filament of carbon, heats it by incandescence to nearly a white heat, by reason of the resistance it offers to the passage of the current.

In the "arc system" an electrical current flowing from one rod of hard carbon to another, heats the rods sufficiently to cause a stream of carbon vapor to pass between them. This vapor, heated to intense whiteness by the electricity, forms what is known technically as the "voltaic arc."

In the "incandescence system" it is necessary, in order to prevent the oxidation and destruction of the wire or carbon filament, to surround it completely by a glass globe or cover from which all the air has been removed. In this system, therefore, external oxygen cannot come in contact with the source of light.

In the "arc system" it is not necessary to exclude the atmosphere from contact with the carbons, or electrodes as they are sometimes called, as the light can, therefore, be viewed in the open air. They are generally much brighter than incandescent lights, and are, in practice, usually surrounded by a globe of glass, in order to lessen the intensity of the light of the glare. They can, however, be placed in a globe from which all the air has been removed, since the light produced is not dependent on the burning of the carbon electrodes—but is, on their combustion.

The source of the electricity employed in all systems of lighting is the dynamo-electric machine. This machine produces, more cheaply, a current of those properties are similar to the current obtained from the ordinary voltaic battery.

In the dynamo-electric machine, mechanical energy, derived from a steam engine, water wheel, or any other suitable source, is converted directly into electrical current. The change of mechanical into electrical energy is obtained by the motion, at most powerful magnets, of a number of coils of insulated wire wrapped on cores of iron. The combination is called the armature. The armature moves close to the poles of the magnets already referred to, but does not actually touch them. There is, therefore, no friction in the dynamo-electric machine, as in the ordinary electrical machine. The attraction of the magnet poles, as it tends to hold the armature in fixed positions. Mechanical power is required to move it out of such positions, and when so exerted is converted into electrical currents which flow through the coils of wire on the armature.

The current in the armature flows alternately in different directions through the wire wound thereupon. It is generally caused to flow continually in one and the same direction by means of a contrivance called the commutator.

The current so produced flows out of the machine, through a conducting wire, into and through a number of lamps placed at suitable points in the circuits of the wire, and finally through a continuation of the wire back to the machine.

The path of the current from the machine to the lamps, and out of the lamps back again to the machine, is known technically as an "electric circuit."

Any conductor is said to be placed in an electric

* Report of the committee of the Franklin Institute, &c., &c., on the recent investigations into the dangers that may arise from systems of electric lighting.

circuit, or to form part of an electric circuit, when it is so arranged that the current from the machine or battery causing the electricity can flow through it and back again to the place where the current was produced. That is, anything placed in an electric circuit forms part of the conducting path through which the current is circulating.

Dynamo electric machines are now made to furnish very powerful currents; currents capable of conducting fifty or more arc lights in one circuit or line. Such currents require care in their management, and judgment in the selection of the best buildings or public places for purposes of illumination.

Fortunately, however, the currents produced by dynamo-electric machines have some properties very different from those produced by the ordinary frictional machine. The former possess little or no power of leaping from one conductor to another across an intervening non-conducting body, for example, as air; the latter can, as is well known, readily so pass, often through several feet or more of dry air.

The current from dynamo-electric machines, or the currents employed in systems of electric lighting, are, we, therefore, at all comparable to streams of lightning, to which they have often been ignorantly likened. Lightning discharges frequently pass through miles of air, but, even in the largest machines, the arcs between the arc lamps must first be brought into contact and afterwards separated, before the arc is established and the current passes between them. The current will not, in fact, leap through the air. It may, however, contact of the two carbons develops sufficient heat to form a cloud of carbon vapor between them, and this cloud, being an electrical conductor, permits the current to pass.

When, however, the cloud of vapor is once established between the two carbons it will continue to pass it till the carbons are sufficiently divided to have the difference of potential due to their conducting powers.

Suppose, now, that two different portions of an electrical circuit be bridged over by any conductor of any material. Say, for example, that a wire from a line of telegraph or telephone falls across a line of electrical conducting wires, so as to connect the wire carrying the current from the machine with the ground, and the wire carrying the current back to the machine. If such electrical conducting wire be suddenly, or by a series of successive steps, would first be heated, and two different paths be opened to the current. Since the resistance to a power of the short wire, forming the cross circuit, would probably be much greater than that of a mile or more of fine wire with its included lamp, the greater part of the current than "cut off" or "short circuited" would pass through the cross wire, either fusing it, or burning through one or more of them when the contacts were at times but partial.

This danger may be entirely obviated by insulating the wire. It is therefore permissible to insulate all parts of the wires that lead either from or to the machines producing the current.

As these arcs are at times very hot, their occurrence should be carefully guarded against in all buildings or spaces to be lighted.

Dangers of this character may, however, be avoided by carefully insulating all the wires which carry the electrical current from the machine to the building or space to be lighted.

The comparatively feeble leaping power of the currents developed by dynamo-electric machines, as already referred to, does not, however, prevent there are very slight degrees of insulation for wires. Whatever the character of the insulation employed, care should be exercised to see that it is being preserved intact on all parts of the wire. The removal of the insulation from a few points of the wire might cause a dangerous discharge at such points.

When two different paths are open to the current, it will flow through both such paths in the same proportion of different conducting powers. more current will flow through the path set to the better conductor. If one of the paths be twice as good a conductor as the other, twice as much current will flow through it. If it be a hundred times a better conductor, a hundred times more current will flow through it; and so for any other proportion. In other words, the currents will be consumed to equal the distances between them to become too great to be bridged over by the vapor. While, therefore, the current will always divide or no power of a leaping through air, yet it is even-any that no opportunity be offered it to form such conducting clouds between it and neighboring conductors. A brief

OF THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT. Jan. 10, 1882.

NOTES.

THE WASTE OF POWER IN INCANDESCENT ELECTRIC LIGHTS.

There is considerable difficulty in the way of ascertaining, with any approach to exactness, the actual expenditure of power in the production of light from incandescent electric lamps. Laboratory tests are quoted by the agents of Messrs. Swan, Edison, Maxim, and Lane-Fox, to show that an illuminating power of at least 100 or 120 candles per horse power may be produced from these arrangements; while sometimes the useful effect is stated at a much higher figure. It is manifest, however, from such information on the subject as transpires occasionally with respect to the experiences of users of these lamps, that there is a disastrous discrepancy between their nominal laboratory duty and that which is practically available in actual working. At the Savoy Theatre, although the working details of the lighting of the stage and building with Swan lamps by Messrs. Siemens's machinery are not published, it is very improbable that an average illuminating power exceeding 30 or 35 candles per horse power is realized nightly by night. From an independent and very trustworthy authority in America—where greater wonders than here—was learnt that the best performance of the Maxim light is to maintain 8½ lamps, or about 12-candle power, per horse power. This result accords tolerably well with that estimated to be obtained at the Savoy Theatre, allowing for differences in the design of the lamps and fittings. Taking the resultant these two examples together, and averaging the illuminating power of the lamps in ordinary working to be at least 40 candles per horse power expended, the following observations will be found to apply:— Every horse power developed in an ordinary portable steam-engine or horizontal steam-engine of the usual design, requires at least 6 lbs. of coal an hour, besides water and other materials. In the average working of the London Gas Companies this weight of coal would represent about 27 cubic feet of gas delivered to the consumers' burners, and developing a normal illuminating power of 27×2 candles. Besides affording this superior amount of light, the gas companies would remain the richer by a definite quantity of coke, tar, and other residuals, which the electricians buy up with the gas in their steam-boiler. The gas companies probably pay less for their coal in the first place than the electric lighting estimates; and yet, although the incandescent system of lighting by electricity renders less light per unit of power expended, wastes all the residuals of coal carbonization, is more uncertain than gas lighting, and can only be modified in intensity by the introduction of another source of loss, it is fashionable to call this particular method of lighting more *scientific* than the use of gas!

THE ENGINEERING AND MINING JOURNAL. March 19, 1881.

Electricity in the Wrong Place.—*The Albany Journal* records an incident that exhibits the good servants in the character of a bad master. In one corner of Wood, Parsons & Co.'s printing establishment stands the machine that furnishes the electric light for an adjacent store, the power coming from the engine of Wood, Parsons & Co. The wire from the machine in the armature, a wheel containing coils of insulated wire through which the electricity flows in powerful currents when the apparatus is in operation. This armature revolves with terrific velocity, and constitutes a powerful motor for the use of machinery. Yesterday, a young man came in and ground a pair of large scissors at an emory wheel near the generator. Turning to get out the machine, he carried the scissors carelessly in his hand, when they were immediately drawn into the armature, and were soon revolving with it at frightful speed. The young man got out of the way as quickly as possible and was unhurt. For a few minutes, the machine presented a very startling spectacle. The whirling scissors, twisted and broken, but still adhering to the revolving armature, began to cut the wires, and then broke the electric current, which escaped in streams from the fractured ends of the wires, and in a moment each of the portions of the wires was literally rolled to the ceiling with vivid lightning. No one dared to approach the machine for some little time, but the belt was finally thrown off, and the dangerous show was at an end.

Perils

THE ENGINEERING AND MINING JOURNAL. (Oct. 8, 1881.)

The application of electricity for many practical purposes has grown so rapidly within the last few years, and the success in some fields has been so startling and has suggested such possibilities, that the general public takes an eager interest in all that relates to it, and many busy and ingenious inventors and engineers are working in its various specialties Appealing as they frequently do to the senses for aid, they have often allowed themselves, or others for them, to speak in a sensational style that has done much injury to the cause of real progress, and it is with much satisfaction that we note a tendency in a better and safer direction. Calm examination and the presentation of specific data are commencing to supersede the glowing generalities which often sounded very nearly like passages from one of JULES VERNE'S works. The public has learned that a very meritorious invention may be unsuccessfully handled by speculators, and the early enthusiasm has given way to a desire to obtain more and better information on such matters. The Electrical Exhibition now being held at Paris is contributing much toward that end, and it gives evidence, too, of the efforts making to apply electricity to various departments of mining and metallurgy. At the present early stage of progress, many points are not thoroughly under, stood, and there is noticeable the absence of co-operation between the electrician and the engineer; and before the one has fully appreciated the requirements of the other, and has command of the means at his disposal, errors will be made, and the new inventions will not have assumed a practical shape. We hear of electrical hammers, rock-drills, elevators, tramways, and processes, and it is likely that they will in the near future obtain and receive much attention. While there is much that gives promise of ultimate success, and developments ought to be closely watched, it should not be forgotten that all these appliances will have to go through a period in which means are adapted to the ends. As probably capable of adding valuable methods to those now in use for the utilization of our mineral wealth, engineers will welcome the electrician, but they should move forward with the caution that vast experience has shown them to be necessary.

THE SANITARY ENGINEER.

[DECEMBER 29, 1881.]

ELECTRIC LIGHT NOTES.

St. Paul and Minneapolis, Minn., are to have the electric light.

The Chief Engineer of the Springfield (Mass) Fire Department advocates the passage of an ordinance forbidding the running of telegraph wires over those of the fire-alarm line.

It is reported that an Electric Light and Power Co. is to be formed in Bristol, Eng., for the purpose of utilizing the tidal force of the Avon in the production of electricity.

The London Commissioners of Sewers have granted Mr. Edison permission to light Holborn-viaduct with his incandescent electric lamps. The work is to be done at his own expense.

The Edison incandescent lamps have been introduced at the Baldwin Locomotive Works, in Philadelphia; and the Brush Company are preparing to light the Market street depot of the Pennsylvania Railroad Company in the same city.

The corporation of Hull, Eng., have decided to ask the Siemens and the Brush Electric Light Companies, for estimates for lighting the town for twelve months. A proposition to experiment on a small area met with decided objection.

It is stated that in lighting two streets of Albany, forty-eight gas lamps have been replaced by twenty electric lights. The yearly cost of maintaining this number of gas lamps is $1,580, while the yearly electric lamps are to cost $6,320. Not much economy in that.

A correspondent of the *Gas Engineer* states that electric

lighting in Dublin meets with considerable opposition from certain members of the corporation who are shareholders in the Alliance and Consumer's Gas Co. The law agent of the corporation has been instructed to ascertain the legality of the participation in discussing on public lighting by municipal business interests are concerned.

The carbons which Mr. Edison uses in his incandescent lamps require for their production a temperature which softens iron. In order to effect the carbonisation the filaments are placed in small boxes made of nickel. Each box accommodates one filament, which on account of the shrinkage cannot be fastened down, but is held loosely in place by nickel weights.

A California inventor has devised a plan by which it is claimed that every railroad train while in motion can have its own telegraph office. His idea is to stretch two wires parallel with the track, and extending from one end of the road to the other. The wires are over the moving train and are connected with it by sheet wires and wheels, by which connection with either end of the line is established.

The Brush Electric Light Co. have asked permission of the Philadelphia Councils to lay electric wires anywhere in the city. The Company agree to the granting of any such right, and adds that Chestnut street is already displayed by telegraph poles and wires. It would grant the permission only upon condition that the poles on Chestnut street be removed, and that in future all wires be in underground tubes.

Engineering states that forty Jablochkoff electric lamps which have been in use in one establishment for three years are in as good condition now as when first started. The same applies to the machines employed to furnish the current. Other establishments are mentioned in which these lamps have been employed for one and two years, and have given very general satisfaction. The Thames embankment has been lighted by this system, with occasional interruptions, since Dec., 1878.

THE METROPOLITAN.
DECEMBER 10, 1881.
Gas, Water, and Electricity.

Gas Companies and Electric Lighting.—As we fully expected, gas companies are very far indeed from being united as to the best course to adopt in relation to the subject of electric lighting in the ensuing Session of Parliament. The numerous notices of Bills, to which we alluded last week, show that in a variety of ways the question will force itself upon the attention of the Legislature, and certain Bills in which whose offices are situated not a hundred miles from the Houses of Parliament itself, have issued a letter, addressed to gas companies generally, counselling, apparently, an alliance offensive and defensive. But there would appear to be a very considerable difference of opinion as to what should be the basis of any such common action. On the one hand, it is contended—and this would seem to be the view of the supposed authorities in regard to legislation affecting gas interests—that electric lighting is altogether too much in its infancy, and too costly and unreliable a luxury, to justify gas companies in seeking powers to supply it, but that at the same time they should in no way be parties to the granting of such powers to independent companies. Many of our readers will doubtless be able to place their own interpretation upon advice of this character, especially when direct and active opposition to the applications of electric lighting companies is more than suppressed. On the other hand, we find that not unfrequently the electric light as a practical and useful agent for illumination not considered accessible to commercial means of a number of gas companies have announced their intention of applying to Parliament themselves for permission to undertake its supply to residents within their respective districts. One cause for consolation in the matter is that if these two very different lines of policy are really understood

in the committee rooms of the House of Commons, the result may possibly be more to the advantage of the public than would otherwise be the case. To paraphrase a well-known adage, when gas companies fall out the consumers may get their dues.

Electric Lighting at the Mansion House.—The preparations for the lighting of the Mansion House by means of the Crompton electric light, are making satisfactory progress, although the alterations and repairs consequent on the change of ownership now being carried out, do not render it necessary that the installation should be completed with that speed which, under other circumstances, might have been desired. The machinery now being placed in position in the basement of the building consist of a 16-h.p. gas engine, which is guaranteed to give off 20 h.p. effective, with a short length of shafting on which are keyed four pulleys driving four of Crompton's Bungin Dynamo-electric machines. The conducting cables from the dynamo machines are led up as follows—two pairs to the saloon, and three pairs to the roof of the Egyptian Hall. From the centre of the Egyptian Hall will be suspended by a new arrangement of hanging gear four arc lamps (possibly six), of a similar pattern to the large lamps suspended over Messrs. Crompton's stand at the Paris Exhibition. The lamps, fittings, counterweights, and suspending chains, will be of a very handsome pattern, the City arms being worked into the design. In each side aisle behind the pillars will be suspended two incandescent lights; and in the saloon will be suspended two incandescent lights; and in the saloon whole of the decorative brass work has been specially designed for this installation. The work is well in hand, and the contractors hope to be lighting experimentally in the course of a week or two.

THE SANITARY ENGINEER.

[DECEMBER 29, 1881.]

ELECTRIC LIGHT BILLS IN PARLIAMENT.

It is interesting to note that a large number of bills have been introduced in Parliament for securing power to employ electricity in illumination. These bills are presented not only by electric light companies, but also by corporations and gas companies. Seven electric light companies have applied for power to break up the streets and to erect or lay wires, and prominent among the systems represented we notice the Brush, Edison and Siemens. No less than fifteen corporations and eight gas companies have applied for like powers, although in the latter we do not find any of the London companies. In Liverpool, Manchester and Glasgow the gas undertakings are in the hands of the corporations and in each case power to introduce the electric light has been asked for. It seems probable that a very thorough investigation of the subject will be made before these bills are reported. Mr. W. Livesay, in a letter to the *Journal of Gas Lighting*, questions the wisdom of gas companies in seeking these powers at the present time—a course which imperils other and less objectionable features of the bills. The companies who are not seeking electric light powers represent a capital several hundred times larger than those who are seeking them; and it is not to be expected that the larger companies "will abstain from taking such proceeding as they think necessary for their own security, even to the extent of opposing the applications of other companies, if it is found expedient to do so."

The English Mechanic
AND
WORLD OF SCIENCE AND ART.

FRIDAY, DECEMBER 9, 1881.

DU MONCEL ON INCANDESCENT ELECTRIC LIGHTING.

THE fact that the Electric Lighting Company of which M. Edison is the soul are about to instal their system on the Holborn Viaduct, is an item of news which demands more than passing notice. Count du Moncel, the distinguished French electrician and supporting critic of the Anglo-American mouth which, from time to time, have been made in the United States with regard to Edison's inventions, having had an opportunity of studying the system, at the Paris Electrical Exhibition, has pronounced it complete in all particulars, and worthy of trial on an extensive scale. He does not, as might be expected, endorse all the visionary ideas of the newspaper reporters; but he thinks that sufficient has been done to establish electric lighting on the inexhaustible basis of a system, leaving its perfectibility to be decided by the results of a practical trial that we are about to have on a tolerably large scale before the present month runs its course, for, in addition to the public lamps on the Holborn Viaduct, which the company have agreed to supply gratis for two months, no fewer than 150 incandescent lights are to be fitted up in the City Temple, while the Hotel at the Holborn Viaduct Station is also to be illuminated, at least, in part, by means of electricity. Many of the shops, showrooms, and offices on the Viaduct will, doubtless, be illuminated by the Edison light, as there are special facilities for "laying on" the current, and the site is admirably adapted to the purpose of the inventor of the scheme. As we have already mentioned, a section of New York has been handed over to the Edison Company, and the works will shortly be completed in Paris. The work of putting down the conductors is being done in a thorough and substantial manner, showing that the company, at least, is sanguine as to the permanence of their plant, and their action in the City of London shows that they are confident of success in the future. In New York the conductors are of half-round section approximately, and preferably imbedded in iron pipes by means of bituminous material, the connections at the corners of streets being made by junction pieces and sockets, or we may term them, which are accessible from the pavement for the purposes of testing, &c. To give some idea of the magnitude of the experiment on the Holborn Viaduct, it may mention that the central station will have twelve large dynamo-machines, requiring 2,200 horse-power to drive them, and we believe it is intended to employ a number of for small machines, requiring motive power, as well as for electric lighting. Probably before details of the New York experiment reach us we shall be able to form an opinion of the future of incandescent lighting from the trial to be made on the Holborn Viaduct, which, if no unforeseen hitch occurs, will be experienced on the 12th inst. Of the systems of incandescent lighting, those of Swan and Edison are best known; but, according to Du Moncel, there are about fifteen different inventions of the kind besides those just mentioned and the systems of Lane-Fox, Maxim, and Sawyer, all of which seem equally as well adapted to the purpose as those which have been brought prominently before the public. The earlier experiments in incandescent lighting were made with platinum wire, or alloys of platinum; but owing to the disintegration and consequent loss of the metal —in spite of the improvements introduced by Edison—the use of metal had to be rejected absolutely, at least for ordinary purposes. The use of threads of carbon had been suggested for some time—a natural development to a mind accustomed to the carbon rods of the ordinary electric lamp—and efforts had been made to utilise them by inclosing them in exhausted globes or in globes filled with an inert gas, or a gas capable to a certain extent of resuscitating the waste of carbon. In 1859 Du Moncel, the distinguished French electrician and supporting critic of the Anglo-American mouth which, from time to time, have been made in the United States with regard to Edison's inventions, having had an opportunity of studying the system, at the Paris Electrical Exhibition, has pronounced it complete in all particulars, and worthy of trial on an extensive scale. 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The fate of the so-called "horseshoe" we all know, and we also appreciate the difficulties which attended the failure, caused by one or a dozen failures, steadily pursued his course until success crowned his object. Du Moncel, as he acknowledges, doubted the exactness of the allegations which reached him from America concerning the inexpensive carbon; but, since he has seen the lamps at the Exhibition, he has nothing but praise for them. Of the many inventions for preparing the carbon-threads we have seen, all particulars from time to time; but practical experience alone can show which method yields the best results, instead of carbonised paper, or parchment paper. Edison uses new fibres of bamboo, little larger than a horse-hair, which are bent up in a variety of forms in a state of incandescence. The difficulties attending the expansion of the platinum conducting-wires have been overcome, and though the duration of the lamps, as Du Moncel remarks, has been assured, "long enough," he is careful to add, "to satisfy practical requirements." Some of Edison's, it is said, have served for 1,200 hours, and, being note-worthy, that new lamps are supplied at, according to Du Moncel, 15s., and when they get "out," is not the cost to the public. Great, however, the lamp-lives and results from Count du Moncel his high appreciation of the Edison system of electric lighting; but the completeness of the installation from the motor through the current-generating machine to the lamp itself, every detail being carefully studied, as we have before remarked, nothing remains to be desired in practice," such an expression is, of course, an much above the mark as some of Count du Moncel's statements are below it. Therefore, in the matters of generator, distribution of current, insulation, and regulation of intensity, Edison's methods are, of course, absolutely the most perfect that the present state of knowledge will permit; and although we are not altogether so super-confident that "nothing remains to be desired," as to the practicability of the apparatus is arranged on the Siemens principle, bare of copper being employed instead of wire. These bars lie close to each other around the cylinder which forms the armature, and they are secured to discs of copper in such a way that they form a single circuit. The centre of the cylinder outside the axis is made of wood, which is surrounded by a thick tube built up of very thin discs of iron, separated by pieces of tissue-paper. These thin discs are held together by thick clamping discs, and outside at each end are the copper discs to which the copper bars are secured. This arrangement is said to facilitate the rapid changes of which is characteristic of the real inventor; that is to say, each part is complete and appropriate to its purpose, but is not adopted as final or the best that could possibly be devised, for, in that respect, Mr. Edison is far wiser than his gaslight and former critic. He, at least, has had experience enough to know that nothing is final or altogether perfect. The lamps and the lamp supports have been carefully designed for simplicity and effectiveness. The glass envelopes are cemented into copper sleeves which form the supports, and the latter are provided with joints or articulations, in which communications are made by two plates of the hinges, which are insulated from each other in such a manner that the circuit can be broken without causing anything worse than the slightest spark. Connections of conductors with the lamps are made by pieces of lead wire, which will melt and interrupt the circuit if the current should become of such intensity as to endanger the lamps. According to Du Moncel, Edison's system of electric lighting is as perfect as that now used by gas, It can be laid on to any house, and is controlled and regulated by the simplest turning of two cocks like system thoroughly complete, Mr. Edison has constructed portable candelabras and a portable regulator, which permits of the light being increased or decreased at pleasure. This regulator is, in reality, a rheostat, made up of rounds of carbon of different sizes, and the current, being made to pass through one or the other, its intensity can be regulated within the limits possible to the carbon rounds. The apparatus is simplicity itself, a cylindrical cover perforated with holes, and an ornamental screw-top, being added, to allow the escape of heat, and it is regulated by turning a disc at the bottom which brings a spring into contact with any one of the rods of carbon, or rather into contact with the metal blocks in which they are mounted. Edison has also invented what he terms "meter" to measure the quantity of current consumed, though any lengthy description of which is identical in principle with the meter patented by Mr. J. T. Sprague; but Edison has also devised another method, and it remains to see which will prove the best in practical work. It is obvious that if electric light is to be laid on as gas is now, some method of measuring the quantity used must be employed, and, generally, Dr. Hopkinson and Mr. Edison have satisfactorily solved that part of the problem. The former has found that a combination of arc and incandescent lights is not to be recommended, for the former destroy the effect of the latter, which gives an agreeable light free from the "glaring" fire, as it has been called, of the arc. The light given by the incandescent lamps is really whiter than that of gas-burners, and it can be made as dazzling as that of the arc, but that is not the object of Mr. Edison, or of his rivals, Messrs. Swan, Lane-Fox, and Maxim. It may interest some to know that in the dynamo, which is worked by a steam-engine on the same bed-plate, the

lighting in Dublin meets with considerable opposition from certain members of the corporation who are shareholders in the Alliance and Consumer's Gas Co. The law agent of the corporation has been instructed to ascertain the legality of the participation in discussing on public lighting by members whose business interests are concerned.

The carbons which Mr. Edison uses in his incandescent lamps require for their production a temperature which softens iron. In order to effect the carbonization the filaments are placed in small boxes made of nickel. Each box accommodates one filament, which on account of the shrinkage cannot be fastened down, but is held loosely in place by nickel weights.

A California inventor has devised a plan by which it is claimed that every railroad train while in motion can have its own telegraph office. His idea is to stretch two wires parallel with the track, and extending from one end of the road to the other. The wires are over the meeting train and are connected with it by short wires and wheels, by which connection with either end of the line is established.

The Brush Electric Light Co. have asked permission of the Philadelphia Councils to lay electric wires anywhere in the city. The *Telegraph* objects to the granting of any such right, and adds that Chestnut street is already disfigured by telegraph poles and wires. It would grant the permission only upon condition that the poles on Chestnut street be removed, and that in future all wires be in underground tubes.

Engineering states that forty Jablochkoff electric lamps which have been in use in one establishment for three years are in as good condition now as when first started. The same applies to the machines employed to furnish the current. Other establishments are mentioned in which these lamps have been employed for one and two years, and have given very general satisfaction. The Thames embankment, which has been lighted by this system, with occasional interruptions, since Dec., 1878.

THE METROPOLITAN.
DECEMBER 10, 1881.
Gas, Water, and Electricity.

Gas Companies and Electric Lighting.—As we fully expected, gas companies are very far indeed from being united as to the best course to adopt in relation to the subject of electric lighting in the ensuing Session of Parliament. The numerous notices of Bills to which we alluded last week, show that a variety of ways the question will force itself upon the attention of the Legislature, and certain from the House of Commons itself, have issued a letter, addressed to the gas companies generally, counselling, apparently, an alliance offensive and defensive. But there would appear to be a very considerable difference of opinion as to what should be the basis of any such common action. On the one hand, it is contended—and this would seem to be the view of the supposed authorities in regard to legislation affecting gas interests—that electric lighting is altogether too much in its infancy, and too costly and unreliable a luxury, to justify gas companies in seeking powers to supply it, but that at the same time they should in no way be parties to the granting of such powers to independent companies. Many of our readers will doubtless be able to place their own interpretation upon advice of this character, tions of electric lighting companies is more than suggested. On the other hand, we find that not only is the future of the electric light as a practical and economical means of illumination not considered exceedingly unpromising, but a number of gas companies have announced their intention of applying to Parliament themselves for permission to undertake its supply to residents within their respective districts. One cause for consolation in the matter is that if these two very different lines of policy are *ante* mortem

in the committee rooms of the House of Commons, the result may possibly be more to the advantage of the public than would otherwise be the case. To paraphrase a well-known adage, when gas companies fall out the consumers may get their due.

Electric Lighting at the Mansion House.—The preparations for the lighting of the Mansion House by means of the Crompton electric light, are making satisfactory progress, although the alterations and repairs consequent on the change of mayoralty now being carried out, do not render it necessary that the installation should be completed with that speed which, under other circumstances, might have been desired. The machinery now being placed in position in the basement of the building consist of 2 16-h.p. gas engine, which is guaranteed to give off 20 h.p. effective, with a short length of shafting on which are keyed four pulleys driving four of Crompton's Burgin Dynamo-electric machines. The connecting cables from the dynamos machines are led up as follows—two pairs to the saloon, and three pairs to the roof of the Egyptian Hall. From the centre of the Egyptian Hall will be suspended by a new arrangement of hoisting gear four arc lamps (possibly six), of a similar pattern to the large lamps suspended over Messrs. Crompton's stand at the Paris Exhibition. The lamps, fittings, counterweights, and suspending chains, will be of a very handsome pattern, the City arms being worked into the design. In each side aisle behind the pillars will be seven chandeliers, carrying a total of 32 incandescent lights; and in the saloon there will be four chandeliers also carrying 32 lights. The signed for this installation. The work is well in hand, and the contractors hope to be lighting experimentally in the course of a week or two.

THE SANITARY ENGINEER.
[DECEMBER 29, 1881.]
ELECTRIC LIGHT BILLS IN PARLIAMENT.

It is interesting to note that a large number of bills have been introduced in Parliament for securing power to employ electricity in illumination. These bills are presented not only by electric light companies, but also by corporations and gas companies. Seven electric light companies have applied for power to break up the streets and to erect overhead wires, and prominent among the opposers represented we notice the Brush, Edison and Siemens. No less than fifteen corporations and eight gas companies have applied for like powers, although in the latter we do not find any of the London companies. In Liverpool, Manchester and Glasgow the local undertakings are in the hands of their corporations and in each case power to introduce the electric light has been asked for. It seems probable that a very thorough investigation of the subject will be made before these bills are reported. Mr. W. Livesey, in a letter to the *Journal of Gas Lighting*, questions the wisdom of gas companies in seeking these powers at the present time—a course which imperils other and less objectionable features of the bills. The companies who are not seeking electric light powers represent a capital several hundred times larger than those who are seeking them; and it is not to be expected that the larger companies "will abstain from taking such proceeding as they think necessary for their own security, even to the extent of opposing the applications of other companies, if it is found expedient to do so."

The English Mechan
AND
WORLD OF SCIENCE AND AR
FRIDAY, DECEMBER 9, 1881.

DU MONCEL ON INCANDESC
ELECTRIC LIGHTING.

THE fact that the Electric Lighting
ject of which Mr. Edison is the
ure about to instal their system on the
born Viaduct, is an item of news
thousands more than passing notice.
du Moncel, the distinguished French el
cian and unsparing critic of the inno
ments which, from time to time, have
made in the United States with reg
Edison's inventions, having had an o
tunity of studying the system, at the
Electrical Exhibition, has pronounce
complete in all particulars, and worth
trial on an extensive scale. He does no
might be expected, endorse all the visio
blest of the newspaper reporters; in
thinks that sufficient has been done
establish electric lighting on the incan
cent plan as a system, leaving its pern
ence to be decided by the results
practical trial that we are about to have
a tolerably large scale before the pre
month runs its course, for, in addition to
public lamps on the Holborn Viaduct, wi
the company have agreed to supply gr
for two months, no fewer than 750 inc
descent lights are to be fitted up in the
Temple, while the Hotel at the Holb
Viaduct Station is also to be illuminat
at least, in part, by means of electric
Many of the shops, showrooms, and off
on the Viaduct will, doubtless, be illum
nated by the Edison lights, as there
special facilities for "laying on" the
rent, and the site is admirably adapte
the purposes of the promoters of the sche
As we have already mentioned, a scien
New York has been handed over to
Edison Company, and the works will be
be completed, when no fewer than 1
lamps will be supplied with current fr
central station, the area over which the
pectant is to be tried being a little
of three-quarters of a mile. The wor
putting down the conductors is being
in a thorough and substantial manne
showing that the company, at leas
sanguine as to the permanence of t
plant, and their action in the
of London shows that they are confi
of success in the future. In New York
conductors are of half-round section
proximately, and uniformly imbedded in
pipes by means of insulating material,
connections at the corners of streets be
made by junction pieces and bridges, a
may form them, which are accessible from
pavement at the entrance of each house.
To give some idea of the magnitude of
experiment in New York, it is sufficie
mention that the central station will h
twelve large dynamo-machines, requir
2,200 horse-power to drive them, and
believe it is intended to supply "current
for small machines, requiring motive po
as well as for electric lighting. Prof
before details of the New York experi
reach us we shall be able to form an opi
of the future of incandescent lighting
the trial to be made on the Holborn Via
which, if no unforeseen hitchcocures, will
commence on the 15th inst. Of the system
incandescent lighting, Howard Swan and Hi
son are best known; but, according to D
Moncel, there are about fifteen different inve

speed is about 550 revolutions per
minute. Dr. Mossel naively says, that "this
is not a very great speed, but the armature
is very heavy, weighing over three hundred
a half." The advantage of driving the
armature direct from the engine is very ap
parent when an ordinary reciprocating
piston is employed, but in the case of a
three-cylinder or a rotary engine steady
running is not difficult, however, especially when
the sensible power is in excess of the
requirement. From what has been said, then,
it will be understood that the Edison system
is, according to the opinion of Count du
Moncel, calculated to do the work of electric
lighting in private houses; and the experi
ment about to be made in London will no
doubt be watched with interest, for, if it
succeeds, it will not be long before the shops
and warehouses in the City will be illuminated
by electricity.

THE MAGNETIC STORM OF LAST
AUGUST.

A PERIOD of long interval of comparative
rest, followed by a short
epoch of sunspots and auroræ, the introduc
tion of the present period of decrease of sun
phenomena was accompanied by a notable
disturbance of the magnetic elements on 11-
14 August last. Instruments seem to have
been simultaneously affected on different
parts of the globe widely apart, and the oc
casion has been taken by Herr Wild, of
the Pawlowsk Observatory, near St. Peters
burg, to compare the records (curves,
magnetographica, &c.) at that place with
those at Kew, at Zikawei in China, and at
Melbourne.

On the days referred to three were three
distinct disturbances of the magnetic decli
nation (three second-and-third tenths declining);
and it appears that the beginnings and
ends of them, especially the beginnings,
were simultaneous at all four places. With
regard to the individual waves of each dis
turbance, those in Zikawei and Melbourne
are quite different from those in the two
other places (where the waves are pretty
similar). In the case of the first two disturb
ances, one finds (as normally) a decrease of
the amount of variation in the direction of
lower latitudes; but it is the reverse with
the third.

In the curves of horizontal and vertical
intensity, the same three disturbances are
distinguished, and the beginnings and ends
correspond accurately with those of declina
tion. Generally, Herr Wild remarks,
of disturbance of a mile. We may
it would appear that, if he not a single
force that causes these disturbances of all
three elements of magnetism, they must be
due to forces that simultaneously begin to
act and disappear.

Analyzing the phenomena further, and
comparing the components of intensity, the
author finds certain marked differences be
tween the places; but into these we will not
here follow him in detail. Two facts ap
pear from a comparison of the curves of
normal (August) values, and of the disturbed
values for Pawlowsk and Kew. (1) While
the disappearance of declination at Pawlowsk
and Kew reach nearly the same amount,
those of intensity at Pawlowsk are double
those at Kew, and those of the whole in
tensity nearly five times as great. (2) On
all three days the amount of disturbance of
the three elements, and especially intensity,
presented no sign which essentially agreed
with the normal daily variation of those ele
ments.

These facts (says the author), partly now
on account of their precision, seem to throw
new light on the extraordinary nature
of the disturbing forces. From the second
fact, especially, we may infer that these
forces are to be conceived merely as eastern,
and everywhere simultaneous intensifications
of the forces which produce theuormal vari-

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT. [Dec. 13, 1881.

GAS *VERSUS* ELECTRIC LIGHT AT BARNSLEY.

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THE ENGINEERING AND MINING JOURNAL. DEC. 31, 1881.

Electricity in the Manufacture of Porcelain.—Dynamo-electric machines are used in France in porcelain manufacture. The paste used for porcelain often contains ferruginous particles, which give the baked articles a color or a spotted appearance, which is rare while ivory have been desired. In this way, certain articles may lose as much as fifty per cent of their value. The attempts hitherto made to remove these traces of iron with magnets have met with poor success. Recently, however, at two important French works, the Faience-works of Creil, and the establishment of MM. Filleuzy & Co., of Menlum-sur-Yeres, it was decided to set up powerful apparatus in which the electricity, instead of being supplied from batteries, was obtained by means of a small Gramme machine driven by a steam-engine. The arrangement, which is said to work well, comprises a strong horizontal electro-magnet, with the poles very near each other, and between them a thin belt. The paste, very liquid, enters the upper part of this box, and is deflected toward the polar sides by a hard piece of fiber. As it flows down these sides, the iron corpuscles are caught on them by the magnetic force. The apparatus is cleaned twice a day by means of a jet of water, the magnet being demagnetized for the time. About one gram of iron particles is stopped in the passage of twelve kilos of paste, and from 500 to 600 kilos of paste may be passed through one apparatus in a day.

THE ENGINEERING AND MINING JOURNAL. [NOV. 5, 1881.

Those who have watched the developments of the electric lights in this city during the past year can not fail to have noted what great progress has been made in their steadiness and in the economy in providing lights of medium power. In industrial establishments, the use of arc lamps is becoming more general, and it appears to us that the time has come when mine and mill managers ought to give this subject careful attention. We do not look to any extended use of such powerful lights in underground excavations, but we would urge the expediency of employing them in shaft-houses and mills, where work is done day and night, and where good illumination is so essential to good work. As a rule, the power in such establishments is so irregularly taxed that it would not be expedient to run the dynamo-electric machines from the main engines; but usually there is steam enough to supply a small auxiliary motor, which could furnish what is so much wanted, steady power. Where wood is cheap in the West, but freights high, the economy of electric lighting would be apparent, while elsewhere the advantages of good illumination, though indirect only, would, we believe, fully counterbalance increased cost.

American Gas Light Journal. Feb. 21, 1882.

Dangers of Electricity.

The *New York Evening Post*, of January 25th, contains an account of the new rules adopted by the Board of Fire Underwriters governing electric wires. The capacity of conducting wires was considered, and for arc lights it was stipulated that the conductor must have a weight per running foot at least equal to that of No. 6 wire (or parallel group of wires) constituting the main circuit of the magnetic regulator of the electric lamps, or of the remainder of the machine employed, whichever of these is the largest.

For incandescent lights the conducting wires must be large enough never to grow unpleasantly warm to the touch. In no case must electric wires be connected with the earth, or with gas or water pipes running to the earth.

Exposed wires must be covered with two coatings, and where there is exposure to water one of these coatings must be waterproof. At the point where electric wires enter a building a switch or "cut-out" must be provided, so that in case of fire there will be no danger to the firemen. The outgoing and returning wires for arc lights should enter and leave a building at points at least one foot from each other.

In running along walls or ceilings the wires of an arc lamp should not be nearer than eight inches from each other; for incandescent lights two and a half inches' distance is sufficient. Wherever wires are carried through walls, floors or partitions in buildings, they must be surrounded by a special insulating tube of substantial material. Arc lights must be protected by glass globes, enclosed at the bottom to prevent the fall of ignited particles, and where inflammable materials are present below the lamps, a wire netting must be added to keep the parts of the globe in place in case of its

mixture during use. Wherever a current of such high electro-motive force is employed that, if consentient on one lamp of the series, it would produce no arc capable of destroying or fusing parts of such lamp, an automatic switch must be introduced in each lamp by which it will be thrown out of circuit before the current approaches any dangerous intensity.

The Spectra of Sunlight, Gas, and Electric Light.

Some weeks since a question was put by a correspondent in *Nature*, with the obvious intention of obtaining confirmation of a statement that the spectrum of the electric light was similar to that of sunlight; the teaching of which correlation would be that, for optical purposes, the electric light was equally good with that of the sun.

In a later number of our contemporary, however, the characteristics of the spectra of sunlight, electric light, and gas flames are explained by Mr. J. Read Capron, but not precisely in the way desired by the querist. While admitting that the relative effect of the "same golden glow, the gas flame's duller yellow light, and the electric light's moon-like whiteness," on the optic nerve, have not been scientifically determined, Mr. Capron recognizes the fact that peculiar opinion assigns injurious results to the whiter light. He also states that the illuminating position of a gas flame presents in the spectroscope the appearance of a dull sun spectrum, with all the dark lines. This is equivalent to placing the illuminating gas flame in closer approximation to the sun's light, for optical purposes, than it is possible to claim for the electric arc light.

It is evident that the spectroscopic examination of high power gas flames should now be undertaken with a view to determining the differences which such flames present when compared with the flame of the ordinary small burner.—*Journal of Gas Lighting.*

THE OFFICIAL ON GAS LIGHTING WATER SUPPLY, & SANITARY IMPROVEMENT. [Dec. 27, 1881.

ELECTRIC LIGHTING FAILURES.

Some few weeks since it was announced, with the usual amount of clamour, that the smoking-room of the Junior Carlton Club was to be the scene forth lighted by incandescent electric lamps, to be maintained by relays of Faure accumulators. The attempt to make use of this particular method of lighting was, of course, simply an experiment; but, in the common manner of electric lighting contractors, the commencement of the trial was advertised as the consummation of success which, in reality, remained to be proved. It has now transpired that after a prolonged experiment the electric light has been removed from this particular club-room, and gas has been reinstated. This collapse of the undertaking that was inaugurated in such a very notorious fashion has naturally been allowed to pass unnoticed by the friends of the new order of lighting, and the announcements that were made of the satisfactory success—which did not succeed after all—may still be going the round of the Press, and cropping up in various speeches and newspaper correspondence.

Some attempts have been made to light by electricity the immense buildings of the General Post Office, St. Martin's-le-Grand. The experiments have been conducted by Mr. W. H. Preece, but although several well-advertised systems have been tried under his experienced supervision, the matter is at this moment in a state of suspense because of repeated failures. We are not at liberty to assume that the attempt will be finally abandoned until every known system and arrangement of electric lighting has had a fair trial at the hands of Mr. Preece, who can have no other interest in the matter than that of discovering the best among all the methods of lighting that are pressed upon his notice. His ultimate failure to light the Post Office by electrical agency in some form would be a heavy blow to the contemporary progress of the systems so tried and found wanting. It is not for us to prophesy the result of Mr. Preece's experiments in this direction; but in no way can, whether he abandons the use of gas or not, it will be very desirable that he should give us the public an account of his proceedings in this matter. The experiments at St. Martin's-le-Grand, it may be assumed, are conducted in the public service; and therefore the result, with the lessons which the event cannot fail to convey, should be shown to the public by the responsible officials, without regard to the more selfish interests of the inventors and speculators, who might object to have their condemnation published. If Preece does not, as a rule, shun publicity, and it may be hoped that he will not deny to the public the advantage of a record of electricians' failures. They themselves may be trusted to keep the world well informed of their success, both real and imaginary.

of the Royal Institute of British Architects, giving instances of accidents from lightning and accompanied by illustrations of the buildings struck. Appendix E contains the instances collected by Mr. Symons in 1876-7-8-9, and Appendix F, which occupies nearly 100 pages, contains the observations of the various papers and books published on the subjects. Appendix G is a catalogue of works upon lightning-conductors; the other Appendices contain correspondence on the subject, including Faraday's letters to the Secretary of the Trinity House. Messrs. Preece and Symons give some notes on lightning-conductors, collected in Paris last spring, and Messrs. Howard and Spencer report on the conductors at the Electrical Exhibition. A number of plates and small diagrams, and a copious index, complete the volume.

ENGLISH MECHANIC AND WORLD OF SCIENCE: No. 877

JAN. 13, 1882.

CRYSTALS AND ELECTRICITY.

QUITOSE (say MM. Jacques and Curie, in a recent paper to the Paris Academy) that a solid body—e.g., a prism of glass—0·01m. in surface, undergoes a quantities equal to a thousandth of an inch—the quantity would be very difficult to ascertain by a direct process.

If, however, this variation of length be opposed absolutely, the solid will undergo a variation in the pressures of each of its faces, which, by means of a manometer, enabling one by measuring or measure the pressure, would afford the possibility of inferring the variation of length produced. It will be seen that this method is based upon the law of the elevation of coefficient of compressibility of solid bodies.

The authors have devised such a system, utilising the property possessed by quartz, of generating pressures in applied to it in certain directions, quantities of electricity proportional to the pressures. They have made an interesting application of the apparatus—viz., to demonstrating the reciprocal phenomena of the electric polarity of hemihedral crystals—i.e., crystals having but half the normal number of planes, or, in general, wanting some of the planes.

It is known that when a hemihedral crystal of this tetrahedral class is subjected to a variation of pressure along an axis of hemihedry, there are developed at the two ends of this axis, quantities of electricity that are equal, and of opposite signs, the direction being according to the sign of the variation (pressure increasing or decreasing). Now MM. Jacques and Curie have been able to prove, that, reciprocally, if the two ends of the axis of a hemihedral crystal be charged with electric quantities, it undergoes along the axis, either a contraction or a dilatation, according as the direction of the axis to which the electric tension has been applied to it.

M. Lippmann, indeed, has enunciated the law of the reciprocal phenomena, which is simply a generalisation of the law of Coulomb. The phenomena always such that the reciprocal phenomena are of the same order, "the production of opposite electricities." And, taking the principles of conservation of electricity and conservation of energy, he has been able to foresee and demonstrate in anticipation all the peculiarities of the reciprocal phenomena.

MM. Jacques and Curie first measured the quantity of electricity liberated by a quantitative unit by quartz, for a pressure of one kilogramme. It is noted, by calculation, that prisms of these substances should undergo variations of length of about 1-20,000mm. for a difference of potential corresponding to a spark of 0·01m. in air.

The experiments were then arranged so that the apparatus was formed of two solid bronze plates united by three columns which, in fixed connection with one of the plates, traversed the other, and terminated in screws and nuts. Thus, with the nuts, the plates could be approximated to each other on a pile of objects placed between them. These objects were in two systems.

The lower system served simply to measure variations of pressure. It consisted of three bezel and thin plates of quartz, separated by metallic plates put in communication with the electrometer, which indicated the electricity liberated by variations of pressure undergone by the quartz plates.

ENGLISH MECHANIC AND WORLD OF SCIENCE: 78 to 79

JAN. 6, 1882.

Electric Lighting.—Regarding his report upon the different systems of lighting which were exhibited at the Paris Exposition, Dr. Monod says that the systems of incandescence are already numerous, and doubtless many others will soon be added. Most of these differ from one another only by the form of the carbon conductors and by the method by which the carbon is rendered incandescent. Any correct judgment on the same or less brilliant aspect of the lamps, for, as they are fed by electric generators of very different intensity, those which have the strongest currents naturally furnish the most brilliant lights. Dr. Monod has, therefore no hesitation, in thinks, in pronouncing in favour of any single system until a serious examination and comparison has been made by a commission of disinterested scientific men. There is, however, reason to hope for a satisfactory solution of the problem of household illumination by electricity.

ENGLISH MECHANIC AND WORLD OF SCIENCE:

JAN. 6, 1882.

The Danger of Electric Lighting.—A committee of the Franklin Institute recently reported on the dangers of electric lighting. That committee specify a number of precautions to be taken, which are, in substance, as follows:—1. The conducting wires, both to and from the machine, should be kept well insulated throughout. 2. The machine should be supported on insulating cushions, being liable to impairment, especially at supporting bolts, or sharp bends, or wherever moisture may occur. 3. Conductors formed of numerous short pieces of wire should be avoided as far as possible; where they have to be used, the wires should be as long and as straight as possible by stapling, so as to prevent short arcs. 4. A continuous wire should be provided, and no attempt made to cause the current pass back to the machine through the earth. The wire should not be carried over metallic bodies like fans of shafting or gas or water-pipes, since contact with these would be equivalent to a direct ground that part of the wire. Where the wire has to cross metallic bodies, the insulation should be made better than usual. 5. The ready occurrence of cross conductor short circuits must be avoided. Therefore the wires should be of sufficient section to permit the whole current passing without dangerous heating. 6. To avoid danger to life from electrical shocks through the wires, wires should, wherever practicable, be placed out of reach, and, where they have to be touched, should be carefully insulated. 7. Where exposed to accident, they should be covered with a glass globe, and a cap or pan placed below to stop any broken fragments. The committee believe that, if these precautions are taken, electric lighting will be thoroughly safe.

ENGINEERING NEWS.

JAN. 7, 1882.

ELECTRICITY.

Poles for Aerial Telegraph Purposes.—The Elgin (Ill.) Telegraph Company is still furnish the city of Rome (Ga.) gas with four hundred poles for the city with electric light.

Recommended Telegraph and Telephone Wires.—The wires of the National Underground Electric Company, Philadelphia, from the public buildings to the Delaware River, were tested on the 2d, and found satisfactory in every way. On the 3d, they will inform the city council to adopt the underground wire for lighting the city in preference to the present system, which will undoubtedly be discarded. The claim is that city over a fire produced by electric wires will probably result in a renewed effort to bring the telegraph and telephone wires underground. The electrical current over the two-ground Boston, also, has authorized the construction of continuous lines of pipes by private enterprise in a large number of streets, on overhead

over

that all telegraph and telephone companies be allowed to lay their ensemble upon in the pipes at a rental not exceeding the cost of maintaining the wires overhead. In New York our underground wire subscriber has been robbed by the Mayor, pretty much as he would be if he had to pay for water supplied by the full of water, water and gas pipes to give room." It is evident that the time has come for studying and utilizing the whole subsoil of New York. On some definite plan, the entire underground street and park accommodations of the city should be so economized that whether for pipes, sewers, railroads, or other purposes, the least possible interference with the surface and its uses in such a way as to relieve the streets of the needs, cross-pipes, wires, railways and other obstructions, which now help to take away from many carriageways their comfort and size, or clog the feet and ways of the people and obstruct the thoroughfares.

THE SANITARY ENGINEER.

JANUARY 12, 1882.

Gas and Electricity.

Illuminating Power of Gas in New York City.

Week ending	Jan. 1, Sperm Candles.	Jan. 1, Standard Candles.	Jan. 1, Gas Burned per hour.	Jan. 8, Sperm Candles.	Jan. 8, Standard Candles.	Jan. 8, Gas Burned per hour.
Dec. 24.....	No.	No.	Ns.	No.	No.	No.
	Tests.	Tests.	Cub. Feet.	Tests.	Tests.	Cub. Feet.
Dec. 31.....	16-26	17-09	23-34	16-26	16-31	18-32
Jan. 7.....	22-69	17-26	24-32	21-43	21-74	24-79

E. G. LOVE, Ph.D., *Gas Examiner.*

* Mosing Grand Street Station.

THE FRANKLIN INSTITUTE AND ELECTRIC LIGHTING.

The *Journal of the Franklin Institute* publishes the report of the committee appointed to consider what precautions are necessary to obviate the dangers likely to arise from electric lighting. At the outset the committee say "that from a careful consideration of the evidence submitted they believe that the use of electricity as an illuminant, as now generally employed, is not attended with any dangers, either to person or property, that cannot be obviated by the adoption of the precautions hereafter set forth."

The report describes the methods of lighting by "incandescence" and the "arc," the construction of the dynamo-electric machine, and the principal points of difference between static and dynamic electricity. That produced by the ordinary frictional machine, or static electricity, has the power of jumping over considerable distances, and as produced in nature is seen in lightning flashes. The electricity produced by dynamo-machines has, on the other hand, no such power of jumping from one conductor to another. Even in the arc light with a powerful electric current, the carbon rods must be brought in contact and afterward separated, the contact serving to form the vapor of carbon between the rods and supply a conducting material. It is therefore a mistake to compare the currents from dynamo-electric machines to modes of lightning. It is important to prevent the formation of any conducting circuits between the regular conductors of the current. If any conducting material be placed in, or form a part of the electrical circuit, or from any cause a momentary break be made between it and the rest of the circuit, an arc of flame may result." "As these arcs of flame are very hot, their occurrence should be carefully prevented in all places except between the carbon electrodes in the lamp." Danger may be avoided by insulating the wires, and there is no necessity for any very high degree of insulation. "Whatever the character of the insulation employed, care should be exercised to insure its being preserved intact on all parts of the wire. The removal of the insulation from but a few points of the wire might cause a dangerous discharge at such points." "Where two different paths are open to the current, it will flow through both such paths." "Suppose, now, that two different portions of an electrical circuit be bridged over by any conducting material: say, for example, that a wire from a line of telegraph or telephone falls across a line of electrical conducting wires, so as to connect the wire carrying the current from the machine with a part of the wire carrying the current back to the machine. If such electrical conducting wire be uninsulated, a series of cross contacts would thus be formed, and two different paths be opened to the current. Since the conducting power of the short wire, forming the cross circuit, would probably be far greater than that of the portion of the circuit with its included lamp, the greater part of the current thus "cut out" or "short circuited" would pass through the cross wire, either fusing it, or drawing dangerous arcs of flame when the contacts were at times but partial."

If the human body accidentally forms a part of the circuit, a painful or even a fatal shock may be received. It is necessary, however, that the current should enter the body at one point and pass out at another. The mere touching of a conducting wire would not place the person in the circuit and no injury would result. It would be different with a frictional machine, in which contact with a charged conductor would discharge it through the body into the ground.

The committee, in conclusion, recommend that the following precautions be taken in all cases where the electric light is employed:

1st. That the conducting wires be suitable insulated.

2d. That frequent inspection be made to insure the insulation intact. Insulation may be impaired by hooks used in fastening the wire, by abrasion with other wires, and by sharp bends in the wires.

3d. That conductors should not be formed by short pieces of wire, or if such are necessary that the joined ends be securely wrapped.

4th. That the wires be not grounded, but that a continuous line of wire be provided, and that the wires be not carried near metallic bodies as gas or water-pipes.

5th. That the occurrence of cross contacts be avoided by keeping the conducting wire as far apart as convenient, that the wires be fixed in position and not allowed to sag, and that in introducing them into a building they be placed in as dry a place as possible.

6th. That the conducting wires be of sufficient size to carry the most powerful current without heating.

7th. That the wires be placed out of reach so far as possible.

8th. That in the use of the arc lights, they be surrounded with a glass globe, and that a cap or gas be provided at the bottom for any falling fragments.

"The committee believe that if these precautions be taken, electric lighting can be thoroughly safe and reliable, and that all dangers attending its use can be entirely obviated.

ELECTRIC LIGHT NOTES.

Water power is to be employed in lighting by electricity the town of Godalming, in Surrey, Eng.

It is acknowledged that one electric light in Boston has the same effect as five policemen "in uplifting the moral condition" of the people.

It is stated that an iron mast 260 feet in height has just been raised in the public square in Cleveland, for the accommodation of the electric light. Two others are to be put up for a similar purpose.

A laborer, while engaged in repairing a telephone wire at the residence of the Marquis of Salisbury, accidentally came in contact with the insulated electric-light wires, and was instantly killed.

The Philadelphia *Times* records another accident caused by electric light and telephone wires coming in contact. It occurred in the telephone department of the Local Telegraph Company. The woodwork was considerably scorched, but no serious damage was done.

The New York *Herald* states that a midshipman has been detailed by the Navy Department to attend the Crystal Palace Electrical Exhibition in London, to gather whatever material may be of value "in the use of electricity for lighting, and other purposes, on shipboard and in torpedo practice."

According to the *Ledger* of Philadelphia, the Superintendent of the Brush Electric Light Co., of that city, is of the opinion that telegraph and telephone wire s should be placed under ground, but he does not think the electric light wires can be similarly placed, on account of the difficulty of insulating them.

The Pullman cars on the Brighton (Eng.) Railway are lighted by electricity supplied by secondary batteries. The lights can be turned out when not needed, and the effect is said to be very fine. Two men are required to look after the batteries, making an item of expense which, of itself, exceeds the cost of lighting the same cars by gas.

The *Railway Age*, quoting from the London *News*, says that the annual cost of lighting a Pullman car by the present methods on English roads is £480, while with an original outlay of £200 for engine, batteries, etc., the same work can be done infinitely better by electricity for £60 per annum. It is considered somewhat singular that American roads have not adopted electricity for railway lighting purposes. There seems to be no good reason for accepting the above figures as representing the comparative cost of the two systems; and Americans are quick enough to grasp anything new which is likely "to pay."

It is known that with electrical machines which furnish a continuous current, the effect of using such a current in producing the arc light is to cause the upper carbon to assume the form of an inverted cup, the inner portion of which is most intensely heated and emits the greatest amount of light. The sides of this cup shut off much of the light which would be emitted horizontally, and tend to throw it downward. M. Deboscq, with the view of correcting this, recommends that the carbons be not placed exactly in line. We do not see that this plan would be any improvement, for the sides of the carbons opposite the arc would cut off the light in two directions, and not afford the reasonably uniform light which, by the present plan, is thrown on all sides of the roadway.

THE ENGINEERING AND MINING JOURNAL.

SEPT. 3, 1881.]

The Electric Light in Mines.—The Swan electric light, which closely resembles the Edison incandescent lamp, is in process of introduction at the Earnock Colliery, near Hamilton, North Britain. There are now sixteen stationary lamps and sixteen "portable." *Engineering*, which gives some details on the subject, does not state to what extent the latter can be carried about, nor is the candle-power of the lamps mentioned.

Inventors appear to be turning much attention to the utilization of electricity for running drills for mining and quarrying. At the Paris Electrical Exhibition, a Tavernlon diamond drill and a percussion drill, by M. Chenot, *fils*, is shown. These can be little doubt that there is much promise of success in this direction, and that, under special circumstances, electricity may prove a welcome substitute for steam or compressed air.

ENGLISH MECHANIC AND WORLD OF SCIENCE: No. 873.

DEC. 16, 1881.

ELECTRIC LIGHTING—ITS FIRE RISKS AND THEIR REMEDIES.*

By HENRY MORTON, Ph.D.

President of the Stevens Institute of Technology.

SOME very lamentable accidents have strongly directed public attention to the question of the safety of electric lighting as compared with the ordinary illuminating agents. Fortunately, in a source of light, such as the actual conditions of this danger, like the true properties of the agency from which it may arise, are few, and a very brief explanation of some simple facts related to the principles of electricity and electric conduction will be needed. I would remark that this whole subject under two general heads, namely: 1st. The source of danger; 2nd. The conditions of their prevention, or of security. The source of danger in the use of electricity is also essentially two; from the conducting wires and from the electric arc. Since, in the use of electricity as an electric energy, is conveyed by a sufficiently good conductor it is perfectly harmless, resembling a water-forcing in its natural channel, and particles to the shores its banks; it is only when some other channel into surrounding objects is offered or some partial obstruction of a certain character is met with that any danger arises. The nature and conditions of these difficulties are, however, very peculiar. Thus, for example, if two electric conducting wires, forming the outgoing and returning parts of a powerful current, are placed near each other, but are separated by a bad conductor, as, for example, when both are buried on the ground, or when they are suspended in the air by wire from end to end, with no development of heat in the same, no tendency to leave the conductor or pass into any adjacent object. If, however, between the two conducting wires we introduce some imperfect conductor, such as a piece of wet, some metallic dust, or a fine thread of carbon, or even a dry piece of wood, there is portion of the current will be diverted into this "short-cut" from wire to wire and may heat the fine wire or the metallic dust or the wood melted with aqueous solution, so as to cause the ignition of inflammable matter. A moment's reflection will show the already concerned. Thus a telegraph or telephone wire may come across a single wire of the conduction used for street lighting purposes has been fused, or, itself escaping, has caused the fusion of their wires connected with it.

Again, two wires being the outgoing and return circuits of a powerful current, may, from any cause, be side by side for some distance, as on the same post or in the floor, partition, or ceiling; and though used safely for a long time, while the woodwork was in its normal state, have developed a very dangerous activity when the wood between them was wet with dirty or impure water. Metal near the water allows a closed circuit which a cross

ELECTRICAL APPARATUS.

American Institute of Mining Engineers.

ANNUAL MEETING, Wednesday, Thursday and Friday, February 15th, 16th and 17th, 1882.

The Institute will meet at the Stevens Institute of Technology, Hoboken, N. J., on Wednesday, February 15th, at 10 A.M., for the reading and discussion of papers, and the election of members.

Thursday, February 16th, at 10 A.M., will be devoted to visiting the Works of the Edison Electric Light Co., the Sprague Electric Railway and Motor Co., the Bergmann Electric Co., and the Electric Tramway Co., in New York City.

Friday, February 17th, at 10 A.M., will be devoted to visiting the Works of the Consolidated Electric Light Co., the Weston Electric Light Co., and the Thomson-Houston Electric Co., in Boston.

Special trains will be provided over the Pennsylvania Railroad, leaving Jersey City at 9 A.M. and Cortlandt Street at 9.30 A.M. on Wednesday, February 15th, and returning from Boston at 5 P.M. on Friday, February 17th.

Members desiring to read papers at the meeting are requested to notify the Secretary at once, and to forward the papers as early as possible.

Members intending to visit the Works of the Companies mentioned above are requested to notify the Secretary at once, in order that arrangements may be made for their reception.

Members intending to be present at the meeting are requested to notify the Secretary, in order that arrangements may be made for their entertainment.

By order of the Council,

ALEX. L. HOLLEY, Secretary.

Stevens Institute of Technology, Hoboken, N. J.

IN VIRGINIA MEETING

of the Virginia Medical Society, to be held in Richmond, Va., on the 17th, 18th and 19th of January, 1882, a paper will be read by Dr. Hunter McGuire, of Richmond, entitled "Electricity in Surgery." Other papers of interest are promised, and the meeting will be a very interesting one.

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TO CORRESPONDENTS.

W. B.—*The information you ask for, in regard to the Smoke Abatement Exhibition, will be found in another column.*

TRUTH.—*We send Berlien to publish your letter anonymously.*

E. J.—*Duly for this week.*

E. J.—*They write you in the course of the present week for further particulars.*

J. T.—*Answer of the Acts quoted across the Sale of Gas Act.*

H. G.—*We quite agree with you; but the case was not tried under the Burghs Act.*

J. W.—*Duly for those who work it.*

THE JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

TUESDAY, JANUARY 10, 1882.

THE TRUE ILLUMINATING VALUE OF COAL GAS.

One of the most striking results of the progress of invention during the last few years, in the matter of the illuminating power of gas for purposes of lighting, is the upsetting of all preconceived ideas respecting the meaning of the term "illuminating power." The principles, indeed, have never been recognised as a description of some fixed property of gas, such as that of bulk or quality; but only as indicating the quality, depending upon some undefined proportions of its complex constituents, which might be found in the flame of gas when burnt under certain conditions. The conditions under which the flame of any class of coal gas is produced have always been regarded as consisting largely in the question of the power of the light afforded thereby; but the true value of this consideration has only recently been acknowledged. It constitutes a most important principle, which controls a number of conclusions of great interest to manufacturers and consumers alike—the principle that, within certain limits, illuminating power depends upon the burner and not upon the gas.

There was a time, in the earlier days of gas lighting, when the illuminating power of the mixture of coal and cannel gases commonly sold by the Companies was regarded from a very different standpoint to that just indicated. The burners then generally used were not such as are most favoured at the present day, and they wasted a great deal of gas—that is, they gave a very low duty for the gas consumed. Yet from these imperfect appliances a man, her of influential personages considered that they could lain all about the illuminating power of gas in relation to its , onstitution; and they consequently preferred to regard the results of photometrical measurement, not as in themselves declaring the value of gas as an illuminant, but as indicative of a value which was to be found in the composition of the gas itself. This habit of thinking led to a partial reversal of the principle now universally followed—and, of course, also known at the time referred to—inasmuch as the proposal to use an improved burner for photometrical measurements of common gas was resisted, on the ground that it would give a fictitious value to the gas by increasing its apparent illuminating power. So long as the composition of the gas remained unaltered, it was believed that the improved result obtainable by the use of a better burner was not a tangible advantage.

This state of feeling fortunately did not prevail in contemporary counsels so far as to prevent common gas from being invested with additional value, by the adoption, as the legal standard burner for official photometrical operations, of an appliance which was a notable advance upon previously existing patterns. From this time the illuminating power of gas became more generally understood, not as a something apart from the actual light of the gas flame, but more definitely as a result of the combined action of gas and burner together. Judged from the common-sense standpoint, it would have been lamentable if another course had been taken, and the manufacturer had been compelled to supply gas of a quality calculated either with reference to its composition alone, or in conjunction with some imperfect mode of burning. As it is, however, the circumstances attending the production of a gas flame are legally held to account for the illuminating power of the light afforded, in even a greater degree than the substance burnt.

Reviewing the present system of gas supply of the United Kingdom, discarding solitary instances when special considerations regarding quality have been allowed to prevail, it may be considered that Parliament has laid no greater obligations on the manufacturers, in this matter of illuminating power, than can very well be complied with in the ordinary course of careful working with common qualities of coal. This reflection is naturally based on the supposition that the most suitable burner is employed in all cases. If the course of invention had stopped with the evolution of the standard burner, its introduction would have to be accepted as showing the absolute illuminating power of gas for practical purposes. But invention has gone far beyond this burner, gas as it normally is, not responding to the older patterns which it supersided. If, as we contend, the true illuminating power of gas is that which it can be made to yield under the best conditions under which it can be burnt, then the results afforded by the best test burner become of formal value only from the moment when it was shown that other appliances rendered an appreciably better duty. As already remarked, there are numerous kinds of burners which cause the development of so much more light than is possible with the test burner, that gas which is legally valued at sixteen-candle power may actually be made to give twice as much light to the consumer. The old truism that much of the bad lighting complained of by consumers is traceable to causes entirely within their own control, receives strong reinforcement and amplification from considerations such as we have advanced. What may not be accomplished respecting the responsibility of gas consumers for the amount of light they obtain in return for the quantity of gas passed through their meters, when it has been shown to be possible, by merely changing the burners, to vary the illuminating power of the same gas through a range of 100 per cent. above the nominal valuation, to say nothing of the depths below this figure? The illuminating power of common gas is now, in fact, just what the consumer wishes to make it. His responsibility is great; but even more pressing is the duty devolving upon gas engineers and gas apparatus manufacturers generally to guard the consumer in the due enjoyment of his rights. Unless there be a radical reform in the present methods of using gas for domestic lighting, whereby the best inventions of the age, in the matter of gas-burners, can be placed at the ready disposal of consumers, as pointed out in the essay which appears in another column, the best results which might be expected of the electric light inventors will be missed. Street lighting is in no danger of falling back into the old groove. When will every on the work of reform, in securing equal benefits on private consumers?

ELECTRIC LIGHTING ON PAPER AND IN REALITY.

THE friends and foes of electric lighting have alike been busy during the past fortnight. To commence with the former, it

THE JOURNAL OF GAS LIGHTING, WATER SUPPLY, & SANITARY IMPROVEMENT.

Jan. 10, 1882.]

THE ELECTRICIAN'S DESIDERATUM.

At last an expectant world has been informed of what is wanted by electricians to render them masters of the present age. The informant is Mr. Jacob Reese, who, if we are not mistaken, has been heard of before as the inventor of a wonderful disc which cuts through iron and steel without touching the metal. Mr. Reese tells us that electricity is nothing but "dynamic calorie;" which seems very like changing one word for two, until he explains the meaning of this mystic phrase. Calorie, then, is the force of repulsion existing in material substances which prevents the molecules of matter from touching each other. So much of this force as may be in motion is named "dynamic calorie," while the force of mutual attraction keeps another portion of calorie occluded in matter, and this part of it is called "static calorie." Mr. Reese recognizes the fact that where fuel is burnt to produce motion in a steam-engine as a first result, and the engine is made to develop electrical energy by means of a dynamo machine as a secondary result, a great loss of the original "calorie" of the fuel ensues. Therefore it is argued that if the "calorie" of the fuel could be made to produce the secondary result at once, without the introductory stage hitherto assumed to be necessary, considerable economy would be secured. The great want of the present age, we are told, is a process by which the "static calorie" of carbon, or a hydrocarbon, may be set free by non-luminous combustion; or, in other words, a process by which coal or oil may be oxidized at a low degree within an insulated vessel. If this can be accomplished there would be realized from 12 to 15 million foot-pounds of energy (electricity) from 1 lb. of petroleum, and from 10 to 12 million foot-pounds from 1 lb. of good coal. Quite incidentally Mr. Reese expresses his belief that before very long all coast cities will be served with electric force obtained from the power of the tides, in which case the "gas companies will suffer." Mr. Reese's greatest hopes, however, are centred in the notable proposal to obtain "dynamic calorie" by non-luminous combustion, whereby electricity is to be produced at rates so low as to render it the only possible medium for lighting, heating, and driving machinery requiring motive power.

THE INDIANAPOLIS JOURNAL, SATURDAY, FEBRUARY 4, 1882.

EDISON'S MOVEMENTS.

If Edison's electric lighting has not gone forward as rapidly as was at first expected, it has never paused for a moment, much less taken any backward step. Nearly two thousand buildings have been equipped with wires and meters in the first district (down town), the mains are laid in more than four miles of streets, and the twelve large steam-engines with dynamos are now being put in place in the central station. Edison has contracts with the owners of all the buildings. I will not predict when the whole arrangement will be touched off, but it will not be till everything is ready.

Edison's own work in connection with electric lighting being completed, he is now out at Menlo Park taking up the electric railroad on which trains were run forty miles an hour by electricity four years ago, and building another three miles long in better style. He thinks that within a year he will run a train on it at the rate of eighty to one hundred miles an hour.

The chief impediment which prevents steam trains from making more than fifty or sixty miles an hour is the piston-rod jerking back and forth. This must stop once and start again at each revolution of the driving-wheel, and this takes time. But in the electric engine the movement is wholly rotary; the revolving armature is geared directly to the driving wheel, and there is no jerking to and fro, and no dead points. Mr. Edison does not see why a train on a level track should not attain the speed of 150 miles an hour.

The elevated roads here are ready to substitute electricity for steam on all their lines, and are negotiating with Mr. Edison to this end. Last fall they offered him the Thirty-fourth street track, but he declined to have any experiments hampered by a time-table, and it was not thought best to do anything till he was ready to take the whole job.

The Lowell Daily Courier.

WEDNESDAY, JANUARY 11, 1881.

Corporation Notes—Electric Light.

The Merrimack company are to make further tests of the electric light. It will be remembered that this corporation gave a trial about two years ago to a Brush machine, but its use was abandoned after a few weeks for several reasons. One objection to it was the concentration of a powerful light at a few points, rather than an even distribution of it. The company is to experiment with the Edison incandescent light, and the fancy weave room in No. 2 mill has been selected for that purpose. There are 300 gas burners in the room and the same number of electric lights are to be used. The Merrimack company have the right to make a thirty days' test of it before deciding whether to adopt it, and two six-horse-power machines are now being put in the basement of the mill. A large portion of the wires for the distribution of the light were put in position in the room last night. The first of February has been fixed as the time for commencing the trial, but the apparatus will be ready for operation at an earlier day. The electric light burners are to be located at the same points as the gas burners, and at about the same distance from the ceiling. Each light is stated to be of sixty candle power. Each light is in a pear-shaped glass covering, of about the size of an ordinary pear. The very small wire enclosed in the glass receptacle, and from which the light is disseminated, will last for 600 hours, equal to about a year's use, without being replaced. The lights in No. 2 mill will be all turned off at one point, as a matter of convenience, but there are fixtures by which it may be turned off at each burner, like gas, thus adapting it specially for use in dwellings.

The Pemberton company at Lawrence is introducing this light, and it is being satisfactorily tested in other places, although its introduction in New England is quite recent.

In addition to the pending trial of the Edison light in the weaving room of the company, a ten-light Weston machine is being put in the print works, similar to that on the Lowell corporation, and it will probably be in operation next Monday. There have been four Fuller electric lights in use in the print works nearly a year, the corporation having purchased a Fuller machine. It gives very good satisfaction. One of the new lights will be in the new bleachery, two in the basement of the color-room, three in the dye-house, and four in the packing-room. It is understood that the Weston machine has been purchased by the company.

Daily Evening Traveller.

TUESDAY, JANUARY 31, 1882.

Electric Lighting.

The Edison Company for isolated light of New York have completed arrangements for lighting several large mills in New England, two of which will be lighted during the present week. This will afford an opportunity to test the truth of certain rumors which have been afloat as to the danger of fire from the light. The company claim there is absolutely no danger and are glad to thus submit the matter to practical test.

The incandescent system of electric lighting, as perfected by Mr. Edison, has, it is claimed, in itself reduced the danger from fire to a mere minimum, for while in the arc system there is a certain percentage of danger arising from the increased electric motor force, in this the motor force is so low, being only one-thousandth part of that of the arc system, that the danger by contact or otherwise is exceedingly slight. There is, it is also claimed, further progress in the line of absolute safety by a novel contrivance of Mr. Edison's in the shape of fusible cut outs, which are placed along the entire circuit wherever a tap is made from the main or branch wires, and wherever a lamp is adjusted. These cut outs consist of a piece of metal of greater fusibility than that of the copper conductors, so that in case of an increase of current arising from short circuiting or crossing of wires, the fusible wire in the cut out, which is made of lead, would be instantly melted, breaking the circuit and instantly arresting electrical action at that point, without affecting the rest of the circuit. Furthermore, this system has been tested by the New York Board of Underwriters with very flattering results, and is conceded by them to be the safest of all methods of artificial illumination. Some forty or fifty manufacturing establishments in different parts of the United States are now lighted by this system, which gives entire satisfaction. N. W. M.

The Metropolitan August 17. 1881.

Electric Lighting at Eastbourne.—We understand that the experiment of lighting by electricity the Floral Hall and grounds at Devonshire-park at Eastbourne, has proved a great success. The lamps employed are those of Messrs. Siemens; and the motive power is furnished by the engine used for pumping water into the baths. It is proposed to light the esplanade in the same way.

Electric Lamps.—Mr. A. Muirhead, of 27, Regency-street, and Mr. John Hopkinson, of 4, Westminster-chambers, have had granted to them letters patent for "Improvements in Electric Lamps," which we illustrate below. The invention relates both to the mechanism of the lamps and the carbon used therewith. Figs. 1 and 2 are elevation and plan of the lamp. Fig. 3 shows modified form of break gear. The upper carbon C is carried by the holder A, upon which is cut a screw-thread B, engaging a similar thread in the boss of the wheel F. D is a key-way or "screw of infinite pitch," which keeps the holder from revolving. In operation, as the upper carbon falls, the wheel F is caused to revolve by the screw A, and rotates the pinion G and the brake-wheel H. The brake-wheel is controlled by an electro-magnet on a shunt circuit acting against a spring, which, when the resistance of the arc increases, is overpowered and drawn away from the wheel. In Fig. 3 the toothed wheels are replaced by a brake disc provided with paddles working in fluids.

Fig. 1.

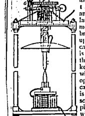


Fig. 2.

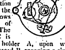


Fig. 3.

THE RAILWAY AGE.

[January 19, 1882

Electric Light on Railway Trains.

A correspondent of a Sheffield, (Eng.) paper writing from London of the recent trial of electric lights on the Pullman train of the London, Brighton & South Coast railway, says:

There is no doubt whatever on the point that this, apart from the question of cost, is a decided success. It is easily manageable, and diffuses through the train a pleasant, equable light, scarcely less agreeable than daylight. It is turned on and off with instantaneous effect as the train enters and leaves a tunnel, and of course is kept burning the whole of the time during the night journeys. The electricity is stored in a number of lead plates, which are kept in water in iron boxes in the guard's van. There are two lots, one at either end of the train, and two mechanics in charge of them. This discovery of ability to store electricity for application to lighting purposes seems to carry the discovery further than anything since it was first introduced. It gets over many difficulties which seemed insuperable—especially the important one of the great waste of power which is illustrated every night at the Savoy theatre—and would be applicable to the introduction of electricity for household use. At the Savoy, when the exigencies of the play require that the lights should be turned down in the auditorium, there is no cessation of the enormous power required to produce the full effect. What happens is that, by a mechanical contrivance, the electricity is carried off from the light and goes to waste. With this system of storing, electricity can be used just like gas, as much or as little as people chance to want. Another great advantage is the freedom from jumping inseparable from the action of the driving power of the steam engine, or of the motion power of water. The lights on the Brighton train burn just as steadily as gas, an effect not in any way obtained where the light is maintained directly by the driving power of steam. But after all, the question of gas v. electricity will resolve itself into one of cost, and it is here where gas will inevitably hold its own. The fundamental principle of the electric light is that for a given exertion of power you obtain a given proportion of light, neither more nor less. For every hour it is burning there will require a certain exactly ascertained proportions of revolutions of the steam engine, and therefore if the whole town is lighted, it can be done only at a strictly proportionate expense to the lighting of a single house. As to what that expense will be as compared with gas, the Brighton train would, if we had an idea of the actual figures, afford a precise means of information. I met on the train a well known gas engineer, attracted like myself by the novelty of the experiment. What the electric lighting cost he was not able to say; but when we take into account the capital sunk in plant, involving a steam engine with the necessary buildings, consumption of coal and necessary employment of skilled labor, it must be something considerable. Against this is the bare fact that the Brighton train could be lighted with gas for the double journey at the cost of 10d. It is a physical impossibility that electricity should ever come anywhere near this, and that probably explains the singular phenomenon that at the time when electricity is making many conspicuous advances in public favor, the value of gas shares is not only steadily maintained, but is actually rising in the market.

THE SANITARY ENGINEER.

[NOVEMBER 1, 1882

THE ELECTRIC LIGHT IN NEW YORK.

The experiment of lighting the streets of this city by electricity has progressed sufficiently far to allow something of an estimate as to its value and economy. In May last the Gas Commission awarded a contract to the Brush Electric Light Co. to light the following streets for one year, at the rate of $7,400 per annum: 14th street, from 4th to 5th avenue; 5th avenue, and Broadway from 14th to 34th street, and 34th street from 5th avenue to Broadway. In addition to the lamps necessary on these streets, the company were to furnish two groups of six lamps each, to be placed in Union and Madison Squares respectively. The street lamps were erected and in operation some months previous to the awarding of the contract, it having been done by the company as an experiment, to give the people an opportunity to judge of the suitability of the electric light for street illumination. On account of the labor and experiment necessary, the groups of lamps have been in operation but a short time.

On counting the electric lamps which have been furnished and also the gas lamps extinguished, we find that there are forty-three lamps used in lighting the streets already mentioned, besides the twelve lamps of the two groups, making fifty-five in all. The total number of gas lamps which it has been possible to extinguish is 430. In Union Square all of the gas lamps, thirty-eight in number, have been extinguished, while in Madison Square, which is considerably larger, sixty-four have been extinguished, and twenty-five continued in use. These figures include those lamps on adjoining streets, which the electric lights have rendered needless. It is hardly necessary to state that there were more gas lamps required in the Square than in ordinary street lighting, where there is little or no foliage to interfere with them. In Madison Square each one of the groups of six electric lamps replaced ten and two-thirds gas lamps, while in Union Square the ratio was 1 to 6⅓. In the lighting of the streets forty-three electric lamps have replaced 328 gas lamps or one electric lamp to about 7½ gas lamps.

The city pay the gas company $17.50 per lamp, per annum, or $7,525 for the total number of gas lamps replaced by the electric lamps costing, $7,400. Thus there is a saving to the city in this respect of $125 per annum. The gas company say that there is not sufficient margin in maintaining the street lamps for $17.50 per annum to make competition desirable, and if the Brush Company are content to light the streets at the present price, there certainly is an element of cost in their favor, or they are satisfied to do the lighting for a less percentage of profit than the gas company. The gas burners in use are of three feet capacity and burn for 4,000 hours during the year. Deducting for cleaning, etc., the company receive about $1 per thousand for the gas used. At the same time they would willingly turn over to the electric light companies the lighting of the streets. It is impossible to say how much the Brush Company will make out of this undertaking, or how much of the total cost will be considered as covered by the advertising thus afforded.

The electric illumination is, in many respects, very satisfactory, while in others there is still much to be desired. The system of lighting by means of the poles or towers is

somewhat disappointing, on account of the comparatively small area which is illuminated. In clear weather the groups of lamps are very effective at beacons, but if they were separated and placed at different points over the same area, the illumination would be more satisfactory. The following interferes with the efficiency of the lamps, and this objection would be still more noticeable in midsummer.

As to the illuminating power of the electric lamps employed, it should be stated that it is a matter of importance as to how this is measured. In the Brush and other systems in which the lights are fed by continuous current machines, the upper carbon, in the case of the arc light, soon becomes sooty, and in the form of a bulbous, ring-like or deeper part of which emits the greatest amount of light. It is evident, therefore, that in determining the illuminating power of arc lights of this nature by horizontal measurements, a portion of the light will be cut off by the sides of the hollow or ring formed. For a similar reason the greatest amount of light would be thrown downward at an angle of about 60°, and angular measurements would give a result three or four times greater than the horizontal.

The illuminating power of the Brush lamps with ¾ inch carbons is from 300 to 400 candles, horizontal measurement, and from 1,000 to 1,300 candles, angular measurements. There is no reason for the expression "French measurement." It is without any advantage and being unlike the plan customary in expressing photometric results is very misleading. A gas flame of twenty candles would, by French measurement, be rated at eighty candles.

The carbons employed in the groups of electric lights in the Square, are said to be of ¾ inch diameter, and presumably the illuminating power is greater than in the case of the arcs lamps, but the effect produced we are inclined to think that the estimate given (36,000 candles), is rather high, unless expressed as "French measurement."

ELECTRIC LIGHT NOTES.

At the recent exhibition of gas apparatus at Aberdeen, Eng., there was a spirited contest between the Swan incandescent lamps and the gas burners of Mr. Bray. Reports seem to agree in giving the first place to the gas burners.

According to the *Journal of Gas Lighting*, the Directors of the British Museum have decided to again light the reading room by means of the Siemens electric lamps. There will be four arc lights, with a stated candle power of 4,000 candles. In addition it is expected that there will be several of the Swan incandescent lamps.

The *Review of Gas and Water Engineering* mentions the visit of the members of the mining districts of Scotland to the Earnock colliery, near Glasgow, where the Swan incandescent lamps are used for lighting. There were twenty-one lamps, each giving the light of fifteen candles. Two lamps, which were placed at some distance from the rest, were noticeably inferior; the cause for which was subsequently found to be in the higher resistance of those lamps. It appears that there is considerable variation in the Swan lamps in this respect, and the engineer in charge has tried the plan of putting the worst lamps in those branches of the circuit where the resistance was low, and also in regulating the resistance in the different branches. A lamp which is deficient in the nature of gases, showing the necessity for the complete protection against the breakage of these lamps in mines, and the care needed in their use under such circumstances. In lighting the Earnock colliery, the lamps are inclosed in strong protecting cases.

Scientific American.
NOVEMBER 12, 1881.

The Expenditure of Energy in Incandescent Electric Lighting.

At the York meeting of the British Association, Sir W. Thomson and Mr. Bottomley gave the results of some experiments carried out by them in order to determine the illuminants carried out by them in order to determine the illuminating power of incandescent vacuum electric lamps with various strengths of current. Every lamp was tried with lighter and lighter potentials until the carbon broke. The electricity was obtained from a number of Faure's cells, of which 26 were first put in circuit, developing 0 0393 horse power, and others were added until the lamp was destroyed. Three lamps only were tried, the first of which broke down after fourteen experiments; the second lasted through fifteen tests; and the third broke before the third reading could be completed.

With 26 cells the first lamp gave the illuminating power of with 32 cells it showed 42 candle power; and successive additions of cells forced the light up through a very irregular scale until, when giving the maximum of 114 candle power, the carbon gave way. The next lamp was first tried with 40 cells, affording 0·27 horse power, and giving the light of 0 candles; and the lamp broke when connected with 70 cells, when the light would have been over 700 candles. The irregularity of all the records is very striking, the power of the batteries and the light given by the lamps being very uncertain and by no means increasing in any common ratio. For example, the first lamp gave the light of 84 candles, with the expenditure of 0·247 horse-power, from 69 cells. The next lamp, with the same number of cells, gave only 19 candle power in one instance and 35 candle- in another, although the energy of 0·27 horse power was recorded, or nearly the same as before. Again, the second lamp gave 108 candle power with 80 cells, while the addition of 6 more cells, instead of increasing the light, brought it down to 103 candles. Much of this irregularity is said to be caused by the blackening of the interior surface of the globes by the deposition of volatilized carbon, when high powers were applied. The photometric method employed by the authors consisted of directly comparing the light of shadows thrown by a pencil on a piece of white paper, and the candle employed was the usual standard sperm candle, assumed to burn at the normal rate, but not weighed, as the object of the experiments was simply comparative.—*Journal of Gas Lighting.*

Scientific American.
NEW YORK, SATURDAY, NOVEMBER 12, 1881.

Medals for Electric Lights.

The jury of the International Electric Exhibition has awarded gold medals of the highest class to Edison and Brush for dynamo magnetic machines, and a gold medal to Maxim. Also, gold medals to Edison, Brush, and Maxim for arc incandescent lights. Edison takes five gold medals in all, being more than any other exhibitor.

Scientific American.
NEW YORK, SATURDAY, JANUARY 14, 1882.

Electric Lights at Hell Gate.

The dangerous condition at Hell Gate, the eastern entrance to the harbor of New York, causes a nightly blockade of vessels. To obviate this delay to commerce the Light-house Board has believed a proposition to provide Hell Gate with electric lights, and Congress has been asked to authorize the necessary experiments. The plan is unquestionably practical and cannot fail to be beneficial,

wheel mould has been patented by Mr. Grisburg, Pa. This invention relates to its car wheel moulds of that form in sured through a central hole in the core, ized space from the bottom; and it consider ours with an annular re-enforcing , perforated to permit the passage of air and combining this with the drag-sand, h a circular recess to receive the lower d rollating channels that connect the the wheel spaces.

In common use are moles of links strength of the chain being determined ze of the rivets and their resistance to or pull of the links, and when a link nks have to be cut out and a new link ew sides, which latter must be upset, of repairing a flat link chain of ordi- slow and expensive. Mr. James W. ille, Fla., has patented an improvement to the repairing and lengthening and ink chains. The improvement consists having the thick or double link made vened and socketed at each end, the it, and in forming each single link with ojecting at right angles from one face ain is made by coupling the double and r by means of the engagement of the the undercut sockets of the former. ocates for the water packing of screw- and durable. The invention consists in a coarse cloth, such as a burlap, which is covered on one or both sides with a mixture of clay and tar.

Mr. John J. Tierney, of New York city, has patented an improved door scanner, consisting in the combination with a screw, for securing a door, of a post socket having on its forward end the right angled plate fitting into a notch of door post and secured by screws, so that a scanner cannot remove the socket, even after he has withdrawn the bolt.

Mr. John B. Bennett, of San Luis Obispo, Cal., has patented an aromatic or mechanical lubricator, which consists of a compression gauge, a measurement, and a valve, for giving a lasting and uniform flow of oil, and which is adjustable to suit any consistency of oil of such construction that it can be placed in almost any place or position required.

THE GASTROSCOPE.—AN ELECTRIC LIGHT FOR THE HUMAN STOMACH.

The application of electricity in ways the most varied, and, perhaps, we might add, unexpected, has, within the last few years, developed with almost bewildering rapidity. As in so many other things, it has its applications also in medicine; perhaps one of the most novel and ingenious of these, as well as the least generally known, is the employment of the electric light to illuminate various parts of the body which are only obscurely visible, if they can be seen at all, under ordinary circumstances. There have been many instruments, says Mr. H. Wilson in the *English Mechanic*, designed to facilitate in this way the diagnosis of the less accessible cavities of the human frame. The oesil-

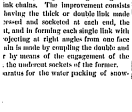
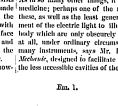


FIG. 1.

FIG. 2.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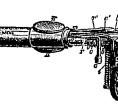
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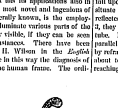
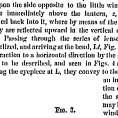


FIG. 5.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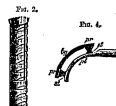
FIG. 7.

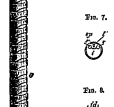
FIG. 8.

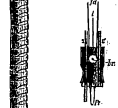
FIG. 9.

THE GASTROSCOPE—AN ELECTRIC LIGHT FOR THE HUMAN STOMACH.

nary instruments are constructed to reflect the light either of day or of some artificial source upon the part to be examined. The bright oil-lamp which a medical man will often use to help him to see a sore throat more clearly by reflecting additional light upon it, is of course a primitive form of such instrument. In some of the most recently perfected of these appliances a small piece of platinum foil is the electrode from a source of electricity, is placed in the focus of a small mirror. By allowing a carefully regulated electric current to circulate through this, when the platinum is, of course, reduced to a white heat and emits a brilliant light. This is reflected upon the part to be diagnosed, which is then made clearly visible to the operator. Instruments for viewing the interior of the bladder, the œsophagus, or the stomach (for obvious reasons the examination of bowels is no longer to escape the scorching gaze of science), are necessarily more complicated than those for diagnosing, for instance, the mouth or the ear.

We select the gastroscope for viewing the interior of the stomach, as the most ingenious and remarkable of all these instruments which have recently been brought to great perfection in Vienna, and also as showing to what a point of delicacy the executive scientific instruments has been carried in our day. We add that the gastroscope is not a mere model or plaything, but has been in actual use. A figure of the complete instrument is shown in the first block, Figs. 1 and 2, and references to it and to the smaller cuts will enable us to explain the principal features, which will, we think, interest all lovers of ingenious mechanical appliances.

The gastroscope consists mainly of a right horizontal tube, Fig. 1, *a*, terminating in one direction in the eyepiece, *b*, Fig. 1, *c*, terminating in one direction in the eyepiece, *b*, and in the other prolonged into a partially flexible tube, and which can be passed down the œsophagus until its end reaches the stomach. This flexible metal tube, Fig. 2, is is formed of 40 annular pieces, united by lateral joints, and thus forming a completely closed tube, whether it be disposed in a straight line or in a curve, without any chinks or openings, in which, did they exist, the folds of the mucous membrane might easily be caught and lacerated. This closefitting arrangement is effected by making the inside of the guide-tube without this plate.) The most ingenious feature of this arrangement is that it allows the guide-tube to move freely backward and forward through the curved outer tube or guide, Fig. 2, and yet at the same time maintains the guide-tube in a constant position. This is effected thus: The guide-tube, Fig. 3, has a small oblong aperture, *Or*, on the under side, which is of just sufficient size to allow the insertion of the prisms one after another. The aperture *k-k'* is prolonged into a slit for some little distance in the direction of the lower end of the tube. A corresponding slit in the tube, *a*, Fig. 1, slides along the prism supports, which thus offer no obstacle to the motion of the guide tube, which in this manner is movable within the outer tube, while the latter and its inclosed prisms retain a constant position. This arrangement will be better understood by a reference to the sectional drawing of the two tubes and prism plate, Fig. 4.

To obviate the inconvenience which might arise from any elevation of temperature in the stomach, the space between the two sheets of the *hastere* is kept filled with water, and communicates with two diminutive caoutchouc pipes, *rr*, conveyed down the side tube, as seen in the sectional drawing, Fig. 7, and terminating in the bent nozzles, *c-c'*, Fig. 1. To these further India-rubber tubes are adapted, one to supply, and the other to lead off the water which is thus kept in perpetual circulation, and the temperature of which has of course to be regulated so as to obviate any inconvenient degree of heat produced in the stomach.

The ensuing pieces of confirmed and delicate workmanship in the instrument is an equal significance, by which the extremity of the guide-tube, *a*, its little window, may be made to revolve. The eyepiece has merely to turn the little milled wheel, *Ii*, Fig. 1, round which is stretched the silk cord, *fd*. The latter passes from the tube and round the tiny wheel, *Ir*, shown in the section of the tube, Figs. 8 and 9. This tiny wheel, which, it will be observed, is toothed, plays into an indented ring and the interior of the lower rotatory portion of the tube, *Pi*, *Ir*, which it can by its means cause to revolve whenever motion is imparted to itself by the agency of the silk cord which communicates with the milled wheel, *Ii*, placed conveniently near the eyepiece. This ingenious and delicate motion gives the necessary

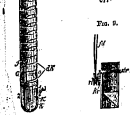
FIG. 10.

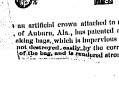
FIG. 11.

FIG. 12.

n an artificial crown attached to the of Auburn, Ala., has patented an eaking bags, which is inpervious to not destroyed, owing to the corro- of the bag, and is rendered strong

THE DAILY GRAPHIC.
NOVEMBER 1, 1881.

ELECTRICITY meets with great opposition from the great monopolists of Europe. M. Gaulard, a French chief of staff, has only just set in motion dynamo-engine for generating electricity into working order. The gloom and the dwarfs that he had to stay were infinite. He blamed more than they deserved the mechanics and laborers employed to raise it, for the needless delay there was in getting through their task. The Messrs. Siemens' patience has been severely taxed by the obstructive course shown in regard to their transversity the Board of Works and the police, at the instigation of two great companies, to whom, it is given, but enough, as astonishing, to have the Siemens' system of electric lighting thrown known-in Cabbs the Vienna, the advantages of electricity over steam as a locomotive power for tramways, but the remarkable was hampered with so many conditions as to be practically of very little use. There were men with low-pressure boxes which were not to be interfered with, the members were not to be disturbed, the waterior service was not to be impeded, and many other things which stood in the way were to be experienced upon. The six company really threw every obstacle in the way of the new invention which threatens to supersede its own, and the omnibus company is not less decided in its opposition; and now that it has been demonstrated that the electric light can easily be transformed into heat and motive power, the companies are against it. Just as they were against the use of steam in the early part of the century.

Scientific Daily Record
Nov 1 1881

ECONOMY OF THE ELECTRIC LIGHT.

Some figures are given showing that the cost of the electric light may be about one-third that of gas under favorable conditions. This is encouraging, but it is evident that the electric light has not yet been so far perfected that it can be employed safely. The one serious danger is that arising from the breach of insulation of the conducting wires. Hitherto these wires have been wound with thread for the most part, but it is evident that a current so anxious as we think to impress which might bring the metal wire into contact with woodwork, in which case a conflagration would infallibly ensue, or with human beings, in which case somebody would probably be killed. Of course it must be possible so to insulate the wires that they cannot be exposed, but this has not been done yet, and it will have to be done before the electric light can be introduced on a large scale.

THE CHICAGO HERALD.
FRIDAY, MARCH 3, 1882.

The Opposition It Does Not and the Success It Has Accomplished.

It is reputed that at the close of the first day's fighting in the Wilderness, General Grant summoned his Division Commanders together for counsel.

Unanimously they expressed their conviction in the necessity for retreat.

To each General Grant gave written instructions, to be opened on arriving at quarters.

To orders were: "Attack at day-break, burying the enemy's flank."

The result of this, judging by former experience, stood in the way of such disposition, but when the forward movement dawned upon them an immense clear accepted was the Union lines, and like a flash of lightning the spirit was changed to confidence of victory.

That magnificent Army of the Potomac had

at last found a chieftain worthy of its heroism and patriotism.

Whether or not the foregoing is historically accurate, it is certain that General Grant possessed those rare qualities of soul which inspire others on the battle-field and hasten success.

In other realms of human activity circumstances frequently arise which call into action prophetic and heroic qualities which demand our admiration. The storm of adverse criticism from the scientific world, which fell like shot in the Titan, failed to overwhelm the practicability of the substitution of the electric light, as still the electric light burns.

A plentiful harvest fall in of wealthy genius, and wise not slow to avail itself of such instrumentalities as are proved. Messrs. Gilliland, of Montreal, in the United States; William Henry Preece, of Dolgelly, in Wales; Messrs. Siemens, of Berlin, and Gaulard and Gibbard, of Paris, and Professor Jamin, of the French Academy, in adapting the force of their scientific.

These years of persistent and courageous labor followed, during which the public, losing confidence, withdrew their support, and the inventors themselves were disheartened with so many conditions as to be practically of very little use. There were men with low-pressure boxes which were not to be interfered with, the members were not to be disturbed, the waterior service was not to be impeded, and many other things which stood in the way were to be experienced upon. The six company really threw every obstacle in the way of the new invention which threatens to supersede its own, and the omnibus company is not less decided in its opposition; and now that it has been demonstrated that the electric light can easily be transformed into heat and motive power, the companies are against it. Just as they were against the use of steam in the early part of the century.

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The National Scientific Journal.
November 1, 1881.

MECHANICAL ACTION OF HEAT AND ELECTRICITY.

The difference between heat and electricity in their modes of mechanical action is very wide. Heat acts by expansion of volume which we know to be a necessarily wasteful principle, while electricity operates by attraction not repulsion, and thus produces motion in a manner which is subject to no greater loss of effect than attends the motive action of gravity as exemplified in the pondera bleapplication of falling water in hydraulic machines. If then we could produce electricity with the same facility and economy as heat, the gain would be enormous, but this, as yet at least, we cannot do. At present by far the cheapest method of generating electricity is by the dynamic process. Instead of beginning with electricity to produce power, we begin with power to produce electricity. As a secondary motor an electric engine may, and assuredly will, play an important part in future applications of po_____ but our present inquiry relates to a primary, and not a secondary, employment of electricity. Thus we are brought to the question, From what source, other than mechanical action, can we hope to obtain a supply of electricity sufficiently cheap and abundant to enable it to take the place of heat as a motive energy? It is commonly said that we know so little of the nature of electricity that it is impossible to set bounds to the means of obtaining it; but ignorance is at least as liable to mislead in the direction of exaggerated expectation as in that of incredulity. It may be freely admitted that the nature of electricity is much less understood than that of heat, but we know that the two are very nearly allied. The doctrine that heat consists of internal motion of molecules may be accepted with almost absolute certainty of its truth. The old idea of heat being a separate entity is no longer held except by those who prefer the fallacious evidence of their senses to the demonstrations of science. So also the old idea of electricity having a separate existence from ponderable matter must be discarded, and we are justified in concluding that it is merely a strained or tensional condition of the molecules of matter. Although electricity is more prone to pass into heat than heat into electricity, yet we know that they are mutually convertible. In short, I need scarcely remind you, that according to that magnificent generalization of modern times, so pregnant with great consequences, and for which we are indebted to many illustrious investigators, we now know that heat, electricity and mechanical action, are all equivalent and transposable forms of energy, of which motion is the essence.

To take a cursory view of our available sources of energy, we have, firstly, the direct heating power of the sun's rays, which as yet we have not succeeded in applying to motive purposes. Secondly, we have water power, wind power and tidal power, all depending upon influence lying outside of our planet. And, thirdly, we have chemical attraction or affinity. Beyond these there is nothing worth naming. Of the radiant heat of the sun I shall have to speak hereafter, and bearing in mind that we are in search of electricity as a cause, and not an effect, of motive power, we may pass over the dynamical agencies comprised under the second head, and direct our attention to chemical affinity as the sole remaining source of energy available for our purpose. At present we derive motive power from chemical attraction through the medium of heat only, and the question is, can we with advantage draw upon the same source through the medium of electricity. The process by which we obtain our supply of heat from the exercise of affinity is that of combustion, in which the substances most consist, on the one hand, of those we call fuel, of which coal is the most important, and on the other, of oxygen, which we derive from the atmosphere. The oxygen has an immense advantage over every other available substance in being omnipresent and costless. The only money value involved

at once in the fuel, and in being cast we employ the cheapest available substances to be found in nature. Moreover, the weight of coal used in the combustion is only about one-third of the weight of oxygen, so that we only pay upon one-fourth of the whole material consumed. Then we have conditions of the most favorable description for the production of energy, in the form of heat, and if we could only use the affinities of the same substances with equal facility to evolve electric energy instead of heat energy, there would be nothing more to desire; but as yet there is no appearance of our being able to do this. According to our present practice we consume coke, instead of coal, in the volatile production of electricity, and not only is zinc thirty or forty times dearer than coal, but it requires to be used in about six-fold larger quantity in order to develop an equal amount of energy. Some people are bold enough to say that with our present imperfect knowledge of electricity we have no right to condemn all plausible theories, other than coal, as impracticable substitutes for metallic zinc, but it is manifest that we cannot get energy from affinity, when affinity has already been satisfied. The numerous bodies which constitute the mass of our globe, and which we call earths, are bodies in this inert condition. They have already, by the union of the two elements composing them, evolved the energy due to their combination, and that energy has ages ago been dissipated in space in the form of heat, never again to be available to us. As well might we try to make the ash ashes, as to use such bodies over again as sources of either heat or electricity. To make them fit for our purposes we should first have to annul their state of combination, and this would require the expenditure of more energy upon them than we could derive from their recombination. Water, being oxidized hydrogen, must be placed in the same category as the earths. In short, the only abundant substances in nature possessing strong unsatisfied affinities are those of organic origin, and in the absence of coal, which is the accumulated product of a past vegetation, our supply of such substances would be insignificant. This being the case, until a means be found of making the combination of coal with oxygen directly available for the development of electric energy, as it now is of heat energy, there seems to be no probability of our obtaining electricity from chemical action at such a cost as to supplant heat as a motive agent.

But while still looking to heat as the fountain-head of our power, we may very possibly learn to transmute it, economically, into the more available form of electricity. One method of transformation we already possess, and we have every reason to believe there are others yet to be discovered. We know that when dissimilar metals are joined at opposite ends, and heated at one set of junctions while they are cooled at the other, part of the heat applied disappears in the process and assumes the form of an electric current. Each couple of metals may be treated as the cell of a voltaic battery, and we may multiply them to any extent and group them in series or in parallels with the same results as are obtained by similar combinations of voltaic cells. The electricity so produced we term Thermo-electricity, and the apparatus by which the current is evolved is the thermo-electric battery. At present this apparatus is even more wasteful of heat than the steam-engine, but considering the very recent origin of this branch of electrical science and our extremely imperfect knowledge of the actions involved, we may reasonably regard the present thermo-electric battery as the infant condition of a discovery, which, if it follow the rule of all previous discoveries in electricity, only requires time to develop into great practical importance. Now, if we possessed an efficient apparatus of this description we could at once apply it to the steam-engine for the purpose of converting into electric energy the heat which now escapes with the rejected steam and the gases from the fire. The vice of the steam-engine lies in its inability to utilize heat of comparatively low grade, but if we could use up the leavings of the steam-engine by a supplemental machine acting on

thermo-electric principles, the present excessive waste would be avoided. We may even anticipate that in the distant future a thermo-electric engine may not only be used as an auxiliary, but in complete substitution of the steam-engine. Such an expectation certainly seems to be commanded by what we may observe in animated nature. An animal is a living machine dependent upon food both for its formation and its action. That portion of the food which is not used for growth or structural repair, acts strictly as fuel in the production of heat. Part of that heat goes to the maintenance of the animal temperature, and the remainder gives rise to mechanical action. The only an logy between the steam-engine and this living engine is that both are dependent upon the combustion of fuel, the combustion in the one case being extremely slow, and in the other very rapid. In the steam-engine the motive [illegible] produced by pressure, but in the animal machine it [illegible] fected by muscular contraction. The energy which [illegible] t not purely electrical, but it is so similar [illegible] of produce the same effect by electricity. A scientific system of the nerves is also [illegible] with our conception of an electrical arrangem[illegible]s. In a description of the animal machine [illegible]body exhibits that of an electrodynamic machine actuated by thermo-electricity, that we may sometimes have to be substantially the same thing. At all events, the animal process begins with combustion and ends with electrical action, or something so nearly allied to it as differ only in kind. And now observe how superior the result is in nature's engine to what it is in ours. Nature only uses heat of low grade, such as we find wholly unavailable. We reject as worthless, as useless, at a temperature that would cook the animal substance, while nature works with a heat we unite as not to hurt the most delicate tissue. And yet, notwithstanding the greater availability of high-grade temperature, the quantity of work performed by the living engine relatively to the fuel consumed, puts the steam-engine to shame. How all this is done in the animal organism we do not yet understand, but the result points to the attainability of an efficient means of converting low-grade heat into electricity, and in striving after a method of accomplishing that object we shall do well to study nature, and profit by the excellence which is there displayed.

But it is not alone in connection with a better utilization of the heat of combustion that thermo-electricity bears so important an aspect, for it is only the want of an efficient apparatus for converting heat into electricity, that prevents our using the direct heating action of the sun's rays for motive power. In our climate, it is true, we shall never be able to depend upon sunshine for power, nor need we regret that our ground is so far away as we have the perennial mines which we possess in the condensed and portable form of coal, but in regions more favored with sun and less provided with coal the case would be different. The actual power of the sun's rays is enormous, being computed to be equal to melting a crust of ice 100 feet thick over the whole earth in a year. Within the tropics it would be a great deal more, but a large deduction would everywhere have to be made for absorption of heat by the atmosphere. Taking all things into account, however, we shall not be far from the truth in assuming the solar heat, in the part of the world, to be capable of melting annually, at the surface of the ground, a layer of ice eighty-five feet thick. Now let us see what this means in mechanical effect. To melt one pound of ice requires 142.4 English units of heat, which, multiplied by 772, gives us 109,932 foot pounds as the number of foot pounds of the heat consumed in melting a pound of ice. Hence we find that the solar heat, operating upon an area of one acre, in the tropics, and competent to melt a layer of ice eighty-five feet thick in a year, would, if fully utilized, exert the smarting power of 4,000 horses acting for nearly nine hours every day. In dealing with the sun's energy we could afford to be wasteful. Waste of coal means waste of money and premature exhaustion of coal-beds. But the sun's heat is poured upon the earth in endless profusion—useless at all events in a practical sense, for whatever anxiety we may feel as to the duration of coal, we need have none as to the duration of the sun. We have therefore only to consider whether we can divert to our use so much of the sun's motive energy as will repay the cost of the necessary apparatus, and whenever such an apparatus is forthcoming we may expect to bring into subjection a very considerable proportion of the 4,000 invisible horses which science tells us are to be found within every acre of tropical ground.

But whatever may be the future of electricity as a prime mover, either in a dominant or subordinate relation to heat, it is certain to be largely used for mechanical purposes in a secondary capacity, that is to say, as the offspring instead of the parent of motive power. The most distinctive characteristic of electricity is that which we express by the word "current," and this gives it great value in cases where power is required in a transmissible form. The term may be objected to as implying a motion of translation analogous to the flow of a liquid through a pipe, whereas the passage of electricity through a conductor must be regarded as a wave-like action communicated from particle to particle. In the case of a fluid current through a pipe, the resistance to the flow increases as the square of the velocity, while in the case of an electric current the resistance through a given conductor is a constant proportion of the energy transmitted. So far, therefore, as resistance is concerned, electricity has a great advantage over water for the transmission of power. The cost of the conductor will however be a grave consideration where the length is great, because its section must be increased in proportion to the length to keep the resistance the same. It must also be large enough in section to prevent heating, which not only represents loss but impairs conductivity. To work advantageously on this system, a high electromotive force must be used, and this will involve loss by imperfect insulation, increasing in amount with the length of the line. For these reasons there will be a limit to the distance to which electricity may be profitably conveyed, but within that limit there will be wide scope for its employment transmissively. Whenever the time arrives for utilizing the power of great waterfalls, the transmission of power by electricity will become a system of vast importance. Even now small streams of water inconveniently situated for direct application may, by the adoption of this principle, be brought into useful operation.

For locomotive purposes also we find the dynamo-electric principle to be available, as instanced in the very interesting example presented by the Siemens electric railway, which has already attained that degree of success which generally precludes even an important future. It forms a combined fixed engine and locomotive system of traction, the fixed engine being the generator of the power and the electric engine representing the locomotive.

Steam power may both be transmitted and distributed, by the intervention of electricity, but it will labor under great disadvantage when thus applied, until a thoroughly effective electric accumulator be provided, capable of giving out electric energy with almost unlimited rapidity. How for the secondary battery of M. Faure will fulfill the necessary conditions remains to be seen, and it is to be hoped that the dilations which may be expected to take place at this meeting of the British Association will enable the jury of its capabilities to be formed. The introduction of the Faure battery is at any rate a very important step in electrical progress. It will enable motors of small power, whether their nature may be, to accomplish, by uninterrupted action, the effect of much larger machines acting for short periods, and by this means the value of very small streams of water will be greatly enhanced. This will be for electric lighting, which, in summer, when the springs are low, will only be required during the brief hours of darkness, while in winter the longer nights will be met by a more abundant supply of water. Even the fitful power of wind, now so little used, will probably acquire new life when aided by a system which will not only collect, but equalize, the variable and uncertain power exerted by the air.

It would greatly add to the utility of the Faure battery if its weight and size could be considerably reduced, for in that case it might be applicable to many purposes of locomotion. We may easily conceive its becoming available in a lighter form for all sorts of carriages on common roads, thereby saving to a vast extent the labor of horses. Even the nobler animal that strides a bicycle, or the one of inferior courage that prefers the safer seat of a tricycle, may ere long be spared the labor of propulsion, and the time may not be distant when an electric horse, far more amenable to discipline than the living one, may be added to the businesses gifts which science has bestowed on civilized man.

In conclusion I may observe that we can scarcely sufficiently admire the profound investigations which have revested to us the actual dynamical relation of heat and electricity to outward mechanical motion. It would be a deliberate task to apportion praise amongst those whose labors have contributed, in various degrees, to our present knowledge; but I shall do no injustice in saying that of those who have expounded the modern doctrine of energy, in special relation to mechanical practice, the names of Joule, Clausius, Rankine, and William Thomson, will always be conspicuous. But up to the time our knowledge of energy is almost confined to its inorganic aspect. Of its physiological action we remain in deep ignorance, and as we may expect to derive much valuable guidance from a knowledge of Nature's methods of dealing with energy in her wondrous mechanisms, it is to be hoped that future research will be directed to the elucidation of that branch of science which as yet has not even a name, but which I may provisionally term "Animal Energetics."—*Sir William Armstrong, Section G, British Association.*

The National Scientific Journal.

November 1, 1881.

Electricity and Chemistry.

The Electro-Technical Society of Berlin (*Elektrotechnischer Verein*) offers a prize of a thousand marks (shillings) for the best essay on the transmission of power by electrical and mechanical means, which must be sent in before the 1st of October, 1882.

The galvanic current has for many years been applied successfully in quantitative determinations of copper, lead, cobalt, nickel and manganese. The case of zinc presents peculiar difficulties, however, and none of the series of methods proposed for its determination has proved satisfactory. From a paper in the *Journal für Praktische Chemie*, it appears that Herr Hampel and Dr. Ilin have succeeded, even with a weak current, in getting zinc, in a form well suited for weighing, from an oxalate solution. They chose oxalic acid, as being an acid easily removed by the current, and not formed again by secondary action. Since, however, oxalate of zinc could not be used because of its insolubility in water, they had recourse to the soluble ammonium double salt.

Use of Magneto- and Dynamo-Electric Machines for Electric Lighting.—The fundamental principles which underlie all magneto-electric machines are the four great principles discovered by Oersted in 1819, by Ampère and Arago in 1820, and by Faraday in 1831. In 1820 Oersted discovered the action of a current of electricity on a magnet. In 1820 Ampère discovered the action of magnets and currents on currents of electricity in their neighborhood, and in the same year Arago showed that currents of electricity produced magnetization, thus laying the foundations of electro-magnetism; and in 1831 Faraday showed that induced currents were produced by the motion of magnets. All machines for the conversion of work into electricity are founded on Faraday's great discovery of the induced current, derived from the relative motion of a magnet and a coil of wire.

Magneto-electric machines are divided into two great classes, according as they furnish continuous currents or alternate currents. All such machines are alternate, in so far as regards the currents in the coil; but these currents are made to flow always in the same direction in the external circuit, in continuous-current machines, by means of a commutator, which reverses the contact at every half-turn.

The machines of Pixii, in 1832, followed by those of Saxton and, Clarke, were the first continuous-current machines. From these we may pass to Wheatstone's introduction, in 1845, of electro-magnets in place of permanent magnets, to produce a magnetic field. In 1854, Messrs. Wertner, Siemens, and Halske introduced the Siemens armature, in which the coil is wound longitudinally in a groove. The strength of the contiguous-current depends on the velocity of rotation, on the length of the wire, and the power of the magnetic field form[illegible] the magnets.

It is remarkable that, [illegible] which was some thirty-[illegible] big[illegible] patented an improved ma[illegible] in which the currents induced in the revolving [illegible] 388 round the electro-magnets, and increase their [illegible] s and so increase the induced currents at a compound [illegible]. This was the celebrated principle afterwards rediscovered by Siemens and by Wheatstone simultaneously in 1867, which has formed the basis of all dynamo-electric machines, and which, for equal power, are cheaper and more compact than all other multiple guidance from a knowledge of Nature's methods of dealing with energy in her wondrous mechanisms, it is to be hoped that future research will be directed to the elucidation of that branch of science which as yet has not even a name, but which I may provisionally term "Animal Energetics."—*Sir William Armstrong, Section G, British Association.*

Dynamo-Electric Machines.—In February, 1867, Dr. Siemens and Sir Charles Wheatstone, on the same evening, presented to the Royal Society their two papers, "On the Augmentation of the Power of a Magnet by the Reaction thereon of Currents induced by the magnet itself." According to the principle then put forward by Dr. Siemens, the sphering armature, the electro-magnet and the external resistance, such as an electric lamp, are joined up so as to form one simple circuit. A small amount of magnetism is communicated to the electro-magnet, so that, on rotating a coil, a current is induced alternately in opposite directions, and after being reduced to the same direction by a commutator, this current passes through the coils of the electro-magnet, in such a direction as to make it stronger, so enabling it to rend in the armature. Thus the magnet and the armature act and react on one another, strengthening the magnetic field and continually energizing the induced currents. Sir Charles Wheatstone put forward the same principle, and called attention to the fact that at the first moment of completing the combined circuit, the effects are stronger than they are permanently.

He also pointed out that a very remarkable increase of all the effects is observed when a shunt is employed to divert a great portion of the current from the electro-magnet. By that means 4 in. of platinum wire, .0007 in. diameter, was made to glow. A certain resistance in the shunt was found to be necessary to produce best effects, so as neither to weaken the magnetism too much, nor to give the current too much work to do in heating a high resistance.

In addition to this, Sir Charles Wheatstone showed that the effects above described are far inferior to the effects obtained by placing the work to be done in the shunt circuit. Three series coaches of wire were made to glow in the shunt, when *only four* inches of the same wire would glow in the original circuit. There is thus a double advantage for there is no loss of resistance by introducing the shunt, the resistance of the shunt being the resistance on which the useful work is done.

This improvement was suggested by Sir Charles Wheatstone in 1851, and is now being adopted by Dr. C. W. Siemens in his latest dynamo-electric machine.

Wheatstone also showed that the effects are much less influenced by a resistance in the electro-magnet branch than by either of the other branches. Thus, with about four inches of glowing platinum wire in circuit, the addi-

tion of about five inches of platinum wire in the armature
branch, or in the shunt, produced a three-quarter-inch
glow, whilst four feet of the same wire was required in the
electro-magnet branch to reduce t
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THE GRAMME RING.—In the Gr
wire was wound in sections, all in t
a ring; and each section, whe
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one of these electro-magnets with
towards the south pole of anoth
treated towards it, and with great
nearer it approaches; on passing
south pole will be presented to the
magnet which it has just passed
continued in the same direction.

Now suppose no current to be f
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induced current in the coil is roun
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With right-handed winding of t
a cork-screw, the current is coun
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If we consider a section of the r
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electric machines, where the same
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To obtain greater regularity, Wi
employ a separate continuous-cu
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the second machine between the p
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F. R. S.

one half of which has been treated. Although there is scarcely any difference as regards the appearance of the two halves, you see that water is readily absorbed by the untreated half, but not by the portion which has been rendered impervious by the solutions of Messrs. Ransome and Co.

The dephosphorising properties of lime have been rendered available in obtaining compact masses of the refractory metal, iridium; the spongy metal being first fused with a moderate proportion of phosphorus, after which the comparatively fusible phosphide is located in powdered lime, until all the phosphorus becomes removed.

As an indirect measure, lime possesses some value, decomposing silicates, disintegrating organic matter, and destroying insects. As an agent in various chemical industries, lime holds an important position; its uses in tanning, the preparation of the caustic alkalies, the liberation of ammonia, and other processes, being very considerable. With respect to its bearing on the iron industry, my remarks must be deferred until the utilisation of the furnace slag is considered. Some kinds of glass, as for example the hard Bohemian varieties contain a considerable proportion of lime; and powdered lime is often used in packing [illegible] to prevent [illegible] during annealing.

READ

JUVENILE LECTURES.

RECENT WONDERS OF ELECTRICITY.

By W. H. PREECE, F.R.S.

Lecture II.—Delivered on Wednesday, 4th January, 1875.

Last week, when we had the pleasure of meeting, I endeavoured to disclose your minds of any such idea as that electricity was a fluid, or, in fact, any kind of matter. I pointed out to you that every electric phenomenon really was a form of that curious, mysterious agency that exists throughout nature, that produces all the work done on the face of the earth, that probably is at the root of life itself, called energy. Nevertheless, we can speak of electricity as though it were a distinct entity; precisely in the same way that we speak of sound, of light, and of heat. We know that sound and heat are not sensible to the touch, or taste, or sight; so electricity is of the same character, and is invisible and intensible in every shape or form. Moreover, we cannot either create or produce energy; there is only a certain fixed quantity of energy in the universe, and all that we can do is simply to transform it into its different shapes, such as I illustrated to you last week. All physical phenomena, without a single exception, may be traced to the mere transformation of this energy. I showed you on the last occasion how, by simply winding a wire round a mass of iron, and sending a current of electricity through the wire, we could produce that form of energy called electro-magnetism. To-night I have to speak of one or two other forms in which this energy does its work, forms in which, when electricity is transferred through matter, it does work in some shape or another. The operation of the electric current, when passed through chemical compounds in solution or liquid, is to tear asunder the constituents of the compound, and to arrange them on different sides. A simple means of illustrating this is a glass jar, like the one before you, containing water and two glass tubes, each fitted with a stop cock. When an electric current is passed through the water, the elements of water, oxygen, and hydrogen, are driven asunder, and take refuge, as it were, in the right or left-hand tube respectively. To prove that these gases have been collected, if a lighted match be placed over the hydrogen tap, the hydrogen will give evidence of its presence by inflammability; but if the match be blown out and immediately presented to the tap of the tube containing the oxygen, that gas will make its presence evident by relighting the match. [Experiment shown.] The effect of the passage of electricity through water is something like the effect which would be produced by a storm, or other agency, in this room, which caused all the boys of this audience to go to one side, and all the girls to go to the other—excepting that in water there are always two parts of hydrogen to one part or volume of oxygen. Not only does the current tear asunder the oxygen and hydrogen of water, but it also breaks up the constituents of most of the chemical compounds, and the weight of material decomposed per second is an exact measure of the work done, and of the current flowing. For instance, if we take a solution of sulphate of copper and pass electricity through it, the solution is broken up into copper and sulphuric acid, and if a bunch of keys were put into the solution while the electricity was passing through it, the keys would receive a deposit of copper. If nitrate of silver solution were used instead of the sulphate of copper solution, silver would be

deposited upon the keys or piece of metal inserted. Through the kindness of Mr. Boles, I am able to show you an experiment of this kind, which will enable me to give you a record of this evening's entertainment. I have here, a large glass dish containing a liquid, which, no doubt appears to you like water, but, which is really a solution of the double salt of cyanide of silver and potassium. In this solution, I now place a piece of sheet copper, which you see has the usual appearance of copper all over it. Now, while that plate of copper is inserted to one half its extent in water, we will pass electric currents through the liquid from the hand-dynamo machine on the table [experiment proceeding], which cause the cyanide of silver to break up into cyanogen on one side, and silver on the other, and if I take out the plate of copper, you see there has been deposited upon its immersed surface a coating of silver. Silver spoons and all the various kinds of electro-plate wares receive their silver deposit in the manner I have just shown you. Now, we will set this small dynamo-machine in action by turning its handle, thus converting the energy of the human body into electric energy; and we will immerse a quantity of brass bottom in the liquid, which, when they have received their coating of silver, will be laid aside, ready for distribution as a memento at the close of the lecture. Through the kindness of Messrs. Elkington, I am able to show you the handsome specimens of electro-plating which hang on the walls of the room, and which were plated at their works at Birmingham, by a process exactly similar in character to that I have described, excepting that steam-power is substituted for the manual labour you just saw for producing the electric currents.

We next come to the work performed by electricity in passing through solids. The result of this work is simply the production of heat. Before me you will notice two brass stands, and between them I will suspend a piece of fine platinum wire. I now join up one of my battery wires (the same that I used last week) to one of the brass stands, and touch the other brass stand with the other battery wire; the effect appears as a red glow in the platinum wire. If I bring one of my battery wires from the bottom of the brass stand to the end of the platinum wire, the colour of the glow becomes brighter; and as I move my battery wire along the platinum wire the glow or light produced by the high temperature to the platinum becomes more and more intense, until finally, when it reaches a certain temperature (about 3,000° Fahr.) the wire is ruptured, and falls to the ground. That is evidence that the passage of electricity, through solid conductors, produces heat, and the amount of heat produced is proportioned to the work done in the battery. Energy expended in one part of a circuit must be given out at another. If zinc is consumed in a battery, it generates a certain amount of energy, that energy must be evident in some other part of the circuit, and the best you saw in the platinum was really the heat that would have appeared in the battery itself if we had not caused the current to flow through a solid conductor which offered a considerable amount of resistance to its progress, as compared with the resistance in the battery itself. This power of producing heat has been utilised in various ways, such as for firing fuses. [An Abel fuse was exploded.] At many places throughout the country, time guns are fired by such an electric fuse to announce the Greenwich time current at a certain hour. Mines and torpedoes are exploded in a similar manner; quarries are blasted, and many other results are brought about by passing electricity through platinum wire placed in explosive substances, or by special fuses. I do not intend to frighten or alarm you, but for your amusement, and through the kindness of Professor Abel, I have had fuses fixed out of harm's way at various points round the room, and when a small current is passed through them you will hear the explosion produced. [Experiment carried out.] Those fuses might have been fixed miles away, and the same effect would have been produced, and from it you will understand how a number of charges can be fired, or a number of guns can be discharged simultaneously on board our large men-of-war.

The next branch of the subject is the work done by electricity in its passage through air and gases. I have shown you that, in its passage through liquids, it tears the constituents of the solution asunder; in its passage through solids heat is produced; and in its passage through air, it not only produces heat, but violent projection of material particles as well, which it renders incandescent, producing sparks, heat, and other disruptive effects. To illustrate this, I have provided an Apps' induction coil, to which can be joined up vacuum tubes of various kinds, and through which the currents produced by the hand-dynamo machine will be passed. [A beautiful collection of vacuum tubes, fitted with various rarefied gases, was then shown, while the lights

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USE OF SEPARATE EXCITING-MA
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P. H. S.

were turned down.] In those effects we have the result of electricity passing through air, and gases of extreme tenuity, and also an indication of the way in which electricity produces heat—and, therefore, light—in gaseous matter. All instances of artificial lighting or heating are simply due to the fact that we are able to produce heat, and heat of a very high temperature. It is a curious fact that all matter, whether metal or porcelain, carbon or lime, begins to emit light at precisely the same temperature, which closely approaches 1,000° Fahr., or, to be accurate, I believe it is 980° Fahr., so that, whenever it is possible by any means to raise any material to that temperature, light is emitted, and the intensity of light increases, until, in the case of carbon, when about 4,000° Fahr. is reached, the material is destroyed. In platinum a lower figure (3,080°) represents the point of fusion. To obtain this very high temperature by electric currents, we must utilise higher means of producing the electricity than I have hitherto shown you. In the battery I have just used, the electric current was produced by the combustion of zinc, but now I want to explain to you how, as I said, muscular power was converted into electric energy. The reason is simply due to the fact discovered by Faraday, that whenever a wire or conductor moved through the sphere or field of a magnet it became electrified. I take up the brass rod before me and move it rapidly, and by doing so have to a certain extent electrified it by causing it to pass through the magnetic field of the earth. The earth is an enormous magnet, a fact which we know, because our compasses guide the mariners across the deep. The air in this room is under the influence of the earth's magnetism, and if I move a wire or rod within that influence, at right angles to the lines of magnetic force, I cause it to be electrified, but only to an excessively small extent. The strength of the current produced, depends upon the strength of the magnetic field, and upon the velocity with which the conductor moves across the field. Instead of having only one rod, or one wire, we have in this hand machine, an arrangement of a thousand turns of wire, instead of having the weak magnetism of the earth, we have the powerful field of permanent magnet, and instead of causing it to move through the air by the velocity of my arm, we apply multiplying gear, which, as you see, imparts velocity to it of great rapidity. Thus motion, through a magnetic field, produces an electromotive force. There never can be a continuous electromotive force without some source of energy. Here we have mechanical energy expended, and all the conditions for the production and maintenance of a current. Energy expended in one point must be found in some form in another point. If it is not utilised, it is wasted. Some of it must always be wasted, and the true economist will try and waste the least possible quantity. If I place a piece of platinum wire between the two wires connected with the hand dynamo-machine, you see that the muscular energy of my assistant, by turning the handle, generates currents of electricity, which give a red heat to the platinum wire. The energy of the body is thrown into the machine, the machine converts it into electricity, the electricity passes through the wire, which, by having work done upon it is rendered incandescent, and, in consequence, becomes luminous. I have here a lamp containing a piece of platinum wire, and if I connect it to the wires of the dynamo-machine [this was done], the platinum glows and gives us light. It is a machine precisely similar in principle to the one now before you, fixed under the arches on the Thames-embankment, and worked by a steam-engine (sent for the purpose by Messrs. Robey), that is supplying currents of electricity to the lamps now lighting this room. There is an occasional break in the light; this is produced by the unsteadiness of the engine, which was not specially prepared for the purpose, but was the best available. It is, in fact, an agricultural machine. There are two kinds of electric machines of this class. One is called the magneto-machine, like the one before you, because the magnetic field is produced by the presence of a powerful permanent magnet, which I think is visible to most of you, and which consists of several pieces of steel that have been magnetised. The other kind of machine is called the dynamo-machine, in which the magnetic field is produced by an electro-magnet, which is itself excited by the currents it generates, so that there is a kind of accumulative action, one current piles up the agency on the other current, and all of them together, acting on the electro-magnet, increase the total effects until the iron is saturated with magnetism. So much as regards the production of currents for electric lighting purposes. The motion of the conductor through the magnetic field may be caused by the energy of coal, which is consumed to generate heat and steam for working a steam-engine; or, as at Godalming, by the energy of water on a

water-wheel; and it is very probable that where water is available, it will be the most economical source of energy for electric lighting purposes. Sir William Armstrong, at his seat at Cragside, near Newcastle-on-Tyne, has illuminated his house for some time by currents of electricity, produced by a waterfall in his grounds, so that, he says, his library and his drawing-room are lit by the river flowing through his grounds. As regards the light itself, there are two kinds of lamps. I have already explained and illustrated to you the fact, that electricity in its passage through air produces sparks. I have here what is called an arc lamp; in it two rods of carbon are held by two brass clips (not in metallic connection with each other), and the ends of the carbon are, when in action, a short distance apart. On joining up the wires to the brass clips the current flows, a bright light is instantly set up in the air between the carbon points, and the arc is formed. This light is due to the passage of an infinitely rapid succession of particles of carbon which are projected across the air space, which, in their high state of incandescence, produce light, and which in brilliancy would not compare unfavourably with that of the sun. The light from a larger arc lamp would be far more brilliant than this, but I do not want to damage your eyes or my own. I have experimented on the electric light so much, that I have suffered great tortures from the irritating and exciting influence of its bright rays upon the retina of the eyes, and I advise all people who have no opportunity of examining the arc light, not to look at it too much, or the eyesight may be unfavourably affected. The arc light is used principally for lighting large areas, for instance, Charing-cross Station is lit by one form of arc light, called the Brush; Cannon-street Station is lit by what is known as the Brockie lamp; the space in front of the Royal Exchange is lit up by the Siemens arc lamp; King's-cross Station is lit up by the Crompton plan; and so on. A very brilliant arc lamp at Paris, which attracted a great deal of attention, was called the Jasper light. But all arc lamps play upon one string, similar to the plan I have just shown, viz., that when two pieces of carbon are maintained at a certain distance from each other, and electricity passed between them, great heat and brilliant light is the result. There are certain difficulties in arc lamps which militate against their employment for domestic and internal use generally. The light is very intense; the effect is irritating; the ladies do not like it (and they are a powerful influence in this country), because it does not suit their complexion, nor their style of costume for evening wear: they have not their faces against it for internal illumination, and that being so, it is all up with it. Now, the light that is going to supplant the arc light for domestic purposes, is the incandescent light. The principle of the incandescent lamp is exactly the same as that I showed you in Mr. Becker's lamp, viz., that a suitable substance is enclosed in a glass bulb, from which the air has been extracted, and is brought to a high state of temperature by the passage through it of currents of electricity. The lamps illuminating this room are Mr. Edison's incandescent lamps, whose representative, Mr. Johnson, has been most indefatigable in his assistance for these lectures. The Edison lamp consists of a single curl, or loop, of a fine carbon filament (instead of platinum wire) placed in an exhausted glass bulb. The carbon is extremely thin—as thin as a human hair—but, in spite of its extreme tenuity, you see [knocking a lamp on the table] that concussion or shaking does not cause it to break, but it possesses great resilience, and vibrates like a steel spring; and it is so refractory that it will stand electric currents of enormous strength. As I have said, the lamps before you are worked by electric currents generated by an Edison dynamo-machine on the Thames-embankment, but each lamp is self-regulating and (you see) can be turned on and off by turning a top way like those used on gas-brackets. The stronger the current supplied to the lamp, the greater its heat and brilliancy, and when, by turning a handle in the instrument I have for the purpose, the strength of the current is increased, it forms a brilliant light in the glass tube, until the amount of current is greater than the carbon can stand, when it emits a beautiful blue haze, which indicates that its end is near, and then it is broken (as you see), and the lamp goes out. I can easily replace the broken lamp by unscrewing it out of its socket, and placing a fresh one in its place, when at once all is in good order, and the light resumed. These lamps are water-tight as well as air-tight, and to prove this, I will insert a lighted lamp into the little aquarium on the table, when you see that the globe is brilliantly lit up, and that the fish it contains show rather a sign of curiosity than discomfiture, and seem rather proud of their colours which are so distinctly brought out by the brilliancy of the light. Here I have a globe

tion of about five inches of platinum wire in the armature
branch, or in the shunt, produced a three-quarter-inch
glow, whilst four feet of the same
electro-magnet branch to reduce
of an inch. Dr. Siemens has sho
efficiency, the resistance of the b
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and that in both cases the wires u
considerable diameter.

THE GRAMME RING.—In the G
wire are wound in sections, all in
a ring; and each section, wh
through it, may be regarded as
similar poles of all these sectio
point in the same direction roun
one of these electro-magnets will
towards the south pole of anot
tracted towards it, and with great
nearer it approaches; on passing
south pole will be presented to th
magnet which it has just passe
continued in the same direction.

Now suppose no current to be
on applying force to produce the
the induced current will be in the
as the coil revolves towards the s
induced current in the coil is rou
it from behind, in the direction
the hands of a watch.

With right-handed winding of
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the side nearest the south pole.

If we consider a section of the
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is excited by the first machine.—
V. B. S.

of coloured water to show what brilliant effects
can be produced. A good deal has been said
about the dangers of electric lighting, and how
careful we ought to be in its use, and there is
no doubt that electricity is a very dangerous
agent if you do not know how to use it. We
have heard of the danger from fire through its
use in theatres and houses, but I want to show
you that, when I place a cambric pocket-
handkerchief round a lamp, which I then break
while electricity is going through it, no spark
or fire of any kind occurs, but the lamp in-
stantly goes out. [Experiment shown.] There
is also danger from wires coming in contact
with each other, and in that case they short
circuit the machine; they cause an increased
strength of current to flow, producing heat, and
in that manner setting fire to houses. To obviate
this danger "safety-catches" have been intro-
duced by Mr. Edison. These safety-catches con-
sist in the insertion of a very small piece of lead
wire in the circuit, which is readily fusible, so
that if the current becomes unnecessarily
powerful, it passes through the lead wire, heats
it to fusing point, and so breaks down the
section on which the "safety-catch" is placed,
eliminating at once all danger. [Illustrated.]
It does not affect any other lamps, as you see.
When the fused safety-catch is replaced by a
good one, the lamps which were broken down
by its rupture become lighted up again. We
have the means of regulating the lights now
burning in the room. Here is an apparatus in
connection with the machine at the engine-
station, and by moving the handle and inserting
in the circuit a certain amount of resistance,
I am able so to reduce the current flowing
from the machine that a considerable lowering
of the light takes place. On turning the
handle back again, the former brilliancy re-
turns. That shows the electric light in
the latest stage of its perfection. We have
a bright light now in this room, but no impure
gases are given off by the electric light and
the air is not vitiated by it. The room is warm,
but that warmth is due to the number of people
present, and not to the heat produced by the
electric light; though the electric light does,
as I have said, generate heat to produce its
effulgence. Many people talk of the electric
light as being "cold" and cheerless. The
light produced by the arc lamp does look cold
and cheerless; but the soft, delicious, incan-
descent lamp before you has just as soothing
an effect upon the eye as the prettiest lamps,
or the pleasantest candle; and it has certainly
removed all the objections that were previously
raised to the electric light for internal illumina-
ting purposes.

The next and last branch of my subject is
the transmission of motive power to a distance.
I have shown you how currents of electricity
are produced; also how they do work; how
they produce electro-magnetism; how they
generate heat; how they produce light; and
now I want to show you that the whole thing
is reversible. If, by the exertion of mechanical
power, currents of electricity can be produced,
those very same currents of electricity can in
their turn produce mechanical power. If
instead of receiving currents of electricity from
the dynamo-machine on the Thames-embank-
ment, we transmitted currents of electricity to
it, we should cause it to rotate, but in the
reverse direction. I have here a small
machine for the purpose of illustrating this
to you, it is the invention of Mr. Griscom,
who has supplied it to a large extent in
America for turning sewing-machines. The
wires from the hand dynamo-machine are now
attached to the Griscom machine, and when
currents of electricity are generated by turning
the handle of the dynamo, they are conveyed
to the motor, and cause it to revolve with the
high rapidity you see. It is surprising that
such a tremendous momentum should be pro-
duced by so small a strength of electric current.
The wires connecting the two machines in this
instance are short, but the effect would have
been practically the same had the machines
been miles apart. By changing the wires, the
direction in which the motor rotates is reversed,
so that I not only get power transmitted, but
can reverse its direction. In this case, as the
electricity is generated by hand, its power
is small; and, therefore, with my strength
(which is only about one-twelfth of a horse-
power), I can stop the rotation of the motor;
but if steam-power were employed to generate
the electricity, the power transmitted would be
beyond my control, in that sense. This
motive-power was illustrated, in many dif-
ferent forms, at the Paris Exhibition;
for instance, from the commencement of the
Champs Elysées to the Exhibition building, a
tram-car was propelled (sometimes at the rate
of 25 miles an hour) upon rails laid down for
the purpose, and during the time that the
Exhibition was open, that car carried 25,000 to
30,000 people, who were conveyed to or from
the building by motive power, generated by
steam in the Exhibition, and conveyed by
wires to the further extremity of the track.
An electric railway will form part of the

Electric Exhibition at the Crystal Palace,
and among the proposals to be laid before Par-
liament next Session is a project for constructing
an electric railway between Northumberland-
avenue and Waterloo Station. Again, at the
Paris Exhibition, an enterprising firm of agri-
culturists showed land-ploughing by electricity,
and in fact, the application of electricity to
innumerable useful purposes was illustrated;
rock boring, newspaper printing, driving of
sewing-machines, embroidery, leather work,
glass-cutting, wood-carving, lifts raised, ven-
tilation assisted, &c. I am looking forward to
the Crystal Palace Exhibition with great interest,
to see how far these exhibits will be repeated.
The Exhibition will be well worth a visit; in
fact, all Exhibitions are worth visiting, for
they excite interest, they induce everyone,
more or less, by generating curiosity, to add to
his knowledge, they honestly stimulate national
as well as individual competition, and they
always result in the enlargement of the useful
application of a power like that of electricity,
because a man of one trade who sees electricity
used in another trade cannot resist think-
ing out whether it cannot also be usefully
applied to his own purposes. We sometimes
hear electricity spoken of as a mysterious
agency, and sometimes as a wild, untamed
beast. It is only mysterious to the ignorant,
and it is only untamed to the unskilled. I
hope that the promise I made to you at first
starting, that you would leave this room with
a fair knowledge of how the electric light is
produced, has been fulfilled, and I can only
add that electricity will always prove an
obedient slave to those who take the trouble
to understand it; but it may, and it has, proved
a very dangerous ally to the ignorant and the
unskilled.

A hearty vote of thanks was accorded to Mr.
Preece for his two lectures.

SIXTH ORDINARY MEETING

On Monday, January 16th, 1882, ANDREW CASSELS, Member of the Council, in the chair.

The following Candidates were proposed for election as Members of the Society:—

Ainslie, Oliver Alexander, F.R.Hist.Soc., 48, Lincoln's-inn-fields, W.C.
Birkbeck, Edward, M.P., Henstead-hall, Norwich.
Brereton, Cuthbert Arthur, M.I.C.E., 23, Delahay-street, S.W.
Brind, Alfred Walter, M.I.C.E., East Preston, near Worthing.
Burch, Nathaniel Geach, Bromwich-house, Dartmouth-park, Forest-hill, S.E.
Carmichael, David, Ward Foundry, Dundee.
Carter, E. Harold, F.S.S., 33, Waterloo-street, Birmingham.
Cook, Arthur Stanton, 14, Furnival's-inn, E.C.
Cooke, William Henry, Lea Bank, Coppice, Oldham.
Common, Andrew Ainslie, F.R.A.S., 65, Eaton-rise, Ealing, W.
Cropper, Samuel, 48, Budge-row, Cannon-street, E.C.
Crossley, Richard, Beckliffe-house, Accrington.
Cust, Robert Needham, F.R.G.S., 64, St. George's-square, S.W.
Dodsen, Albert William, 6, Raymond-buildings, Gray's-inn, W.C.
Dawson, Joseph Emerson, A.M.I.C.E., M.I.M.E., 3, Great Queen-street, Westminster, S.W.
Fell, John, Augusta-place, Leamington.
Fyfe, John, 9, Grosvenor-terrace, Glasgow, and Young's Paraffin Light and Mineral Oil Company, 7, West George-street, Glasgow.
Henderson, Kirkby, 9, Bush-lane, Cannon-street, E.C.
Holthouse, Carsten, 15, Penpont, Bedford-sq., W.C.
Jones, Thomas John, 12, Princes-street, Hanover-square, W.
Kingzett, Charles T., F.C.S., F.I.C., 17, Lansdowne-road, Tottenham.
Ladd, John Haskins, 116, Queen Victoria-street, E.C.
Leonard, Hugh, 7, Hanover-square, W.
Lloyd, Robert Samuel, 82, Upper Whitecross-st., E.C.
Macdonald, Colonel R. M., 80, Oxford-gardens, North Kensington, W.
Moll, Frederick Henry Ludwig Raphael, 18, Old Broad-street, E.C.
Radford, Frances, 56, Pembridge-gardens, W.
Russell, Joseph, Glenclune, Port Glasgow.
Schrane, Otto, 29, Wood-street, Woolwich, S.E.
Scott, Edward Lionel, Salters'-hall, St. Swithin's-lane, E.C.
Simpson, James Carrington, M.I.C.E., Broadway-chambers, Westminster, S.W.
Speck, Thomas Samuel, M.I.C.E., 8, Eaton-rise, Ealing, W.
Wallis, George Ambrose, M.I.C.E., 14, Sea-side-road, Eastbourne.
Watson, John William Milton, M.I.C.E., Claremont, Silverhill, St. Leonards-on-Sea.
Williamson, George Charles, The Institute, Guildford.

The following Candidates were balloted for and duly elected Members of the Society:—

Allfrey, Edward Richard, South Eden-park, Beckenham, Kent.
Asselin, Josiah, Nechells-house, Nechells, Birmingham.
Ayrton, William, Wigton-road, Ormskirk.
Clark, John Somervail, 29, Peter's-square, W.
Colvin, Clement S., India-office, S.W.
Glover, Walter T., Moorhouse, Kendal, Manchester.
Hallett, Holt Samuel, M.I.C.E., F.R.G.S., 37, Edgware-road, W.
Hawksley, Thomas, 97, Adelaide-road, N.W.
Hill, James Woodward, A.M.I.C.E. (Mayor of Bedford), Kimbolton-road, Bedford.

HEDGES' ELECTRIC LAMPS.

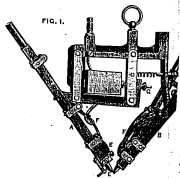
We reproduce from Engineering, illustrations of two new forms of Electric Lamps, belonging to that class in which the position of the ends of the carbons is not determined by clock-work or similar controlling mechanism, but by the position of the geometrical intersection of the axes of the carbon rods, which is determined by mechanical means.

Referring to Fig. 1, *A* and *B* are two troughs recta-

THE MECHANICAL NEWS.

SPRINGFIELD, OHIO, JANUARY 15, 1882.

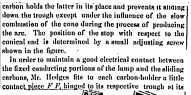
FIG. 1.



HEDGES' ELECTRIC LAMP.

gular in cross section attached to the supports in such positions that their axes are inclined to one another so as to form the letter V as shown in the figure. Within these troughs slide freely the two carbon pencils, which are of circular cross section, meeting, when no current is passing, at the lower point *E*. The carbon-holder *B*, to the right of the figure, is rigidly attached to the framing of the lamp, but the trough *A*, which carries the negative carbon, is attached to the framing by a pivot shown in the figure, and on this pivot the carbon-holder can rock, its motion being controlled by the position of the armature of an electro-magnet *M*, the coils of which are included in the circuit of the apparatus. By this means, the moment the current is established through the lamp, the armature is attached, and the points of the two carbons are separated, thus forming the arc. The positive carbon *H* is held firm sliding and dropping through the trough by the gentle pressure against it of the smaller carbon rod *C*, which also slides in a trough or tube fixed in such a position that the point of contact between the two rods is sufficiently near the arc for the smaller rod to be entirely consumed as the other is burnt away; the latter in that way is permitted to slide gradually down the trough as long as the lamp is in action. The negative carbon-holder *A* is provided with a little adjustable platinum stop *K*, which by pressing against the side of the conical end of the negative carbon holds the latter in its place and prevents it sinking down the trough except under the influence of the slow combustion of the cone during the process of producing the arc. The position of the stop with respect to the conical end is determined by a small adjusting screw shown in the figure.

In order to maintain a good electrical contact between the fixed conducting portions of the lamp and the sliding carbons, Mr. Hedges fits to each carbon-holder a little contact piece *F F*, hinged to its respective trough at its



Claims:—1. The method of demagnetizing watches or other similar articles of or containing steel, which consists in subjecting the same to rapid reversals of polarity in a gradually weakened magnetic field.

2. The method of demagnetizing watches or other articles of or containing steel, which consists in gradually withdrawing them from the influence of a rapidly-alternating magnetic attraction.

3. In an apparatus for the demagnetization of watches or other articles, the combination, with an electro-magnet and means for revolving the same, of a rotary holder for presenting the articles under treatment to the influence of said magnets, and mechanism, as described, for withdrawing them from the magnets.

4. In an apparatus for the demagnetization of watches or other articles, as described, the combination, with the revolving magnet, of a movable frame or carriage, a holder for the watch mounted thereon, and means for rotating the holder simultaneously in horizontal and vertical planes, substantially as set forth.

completed with the electric generator the carbons are drawn apart by the action of the solenoid on the plunger, and the distance to which they are separated is determined by the diffusion of attractive force exercised upon the armature by the solenoid and the magnet.

Eng. News. March 11, 1882

ELECTRICITY.

BALTIMORE WILL USE ELECTRICITY.—The Mayor will sign the electric light contract which was recently passed by the council, authorizing the Mayor, Comptroller and City Register to contract with the Brush Company to light the business portion of the city. The Mayor said that the contract would provide that although the annual cost would be $50,000, which is $30,000 more than is now paid for the same area roads, the new light would be worth the difference.

ELECTRIC LIGHT PROPOSITION.—St. Louis has received a proposition from the Brush Company to light Union Market with 20 electric lamps of 2,000 candle-power each, at a cost of $5,000 per annum. It now costs $2,000 per annum for gas.

Scientific American Sept 1881.

A Fatal Electric Shock.

A strange and terrible accident occurred last evening at the generating rooms of the Brush Electric Light Company on Geneva street. About 9 o'clock two young men named George Leonard Smith and Henry Rinkhall, in company with another young man and two girls, stepped into the station and stood looking at the machinery in motion. Smith was very inquisitive and wanted to experiment. The manager, Mr. G. Chaffe, allowed him to try a harmless experiment, which consisted in taking hold of one of the brushes attached to the commutator, in which the electricity is held until carried away over the wires, and then, taking hold of the hands of his companions, a gentle current of electricity was passed through their bodies. Smith wanted to take hold of two of the brushes, but Mr. Chaffe grabbed his arm and held him back, telling him it was sure death to touch them. The party shortly afterwards left, Mr. Chaffe telling them to get out. About a quarter past ten o'clock Smith suddenly came into the building, seemingly under the influence of liquor. He leaned over the railing which keeps outsiders at a distance from the machinery, and, before a warning word could be said, he had grabbed the first and third brushes. Mr. Chaffe saw what he was about to do and made a jump for him. His hand stuck fast to the brushes, and, giving the engineer the word to stop the engine, he took hold of Smith and endeavored to pull him from his hold. This he was unable to do, but as soon as the engine stopped Smith raised himself to his feet, and, throwing up his arms, gave a loud gasp and expired instantly.

The thing was done so quickly that those who witnessed it could scarcely believe their eyes. Smith's face had a pale bluish tint and was drawn out of shape. His hands were badly burned, and on several of the fingers the flesh was burned to the bone. Of the unfortunate man but little could be learned, save that he was formerly a sweeper at the Wheeler elevator, but for the past week had been handling lumber in various yards on the island. He was about twenty-eight years of age, and is the neighborhood of five feet eight inches in height. He is stated that he has a wife and child living in the city, but where the writer was unable to ascertain. Mr. Chaffe says the generator is one of tremendous power, and would kill fifty thousand men as easily as one.—*Buffalo Courier, August* 8.

Eng. News. March 11. 1882.

ELECTRICITY.

OPPOSED TO THE ELECTRIC LIGHT.—Jackson, Miss., has refused to appropriate fifty-thousand for electric light purposes.

ELECTRIC LIGHT IN BOSTON.—The Board of Aldermen, of Boston, gave a hearing Monday to electric lighting companies. The proposition of the Brush Company said that the electric light could be furnished for $80,000 a year by its self-extinguishing properties. Its thirteen 1,500 lights would suffice for the city, and possess twice the candle power of the present 10,291 gas lamps. The Common and public Garden, he said, might be lighted at a yearly expense of $10,000.

LARGER BY ELECTRICITY.—San Antonio, Tex., has introduced the electric lights in its streets.

ELECTRICITY FOR DEPOT ILLUMINATION. —The depot at Springfield, Mass., will be lighted by electricity.

TELEGRAPH PIONEER.—The Texas-Mexican line has been finished to Laredo.

PANAMA MINES, will have a telephone exchange.

Reading Daily Eagle July 4. 1882.

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ELECTRIC LIGHT FOR READING.

A Number of Business Firms of the City Contemplating its Use in Their Stores.

H. F. Card, representing the Edison Company for Isolated Lighting, New York, who has been in Reading for about two days calling upon manufacturers and business men with a view of introducing the electric light in their places, left last evening for Philadelphia. He met many others in various parts of the city in the interest of the Eastern Pennsylvania Telephone Co., meeting with flattering success. While in Reading he called upon a number of firms, and in some states that they looked upon his proposition in a very favorable light. Among those whom he has seen may be mentioned the Reading Hardware Co., Wm. Bertolet, Jr., Jacob J. Wilson, T. A. Wilson, Hess, Pancoast & Stewart and others. The latter firm have under consideration the introduction of the electric light in their new four-story building on Penn street, above Sixth. The manager plans to Reading which uses the electric light. The Reading Hardware Co. Union Mill has its factory and office fit up with it. The firm which Mr. Card represents manufactures two electric lamps—arcs of 8 and the other of 16 candle power. Mr. Card explains very advantages for the electric light, and believes that it will eventually take the place of gas and oil. The cost of running the electric light in a central station is about $1.85, which covers the cost of a generator, lamps already piped into position, and everything for their proper lighting. This figure is for from 70 lamps of 16 candle power, each equal to a 10 foot gas burner, to 150 lamps of 8 candle power, each equal to a 5 foot gas burner. Mr. Card has made these figures with him to show that the electric light is 50 per cent cheaper than gas. In regard to lighting the city with the electric light, he hopes that would have to be done by the Board of Trade and as to the cost he could not definitely enquire into it, but thought that the cost would be less than that of the number of lamps we had. There are a number of other parties in Reading besides those called upon by Mr. Card, who, it is understood, talk of introducing the light into their business places. The lamps are very solid, and it is claimed that they can last a long time. The electric light can be stored in such a manner that when not in use the cost of the same as gas. It is conducted through the streets in small pipe made for the purpose, and in this way the horses of consumers can be supplied the same as with gas.

H. W. Spence, of this city, has purchased the right to manufacture in Berks county the Edison electric light generator and lamps in Delaware and forty-one counties in Eastern Pennsylvania, including that portion east of the Susquehanna, and will make arrange for their manufacture and introduction. Mr. Spence states that the firm adding from the electric light current are owned principally by some of the wealthiest men in Philadelphia, and the quality of electricity required for lighting from twenty to fifty arc lights on one circuit. Regular safety less wear and tear of machinery and the last results can be obtained by employing generators adapted for ten or a less number of arc lights. Incandescent lamps, capable of subdivision, and so far as can judge from the electric light will eventually be fully overcome. Where the arc light would be too bright, the incandescent light can be employed, for lighting residences, offices, &c., although its expense, as far as the quantity of light furnished is concerned, is much greater than the arc light.

SCIENT

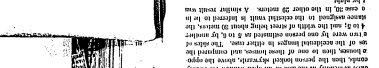
A WEEKLY JOURNAL OF PRACTICAL

VOL. LXXII.—No. 11.
[NEW SERIES.]

PROPOSED ELECTRIC LIGHT TOWER AT NEW ORLEANS.

The convenience and economy of electric illumination for harbors and water fronts, particularly when it is desirable to handle freight by night as well as by day, have been amply demonstrated in this country and in Europe. The experience of Liverpool on this point has been especially valuable, both in showing the economy of the electric light for docks and shipping, and the very satisfactory working of lights raised high in the air.

The crescent shape of the river front at New Orleans, the massing of the shipping business along a comparatively short reach of shore, and the broad open space along the levee, to



[illegible] of the entire [illegible] of the shipping [illegible] by gas pipes [illegible] a distance of [illegible] feet. [illegible] a case 3x4 feet [illegible] 6 ft. 6 in. [illegible] 4 feet [illegible] 6 feet [illegible] a case 2 ft. 6 in. [illegible] 2 feet [illegible] 3 feet [illegible] 4 feet [illegible] 6 ft. 6 in. [illegible] 6 feet [illegible] 8 feet [illegible] 10 feet [illegible] 12 feet [illegible] 14 feet [illegible] 16 feet [illegible] 18 feet [illegible] 20 feet [illegible] 22 feet [illegible] 24 feet [illegible] 26 feet [illegible] 28 feet [illegible] 30 feet [illegible]

90 Sci. News. March 11th 1882.

ELECTRICITY.

RAILROAD LINE TO BE LIGHTED BY ELECTRICITY.—The tracks of the Union Railway Company through Indianapolis will be lighted by electricity.

ELECTRIC LIGHTS FOR STREETS.—A committee is now selecting certain streets in Baltimore, Md., upon which to place electric lights.

ELECTRIC LIGHTS are being put in the House of Representatives at Boston.

NO DANGER FROM FIRE.—A new electric light company is being chartered at Minneapolis upon a system designed to meet the objection urged in Mayor Ames's veto. The wires are to be placed under ground.

PROPOSAL TO LIGHT BY ELECTRICITY.—The Fuller Electric Light Company offers to light the streets of Lynn with 100 arc lamps till midnight every night in the year for 50 cents per light.

ELECTRICITY IN CINCINNATI.—The method by which the Brush Electric Light Company proposes to illuminate the city of Cincinnati, if the Board of Public Works accepts the offer, is to erect towers 200 feet high, at places on hexagonal figures, with a capacity of 30,000 to 70,000 candle power, and on 70 ft. posts lamps of 2,000 to 5,000 candle power. A central station has been established. Five machines, with a total capacity of 268,000 candle power, are now being manufactured, and more machines will be ordered as necessity requires within a year from this date. According to the contract, the cost is to be 25 per cent. less than the price now paid for gas.

THE electrical apparatus for the new City Hall at Delaware, O., cost $250.

XENIA, O., is talking of lighting the town by electricity.

Am. Gas Light Journal, March 2nd 1882.

Paddington Vestry—Electric Lighting.

At the last meeting of the Paddington Vestry a report was presented by the General Purposes Committee upon the comparative cost of the electric light and gas in a certain main thoroughfare of the parish. The report stated that owing to the large outlay which would have to be incurred for the purchase of plant, etc., the committee were of opinion that the time had not yet arrived for inviting tenders for lighting the parish by means of the electric light, and further that it would neither be advisable nor economical for the Vestry to enter into arrangements of the kind. The committee called attention to the experiments now being made in the city, where three rival systems were at work for twelve months, the several contracts being with the Anglo-American Brush Company, £1,410, or £44 per lamp; the Loutin System, £2,220, or £31 per lamp; and Messrs. Siemens system, £3,720, or £116 per lamp, exclusive of plant, each lighting equal areas.

Of the three methods, the first, which was the lowest in price, was considered the best light and the simplest in its action. The committee had ascertained that the cost of displacing 76 public lamps and four Bray's lamps, between Edgware-road and the eastern end of Westbourne-grove, would, as an instance, be very great. These lamps at present cost £276 6s. 8d. per annum, including salaries and everything, whilst the cost under the electric system would be £788 10s. The first outlay would be £1,863 8s., or a gross sum for the first year of £2,702 1s. for the sixteen necessary electric lamps. There would have to be duplicate engines, boilers, etc., in case of breakdown, or the streets might be left in darkness.

Mr. J. P. Anderson said this was a very large question and should be very carefully considered, and he would move that it be taken into consideration at the next meeting of the Vestry. The motion was seconded and carried.—London *Metropolitan*.

Killed by Electricity.

A singular and fatal accident occurred at Carnegie & Co.'s Union Iron Mills, on Thirty-third street, Pittsburg, Pa., Tuesday, Feb. 21st, at about half-past one o'clock in the morning. In the mill there is an electric machine of sufficient power to run the sixteen lights necessary to illuminate the premises. Some trouble has been experienced in the past with boys working in the mill who persisted in making dangerous experiments with the generating machine. In order to stop this practice a fence about four feet high had been built completely around the engine and a special watchman employed to keep the boys away from it. At the time mentioned Henry Balzer, a workman employed in the plate mill, took a lantern in his hand and went over to a clock hanging near the electric machine to see what time it was. After ascertaining the hour he walked to the machine and stood leaning upon the fence around it. The facts just at this point could not be clearly learned, but from the statements made by persons connected with the mill, it appears that Robert Lyon, the engineer, in connection with some experiments he had been making, had stretched a wire from the machine to one of the other wires and along the top of the fence. While Balzer was leaning upon this fence he suddenly turned around, smiled, and gesticulating "Oh," dropped into the arms of Lyon, who was directly behind him, expiring immediately.

It is supposed that while leaning upon the fence he had touched the wire with his lamp and empty hand, thus forming a circuit, the current passing completely through his body and into the ground. A livid mark around the throat and a long furrow running from the thigh of the left limb to the ankle showed the course taken by the electricity. Otherwise Balzer looked as if he had fallen into a deep sleep.—New York *Herald*.

Am. Machinist March 11th 1882.

NIST

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Fire Protection Against Electric Lighting.

In our last issue we published some extracts from a preliminary report of Mr. Edward Atkinson, President of the Boston Manufacturers Mutual Fire Insurance Co., on danger of fire from electric lighting. Another brief report has followed and still more specific information is to appear later. We give some further extracts from the two reports:

"It may be added that we have not yet found any cause of danger of fire, from the use of the electric method of lighting, which may not be avoided, if the right method and proper care be used in putting up and operating the apparatus; but electricity is a force which cannot be too carefully controlled, directed, and watched, if generated in currents of considerable intensity.

"We add also one word of caution. Our members should be careful with whom they deal, and be perfectly sure not only of good and safe work, but also of the responsibility of the contracting parties, both with respect to the character of the work and of indemnity from loss, in view of the fact that the whole subject may be said to be shingled over with patents.

"The frequent manifestation of danger caused by the contact of what may be called the public electric arc-light wires with the public telegraph and telephone wires call for attention and care on the part of members of this company. These accidents do not impair our confidence in the safe use of the arc-light rightly put up and adjusted within the limits of a well ordered city under the control of the manager; they only mark the danger of permitting these various public wires to be carried over or between buildings without any general system or supervision, and without being subjected to a single or central authority with powers competent to regulate and control the matter.

"It is alleged that the difficulties in the way of carrying the arc-light wire under ground are considerable, but it is hoped and expected that they will be overcome.

"We therefore now advise all members whose risks are in places where there is any probability, or even possibility, of contact of public arc-light wires in the manner described, to not to permit any public telegraph, telephone, or electric light wires, to be attached to their buildings, or to be so placed in or across their salt yards as to expose their property to the possible danger of the diversion of the current of a public electric arc-light wire out-

...91

Eng. Mech. & ... March 17th 1882.

ELECTRIC LIGHTING BY INCANDESCENCE.

ON Friday last Mr. Swan lectured at the Royal Institution on the incandescent system of electric lighting, and, in the course of his remarks, gave the following interesting details:—He thought he could fairly say that the difficulties encountered in the construction of incandescent electric lamps had been completely overcome, and that they were now commercially practicable. They knew, in actual experiments, that continuous fusing to a fairly high degree of incandescence through 1,200 hours did not destroy a well-made lamp. What the utmost limit of a lamp's life might be they did not know. Probably it would be never-increasing space; as, with increasing incandescence, the carbon became more perfectly homogeneous and more perfect. Taking it, therefore, as fully established that a cheap and durable lamp could now be made, the further question was as to the cost of the means of its illumination. The cost of producing light by means of electric incandescence might be compared with the cost of producing gas-light in this way: that, of coal produced by the labor of a man for a day, a certain portion of the quality called 16-candle gas, would produce 3,000 candle-light for one hour. But besides the product of gas, the coal yielded certain by-products of almost equal value. He would, therefore, take it that they had in effect 1,000 feet of gas from one cwt. of coal, instead of from two, as was actually the case. For the electric light, the dynamo-machine which he now used produced 1,000 candle-light per horse-power. Repeated and reliable experiments showed that they could obtain through the medium of incandescent lamps of 100 candle-power each one horse-power per hour. But as there was waste in the conversion of motive-power into electricity, and also in the conducting-wires, he made a liberal allowance, and assumed that they had 500 candle-light as the net available product of one horse-power. For fifty horse-power, the products of one cwt. of coal, they had then 7,500 candle-light, as against 3,000 candle-light from 1,000 feet of gas. That was to say, two-and-a-half times the amount of light which the gas from the same quantity of coal was capable of producing. The question, therefore, was reduced to the basis to cover the cost of the renewal of lamps. Whether by the method of multiple arc, which necessitated the multiplication of electrical stations, or by means of the simple series or of secondary batteries connected with each other from house to house in single series, the large lessening of candle-light in the last

THE AMERICAN GAS LIGHT JOURNAL

PUBLISHING OFFICE No. 42 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, VENTILATION, WATER SUPPLY AND DISTRIBUTION, & GENERAL SCIENCE.

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[OFFICIAL NOTICE.]

New England Association of Gas Engineers.

The Annual Meeting of the Association will be held at Young's Hotel, Boston, on the 16th, 17th and 18th days of February next, commencing at 11 o'clock on Wednesday morning, Feb. 16th.

Members intending to propose to the Association the names of applicants for membership are requested to send them to the Secretary at least one day before the meeting. The Directors will meet, at the same place, on the evening of February 16th, at eight o'clock. Papers to be read should be forwarded to the Secretary in season to be presented by him to the Directors, at that meeting, for their approval.

BOSTON, Jan. 10, 1881. GEO. H. NEAL, *Secretary.*

ILLUMINATION BY ELECTRICITY IN NEW YORK CITY.

For the past six or eight weeks there has been quite an extensive demonstration going on in this city as to the results obtainable, in a practical way, with electric lights for thoroughfares.

Upon each block, at one of the street corners, posts of iron about thirty feet high, were erected from 14th to 24th streets, on Broadway, upon which electric lamps were placed; and in the open space in front of the Fifth avenue Hotel a lamp was placed on the top of the two mansard-like gas posts which are placed there. The electricity is generated in 20th street, between Sixth and Seventh avenues. A complete circuit of large insulated wire is made from the source of supply through the different lamps, the wires being carried upon the posts of the city's fire alarm system. Other wires are also used to supply private consumers.

It is said that wires are also to be suspended from the elevated railroad structure to reach some points where the light is desired. The total number supplied at the present time from this source is said to be about eighty, of which twenty-three or twenty-four are especially street lights. All of these street lights are furnished, free, for, to the city free of cost, so that a direct statement of cost, as compared with gas, cannot be arrived at as yet.

Of course the company supplying the light will be able to arrive at a tolerably accurate estimate of the running expenses after so long a practical experiment. The number of gas lamps which have been in use on that part of Broadway where the electric lights are located is about seventy-five. These cost the city $16 per annum, including cleaning, lighting, painting, etc., which would make a total annual cost of $1125.

Where the electric lights are supplied to "private consumers" the charge is one dollar per lamp per night up to 12 o'clock. The street lamps burn all night; but if it be assumed that the company would be willing to furnish the light to the city for all night at the same price as they supply private consumers up to midnight, viz., one dollar per lamp per night, the cost of lighting the one mile of Broadway by electricity would be, for twenty-three lamps, $8395. Of course, this is "supposing a case," and, in the absence of actual data, is only given as a supposable case. As to the character of the light it has been very aptly described by a French writer as "illumination but not lighting." It is true that there is much more light in some places than by the gas system; but the object of street lighting is to light the roadways and sidewalks, and for this purpose all the light that is sent off in the upper air is wasted.

Around each of the posts of the electric lights there is a very dark shadow for a space of twenty feet radius. There is more or less unsteadiness to the light of necessity although those above referred to are the steadiest we have ever seen when taken on the average. The average candle power of these electric lights, so far as can be judged from casual observation, will probably not exceed 250 candles; but in this judgment we may be in error, and no doubt, at times, the candle power is higher than that, but, on the other hand, there are times when it is less. There have been but few extinctions, and during the recent heavy sleet storms, the comparatively limited extent of wire enabled the company to so watch and attend to their lines as not to have an interruption when the hour of lighting arrived. In one or two instances this is said to have been done by cutting the wires during the worst of the storm, which was in the daytime, and thus relieving them from the strain of the heavy weight of ice, which demolished the various telegraph

IL FUNICOLO
Milano, 23 Marzo

Per la patriottica emorranea il Municipio avora fatto lo sforzo di far illuminare straordinariamente anche la Galleria Vittorio Emanuele, dove poi passavano tutti i reduci da Porta Vittoria; per cui anche la Galleria si animatissima fino ad ora tarda.

Un altro richiamo di gente fu per la Galleria la illuminazione elettrica che l'ingegnere Shephort del Ridotto della Scala ha portato al Caffè Biffi, dove ieri sera assolutamente non era possibile di trovar posto.

Così l'esperimento di luce elettrica fa'o con tanto successo al Ridotto, può esse o giudicato da tutta la cittadinanza, ed è certo che i giudizi emessi ieri sera sono favorevolissimi al sistema Edison, e danno come risolto il problema.

Questo pubblico esperimento ha persuaso la Società del gas a migliorare l'illuminazione della città, per cui ieri sera si trovavano, specialmente nelle località centrali, le fiamme dei lampioni più vivaci e luminose del solito — la qual cosa tuttavia non impedirà alla luce elettrica — in un'epoca più o meno lontana — di impadronirsi del campo, perchè il progresso della scienza non può essere fermato. Intanto ieri sera fra gli altri vantaggi della luce elettrica si è notata che l'aria del caffè non era più viziata ed afosa.

L'as sesore Ostuni, che si interessa vivamente a questa questione della luce elettrica si è trattenuto ieri sera molto tempo al Caffè Biffi in compagnia di alcuni capi servizio del Municipio, volendo studiare qua'o su sia l'effetto e con quale risultato può a ale luce venire applicata su larga scala.

LA LOMBARDIA 23 Marzo 1882

Scienza ed industria. — Il trionfo della luce elettrica è assicurato, grazie all'invenzione del genio di Edison e della cura diligentissima del valente ingegnere Shepherd.

Ieri sera il caffè Biffi era illuminato da seicento lampade *Edison*, che diffondevano una bellissima luce, simile assai a quella del sole, perchè conserva l'intonazione dei colori, ed è sempre eguale, chiara, simpatica.

Nessuna oscillazione, nessuna diminuzione d'intensità, nessuna intermittenza; la luce elettrica è dunque un fatto compiuto.

L'ingegnere Shepherd è il primo che è riuscito ad applicare con successo e praticamente il sistema Edison.

La luce elettrica dallo studio scientifico è passata allo studio industriale e qualunque piccola città, qualunque opificio può ottenere con minor spesa e senza alcun pericolo un'illuminazione più bella di quella del gas.

Noi che abbiamo applaudito il Shepherd quando faceva i primi sforzi per introdurre tra noi la luce elettrica, non possiamo trattenere di lodarlo ora che, associato alla potenza del genio di Edison è riuscito a darci così splendidi risultati.

IL SECOLO
23-24 Marzo
Milano 1882

La luce Edison al Caffè Biffi. — Ieri sera si inaugurò al caffè Biffi in Galleria Vittorio Emanuele l'illuminazione elettrica colle lampade ad incandescenza sistema Edison. L'effetto corrispose pienamente all'aspettazione generale, la luce fu brillante, ma moderata, eguale, stabile, gradevole alla vista anche pel suo colore. In prima ora il pubblico si accalcava dinanzi e dentro al caffè per ammirarla dando non dubbi segni di soddisfazione. Ecco un'altra passo verso la meta che a quanto dicesi verrà in breve raggiunta per opera d'una Società che in questi giorni sta costituendosi sotto la direzione dell'ingegnere Shepherd.

Le nostre congratulazioni all'intraprendente proprietario del caffè Biffi.

LA PERSEVERANZA DI GIOVEDI'
Giovedì, 23 Marzo 1882.

Illuminazione elettrica. — Ieri, a cura del signor Shepherd, s'è fatto al Caffè Biffi, nella Galleria Vittorio Emanuele, un esperimento di illuminazione a luce elettrica col sistema Edison. L'esperimento è riuscito ottimamente.

SCIENTIFIC AMERICAN

A WEEKLY JOURNAL OF PRACTICAL

Vol. XLVI.—No. 13. [New Series.]

ELECTRIC LIGHTING FOR SIEGE PURPOSES.

It is extremely useful for the defenders of besieged places to be able at night to illuminate the accesses to the place the enemy generally profits by darkness to make his sapping operations and to effect those movements of troops that are necessary to make an assault or attempt a surprise. So, from all epochs, the endeavor has been to illuminate the country by throwing projectiles composed of materials that are inflammable but of slow combustion. Sometimes these projectiles were held aloft by means of parachute with which they were provided, and while folded itself after a certain length of time; and, sometimes they were allowed simply to drop on the ground. But the latter case, the combustants among whom they fell mutually hastened to extinguish them or to null them into ashes. This is the reason that the fire bombs employed at the present day by the artillery are provided internally with a grenade designed to explode at the moment contact with the ground.

The latter is not fastened to the carriage, and can be removed by a couple of men and carried to any culminating point in the vicinity, while the vehicle remains where it is. The projecting apparatus is set up on a folding support which opens and closes in the form of a sort of lattice work. The engraving gives herewith represents the type adopted for the French army, which at present possesses light apparatus of the kind. One of the apparatus was shown at the recent exhibition of electricity by the Minister of War, and another by the house of Sautter & Lemonnier.

The projector, which was devised by Colonel Mangin of the French army, is 40 centimeters in diameter. The Gramme machine gives a light equal to 600 Carcel burners. The apparatus thus arranged permits of the exploration of the country to a distance of 2,400 meters, and even of three kilometers if the weather is sufficiently clear.

There was also exhibited at the Palais de l'Industrie another type designed for forts of the first category, but on the same system. This was experimented with for a long time at Mont-Valerien, and it was found that an observer standing alongside of the apparatus could recognize a soldier at a distance of more than six kilometers, and distinguish details of construction at five kilometers. With so great a power as this, it is naturally necessary to employ low-power able machines than those above mentioned, and the projecting apparatus and the generator of electricity have to be carried on separate carriages.

We shall now briefly point out the peculiarities of these two essential parts.

What constitutes the originality of the Mangin projector is the form of the mirror. It is well known that in order to reflect the rays diverging from a lamp into a fascicle of parallel rays, it is only necessary to place the lamp in the focus of a parabolic mirror. Now the construction of parabolic curves is difficult and expensive, so Col. Mangin conceived the idea of employing glass cut with two spherical surfaces, thus facilitating the labor. These two surfaces must not be concentric; and calculation permits of finding the degree of excentricity with which the ray, emanating from one of the centers, is sufficiently parallel in practice (though not geometrically so) with the diameter which joins the two centers to give the fascicle all the power desirable. It is easy to verify the fact that the convex surface has a greater radius than the internal concave one, in other terms, that the thickness of the metal in the center is less than at the edges.

A biconvex lens, interposed between the luminous focus and the reflector, diminishes the focal distance, and, consequently, permits of reducing the dimensions of the projector.

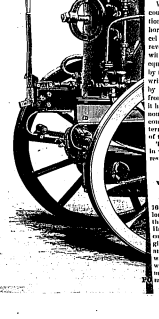
Col. Mangin likewise employs a *diaphragm*, the object of which is to spread out horizontally the fascicle obtained, a height being of slight importance. It appears that this arrangement has been somewhat criticised, as it diminishes the intensity of the light produced. "The projection is demountable," say the adversaries of this system, "their field may be extended, without any loss of illuminating power, by a simple displacement."

Let us now pass on to the source of electricity.

The Gramme machine, adopted in France, Russia, and Norway, is actuated by a three-cylinder engine on the Brotherhood system. The electro-magnets are flat and very wide, and the bobbins have two current collectors. The elements may be coupled for tension or quantity by means of a commutator mounted on the machine, and the changes may be effected instantaneously.

When the electro-magnetic parts of the machine are coupled for quantity, it revolves at the rate of 800 revolutions per minute, with an expenditure of a power of four horses, the light produced varying from 1,200 to 1,300 Carcel burners. When coupled for tension, the machine revolves with a velocity of 1,200 revolutions per minute, with an expenditure of eight horse-power, and gives a light equal to 2,000 to 2,200 burners. With such a power, and by the use of projectors 40 centimeters in diameter, ordinary writing may be read at a mile distant, as has been shown by experiments made at Berlin in 1875. By placing in front of the regulator a mirror inclined toward the horizon it has been found possible to project on the clouds a luminous band which, from a distance, looked like the tail of a comet, and on which (as on the screen exposed before a lantern) exhibited themselves such signals as were made in front of the mirror.

There is thus realized, then, a system of optical telegraphy in which the Morse alphabet is employed as a means of correspondence.—*Revue Industrielle.*



Verdict of the Coroner's Jury.

sion, Monday, Feb. 25, 1878.

We find that Levi J. Bircher came to his death on the 16th day of February, 1878, by the explosion of the boiler belonging to the Jewell Milling Company. We believe and find that the sole responsibility for said explosion rests upon the Hartford Boiler Insurance Company; and we hold said company responsible for the death of Levi J. Bircher, in giving permission to the Milling Company to carry an amount of steam which the age of the said boilers did not warrant, and which, in the jury's estimation, said boilers were unable to carry. We are of the opinion, and recommend, that boilers be tested in the future by both the hammer and hydrostatic test."

THE METROPOLITAN.

APRIL 1, 1882.

Improved Street Lighting.—The employment of Messrs. Siemens's new regenerative gas-burner for the lighting of Holborn and other central spots affords a further illustration of the marked improvements that have taken place in the appliances available for lighting our public thoroughfares since the advent of the electric light. When the use of the Jablochkoff candle, on the Victoria Embankment, and elsewhere, first suggested to the gas companies that if gas was to hold its own for street lighting a vast improvement would have to be made on the system which had hitherto prevailed, large Argand burners and a very much better form of lantern were tried for a time in Queen Victoria-street and Waterloo-place, and although for the purposes of this demonstration three or four times as much gas was used as formerly, the fact that the Argand system has since been discarded for public lighting would seem to indicate that the experiment did not prove in every respect the satisfactory success that was anticipated by the companies. Flat-flame burners were then brought prominently under the notice of the public as being specially applicable to the purposes of public lighting, and there can be no doubt that, as arranged by Mr. Sugg and Messrs. G. Bray and Co., they were so employed as to produce a high illuminating power for the quantity of gas consumed; Messrs. Bray, according to the latest trials, showing, perhaps, the best results in this respect. The new burner of Messrs. Siemens, however, yields a light in excess of that obtainable by the use of any improved form of flat flame burners. Going into figures—we quote from the results of some recent tests by Mr. Vernon Harcourt—we find that while the best light produced by flat flame burners, however governed and combined, is something like 978 candles per cubic foot of 16 candle gas consumed, the Siemens burner for the consumption of a similar quantity of gas gives a light equal to 4,731 candles. Hence in Holborn the Siemens burner has even thus early made its appearance as so many centres of traffic in the metropolis, and its value is evinced in its practical working is fully explained. True the first cost is in advance of that of the better known and more simple form of lamp; but, on the other hand, it gives the same light for about 25 per cent. less gas. Concerning the installation in Holborn, it may be added that Messrs. Siemens are lighting that portion of the thoroughfare between Holborn-circus and Gray's-inn-road, and altogether 26 lamps have been put up. The burners in which the lights are inclosed cannot lay claim to much beauty, judged from an artistic standpoint, but they have the advantage of being constructed on sound scientific lines with a view to making the most and the best of the lighting power available.

Crystal Palace Electric Exhibition.—The directors of the Crystal Palace, acting on the recommendation of the Honorary Council of Advice in connection with the Electric Exhibition, have appointed the following twenty-one British jurymen:—Captain F. W. Abney, R.E., F.R.S., Professor W. Grylls Adams, F.R.S., Major R. F. Ansonyge, R.E., Professor W. E. Ayrton, F.R.S., Sheffield Bidwell, Esq., Sir S. Canning, Professor Fleeming, M.A., F.R.S., T. H. Compton, Esq., C.E., Horace Darwin, Esq., Professor G. Carey Foster, F.R.S., Professor E. Frankland, F.R.S., Captain Douglas Galton, C.B., F.R.S., F.R.G.S., F.G.S., F.L.S., D.C.L., Lieut.-Colonel W. Haywood, Dr. Hopkinson, F.R.S., Professor D. E. Hughes, F.R.S., Professor Fleeming Jenkin, F.R.S., S.L. and E., M.I.C.E., Professor J. W. Langley, W. H. Preece, Esq., F.R.S., Professor Silvanus Thompson, B.A., D.Sc., C. E. Spagnoletti, Esq., C.E., Lieut.-Colonel Webber, R.E., President Society of Telegraph Engineers. The first meeting of the British section of the jury was held at the Crystal Palace on Tuesday evening, when nearly all the jurymen were present. Some of the foreigners who have been asked to act on the jury have already accepted, and the names of the foreign jurymen will be announced as soon as the list is complete.

The Edison Electric Light Company, Limited.—This company was registered on the 15th ult., with a capital of £1,000,000, divided into 200,000 shares of £10 each. The £ shares will be entitled to a preferential accumulative dividend of £5 per cent. per annum on the amount paid up. The company proposes to acquire the whole of the patents taken out for the United Kingdom by Mr. Edison in relation to the application of electricity or magnetism as a lighting, heating, and motive agent. The purchase includes the electric lamps, dynamo machines, and other plant of the vendor now in Great Britain, and, when capable of being used, for the exhibitions of the patents or the production of the electric light. The consideration is a payment not exceeding £50,000 in cash, and further, the allotment to Mr. Edison of one fully paid £ share for every £10 capital paid up, or credited as paid up, in respect of the A shares. The first subscribers include the Right Hon. E. P. Bouverie, Sir J. Lubbock, Bart., M.P., Mr. W. Fowler, M.P., Mr. F. J. Bramwell, C.E., Mr. W. Pilkington, M.P., &c. It is proposed that the first directors are Viscount Anson, Mr. Sheffield Bidwell, Mr. E. B. Wade, and two first-mentioned subscribers.

The Electrical Power Storage Company, Limited, is another new undertaking. It was registered on the 21st ult. with a capital of £200,000, in £10 shares, to carry on the business of electricians and electrical, mechanical, and chemical engineers, and of workers and dealers in electricity, motive power, and light. The first subscribers include Mr. Daniel Spence, Hon. Lieut. C. P. Stuart, Mr. William Ladd, Mr. W. M. Rollivant, Mr. C. Dorman, and Mr. F. Dean.

THE METROPOLITAN.

APRIL 1, 1881.

The Cost of Electric Lighting.—The following communication is from the pen of a gentleman practically acquainted with the subject on which he writes :—

TO THE EDITOR OF THE METROPOLITAN.

SIR,—Considerable interest is now being displayed by the public as to the cost of the electric light as compared with that of gas; but up to the present time we have not any reliable estimate by the electric companies to answer the question. The electric light is not generally given a central station in the same manner as gas, so as to make a comparison, but is from time to time hoisted in the daylight period—and what it would cost if a separate electric apparatus, with generator and engine, were erected for every house, will also give an exact idea of its cost then if you were to calculate the cost of gas on the supposition that every householder had his own gasometer.

Now, to fully analyse this question, we must divide the electric light into its sections, viz., the arc light and the incandescent light. The former is the large light now so extensively used in streets, railway-stations, philanthropic-gas, iron-works, and factories, and is generally of 2,000 candle-power per lamp. These are the lights which have been used in the streets of the city of London and Chesterfield, and the cost of which, including interest on capital, depreciation, repairs, wear and tear, and all other items, does not exceed 2d. an hour; and I am credibly informed by a gentleman who was there the other night that at a distance of 175 yards from one of these lamps a newspaper may be easily read, and the time by the watch told at even 230 yards so that if one of these lamps be erected where four streets meet, you would light four times 175 yards, or 700 feet long. Now, it would take 9,000 lights of equal distance to light those streets, and these at 4d. per hour, would cost £37 10s.

I have given the greatest distance at which gas lamps are ever placed even in badly-lighted districts; but to give an illuminative equal to that of the electric light they would need to be only 30 yards apart, which would take 21 gas lamps = 42d. per hour.

For such quarters the saving is still greater, as the electric light gives a light equal to 100 gas jets, while the cost is 2d. per hour, as compared with 2s. 6d. The cost of the small incandescent light, which is the only one suitable for domestic purposes, I have ascertained by to be as follows :—Electric generator and steam engine to run 2000 of the 16 candle-power each, main leads for say 20 houses, &c., &c., £1,500.

I do not calculate the cost of the gas, because the fittings and lamps for electric light would cost very considerably less than gas fittings. The annual cost would be :—

Fuel for 2,000 hours per annum @ 20 infl.
- extra hour-power engine, with coals, at 20s. per ton £466 13 6
- Cost of screening the carbons of 400 lamps twice yearly, at 3s. 300 0 0
- Wages, engineer, &c. 150 0 0
- Interest and redemption, 10 per cent. 150 0 0

£1066 13 6

Now the cost of lighting 20 houses with 20 gas jets, 365 days, 6,000 hours per annum, at 5d. per hour per light, would be £1,825 0s. 0d., or a saving of £758 6s. 6d. per annum; and I am assured that no house would be taxed by not having the yearly whitewashing.

The electric light, however, would be comparatively cheapest if a whole town were thus lighted, and electric mains and accessories—fitting at each house; and I am assured that such would be practical men, that the latter improvements will shortly be brought out, and, indeed, are likely to be ready before the British public is educated up to electric lighting, and so that to give it a fair chance, it must be supplied in large quantities like gas; and that no practical benefit can be obtained if every one is to have his own electric light generating machinery, any more than if every one had his own private gasometer.

What we want to know is, how it will work out if a whole town were supplied with the electric light, and our municipal authorities would confer an immense boon upon the public if they would make the trial for themselves, or allow some enterprising firm of electrical engineers to make it for them; and I believe there are some who would be willing to make the experiment without any cost or risk to the ratepayers if they were asked to do so.—Yours truly,

P. C. BARKER.

THE METROPOLITAN.

NOVEMBER 5, 1881.

£3,889 15s. 5d. under the scale system, the saving effected being as stated above.—The report was approved and adopted, and ordered to be entered on the minutes.

Electric Lighting at Chesterfield.—The trials of the Brush Electric Light at Chesterfield have been so successful that the Corporation have decided to dispense with gas entirely as far as public lighting is concerned, and to replace it with the electric light. The contract has been secured by Messrs. Hammond and Co., of 110, Cannon-street, London, the general agents of the Brush Co. The lighting will be done by means of about 22 brush arc lamps and about 70 Lane-Fox incandescent lamps. The annual lamps and about 70 Lane-Fox incandescent lamps. The annual cost is guaranteed by the contractors not to exceed the present gas cost in quantity, and it is claimed that the light will be three times as efficient, and it is claimed that the light will be three times as efficient, and it is claimed that the highly improved illumination can be obtained at a less cost. Once in public lighting, the example of Chesterfield will be speedily followed by other towns—in fact we understand field will be speedily followed by other towns—in fact we understand that deputations have already visited Chesterfield from Derby, Nottingham, Barnsley, Sheffield, and other towns who are now in active negotiation with the contractors for the trial of the Brush in other towns.

Electric Lighting at the British Museum.—On the 26th ult. the arrangements were completed for placing the electric light in the hitherto dark places of the British Museum, such as the lavatories, cloak-rooms, passages, &c. Swan's incadescent lamps are now used in these parts yielding a bright light which makes the room as clear and bright as noonday. This principle, it is believed, will be extended to the MS. departments, and eventually the old and large rooms behind the reading-room, and the galleries, which will enable the attendants to supply books to readers in the evening, instead of limiting the time in November and the winter months to 3 or 4 hours—a great inconvenience to library students.

NATURE

August 25, 1881]

ELECTRIC LIGHT IN COLLIERIES

AUGUST 9, 1881, witnessed the first practical application in the United Kingdom of the electric light to the illuminating of coal-mines. The Earnock Colliery, near Hamilton, Lanarkshire, belonging to Mr. J. Watson, has been fitted with Swan's incandescent lamps specially arranged with outer lanterns of stout glass, air-tight, and provided with steel guards. The workings in which the lamps were fixed are 118 fathoms, or 708 feet below the surface. Twenty-one brilliant little lights placed at the pit-bottom, in the roads, and at the actual face of the seam where active operations were in process, supply an illumination of a very different character from the dismal glimmer of an occasional Davy. The electricity was generated by a dynamo-electric machine at the surface worked by a special 12 horse-power engine, and conveyed by two cables, first along telegraph poles to the pit mouth, then down the shaft to the workings, in one section to a distance of half a mile. The overhead wires are naked copper wires of 3 inch diameter, while those below ground are carefully insulated, and in the shaft are protected with an outer tube of galvanised iron. At suitable points of the circuit safety air-tight switches, the invention of Messrs. Graham of Glasgow, are inserted to afford control over individual lamps. The mine was visited two days after the installation of the light by members of the Mining Institute of Scotland, with whom was Mr. W. Galloway, whose remarkable experiments on the explosive effects of coal-dust will be remembered in connection with the more recent report of Prof. Abel. The party were photographed in the workings. An experiment was made with a lamp to test whether in the event of its being broken by accident a surrounding atmosphere of explosive gas would or would not be kindled by the strip of red-hot carbon before it had had time to cool. Into a box containing about three cubic feet of explosive gas a single lamp, removed from its outer protecting case of stout glass, was placed, and the c[illegible]as turned on. The fragile bulb including the incand[illegible]at carbon thread was then purposely broken, when the [illegible]ook inclosed in the box immediately exploded. No such occurrence could possibly happen if the protecting case of stout glass is properly constructed. The risk of accident must be considered as immensely less than that of the ordinary Davy lamp, especially when it is remembered that with the brilliant light of the electric lamps they need no longer be carried in the hand or set down upon the floor near the actual spot where the coal is being got, but will be fixed overhead at a safe distance against the wall of the mine. The ease with which the light can be turned out during the firing of a blast is another point in their favour. The proprietor of the Earnock Colliery is greatly to be congratulated on the step he has taken. In 1880 the death-roll of the shale by explosions of fire-damp in Great Britain reached the figure of 499 persons. We venture to predict that the universal adoption of electric lighting in fiery mines would reduce this figure to one-tenth of its terrible proportions. How many years will it be, we wonder, before the adoption of electric lighting will be made compulsory by Act of Parliament? And how many colliery owners will discover, we would ask, when driven to this course by compulsion, that in the long run they effect an economy by discarding the clumsy and unsafe "safety"-lamp, which will so soon be numbered with the "flint mill" amongst the relics of the past?

American Gas Light Journal.

Sept. 2, 1881.

Mr. B. F. Spice on Electric Light.

The following letter, written to the Directors of the Dublin Gas Company, gives the views of one of the leading gas men of England on the electric light. An effort is being made to induce the Dublin authorities to grant permission to an electric light company to lay wires, etc., the real object of which is to give the shares a good send-off and establish the electric light company in Dublin on a luminous basis without the trouble of going to Parliament for powers, as gas companies are obliged to do.

21 PARLIAMENT STREET, WESTMINSTER, S. W.,
12th July, 1881.

To the Chairman and Directors of the Alliance Gas Co., Dublin:

Gentlemen:—I have not been unobservant of the attention paid and the encouragement afforded to the efforts made for the introduction of electric lighting in your city.

Nor have I been surprised at the effect produced thereby on the market value of the property of your company, experience having proved that public opinion is easily affected, adversely to the interests of the holders of property in gas undertakings, by the highly colored statements of the numerous advocates of the "light of the future," as it is fondly called by its patrons, which, they say, is to supersede gas as a lighting power.

But, while it is to be deplored that the holders of shares in a perfectly sound and stable undertaking, such as yours, should be deluded into parting with their interest in it at a price or prices far below its intrinsic value, no consolation remains to you, and those of your shareholders who know better than so to sacrifice their property, that, as a prosperous and good paying concern, it is worth as much as it ever has been.

I make this statement to you in all seriousness, with an full and intimate an acquaintance with the facts as regards the surroundings of the two systems of lighting as almost anyone can obtain, and without an atom of prejudice against the electric light; regarding it, indeed, with great favor, my opinion being that it is proving to be, to gas companies, a blessing in disguise.

For the past two years I have been proclaiming the doctrine, that, as people became accustomed to a light of great intensity, such as the electric light, they will find it extremely inconvenient to put up with the less powerful gas burners, such as those which the parsimony of local authorities have hitherto commonly insisted on as being sufficient for lighting the streets of cities and towns; and the truth of this doctrine has been abundantly proved by the brilliant specimens of gas lamps which have been set up in London and in the cities and large towns of the provinces.

Perhaps the best known specimens of public lighting by electricity are to be seen in the metropolis; and respecting its cleanness and durability, it is not too much to say, public opinion is divided. Some admire it, some accord to it qualified praise, and others object that it is cold and disagreeable in character, while the intensity interferes disagreeably with the vision in passing from one intense light to another, through the comparatively obscure spaces which intervenes.

Then, again, another objection with which observers in general cannot fail to sympathize is the vital defect of its uncertainty. This has very often been proved most inconveniently, all the lights on a circuit having gone out again and again through some undiscovered defect by which the flow of the current has been stopped, the effect being to leave the district in total darkness. This has occurred several times on the Thames Embankment, on the Holborn Viaduct, and in some of the most important streets of the city of London.

A popular fallacy has lately been widely and industriously propagated, that this may be overcome by the "storage of electricity," Sir William Thomson having had a box of it sent over to him at Glasgow all the way from Paris! Wonderful, certainly, but worth nothing practically, except for scientific purposes. Who would think of sending a box of gas from Paris to Glasgow, except to show that it could be done? And who d[illegible] know that either the one or the other, gas or electricity, can be made and economically produced where it is wanted than it can be made and sent in a package from one place to another, the two places being some hundreds of miles apart?

And then, again, as to the quantity of "electric energy" sent to Glasgow being stated as amounting to "one million foot-pounds," this appears to

me to be studiously defensive. The box containing this energy is said to have weighed 72 lbs., and this weight of coal is capable of giving out 12 million foot-pounds, and the boasted one million foot-pounds of electric energy means about the same quantity as is contained in two cubic feet of compressed gas.

The whole thing, indeed, practically considered, is a delusion, and has not advanced the storage of electricity one single step. We are just where we were, and nowhere else, as concerns the question of "storage."

Electricity has to be produced as it is wanted, and conducted to where it is wanted, and any trifling hitch in the combined operation will prove fatal to the continuity of the current and extinguish the lights depending upon it.

So much for the application of electricity to public lighting.

The most important experiments and display of its adaptability to the lighting of interiors have recently been made in the House of Commons; and the result, after several trials, was a failure. The diameter of the light was objectionable; its uncertainty was more than once made disagreeably manifest, and the old system of lighting by gas was decided to be preferable.

While these experiments were going on, another practical application of it was sought to be effected by an old established firm, having large business premises in Westminster, to which they have recently added a carpenters' shop, adapted to the requirements of sixty workmen; however, as the sum required by the Company for the requisite fittings and dynamo-electric machine was £700, the luxury of the light was abandoned, for the simple reason that the cost of driving the machine to produce the light, the expense of attendance upon its working, and wear and tear, added to the interest on the first cost of fittings, would greatly exceed the cost of gas.

This may serve just as a gauge to enable you to measure pretty accurately the chances of your business of gas supply being interfered with by electric lighting during the twenty generally-due interims. And it may well encourage and resolve confidence to shareholders, whose faith in the continued prosperity of gas undertakings may have been shaken by the assertions of electricians and others that "the days of gas lighting are numbered."

Possibly there days may be numbered, but no one has yet ventured to predict the number, nor can anyone determine it within a century or two. The prediction was made more than thirty years ago, when a great step in advance was effected, and the light was exhibited at the Polytechnic Institution; but although a generation has passed away since then, the prophecy remains unfulfilled, and just about as far from fulfillment as ever." Side by side with modern electric lighting in its most improved forms, the use of coal gas has gone steadily on at an accelerated rate.

It would be difficult indeed, to point to any business which has prospered so steadily through long continued seasons of depression and convulsions, which have shaken the very foundations of commerce, and never has the prosperity of gas undertakings been more solid and assured than at the present time. Nor could a better incentive be increased means of economy in production, and consequent widening of the base of this prosperity be devised than the electric light, and this will be proved as certainly in Dublin as in London.

It is cheering to know that while the zest of some prominent electricians palpably exceeds their common sense, and has led them to make ridiculous assertions, there are others, such as Dr. Siemens and Mr. Preece whose statements in this special branch of science are of the highest order and second to none, who have over and over again publicly declared their convictions that the use of gas will not be prejudicially interfered with by electric lighting. These foremost electrical authorities are content with widening the field of their operations, well knowing there is ample room for both; and we gas men know equally well that the more electric lighting prospers in its acknowledged proper sphere, the better it will be for that interest for the prosperity of which we are more particularly concerned.

My advice to your shareholders, therefore, is that those of them whose main object is a sound investment, steadily yielding a satisfactory income, *stick to their property*, which will certainly continue to flourish, and let those of their fellow citizens who are so minded, manifest their patriotism by taking shares in the projected "Dublin Electric Light Company," and wait patiently for the result of its operations, which may possibly teach a much needed lesson, calculated to enlighten us respecting the actual cost of the luxury, concerning which a great amount of ignorance prevails.

I am, gentlemen,
Yours faithfully,
R. P. Spice,
M.Inst. C.E., M.I.M.E., F.R.G.S.

astened, should be indicated. The ordinary method of representing the common wound-armature is shown in Fig. 13, and a complete representation by Fig. 14. Here the coils are wound on a bar of iron of T-square, it is not necessary to point out a place if the work in appearances, so as to get the important parts on a large scale of full size, and yet not to take up the necessary paper to show the whole or disjointed coil.

If the T-square is of the steel kind, Fig. 6, refer to the "Hints to Inventors," page 305, vol. xiii. A form of hand will no doubt suggest itself to many. Especially those who have had free-hand, or ordinarily angle, will want to bench off into an elaborate display of scroll work, bolstering such pretensions approximate. But the moment the draughtsman begins to conceive forms of his own he will find that he has got into a mess. A well-wood himself, if he is not careful to do it as well as he advances, he will find less to unlearn in after years, and par be back upon with great benefit if he permits fancy to take the place of reason. Tools and machines are not for mere ornament. Neither should they be made ornamental, when they are, they are not what they should be. Just as soldiers, they are, so with the fashion, with which they can be cured for, or kept clean. A strict adherence to these principles does not in the least prevent tools from possessing elegant forms, and the construction of machines possessing grace and beauty in the extreme.

The T-square cannot give grounded forms to which it is adapted, and not likely to depart very much from the original dimensions. If he keeps within these prescribed limits, though he may not produce any very brilliant results, he is sure not to produce any ridiculous ones. Mistake are straight lines, are not least resisted, when possible, by straight bodies, with lines of strain, meeting at least at right angles. In this case, the wire, when pressed on to armature in the direction of the T-square bar, is in a position to resist the tendency to fracture. The tendency to natural strain on the T-square head is at the ends, and must be resisted by the screws. Remembering from the end to the screws, pass an near through the centre of the screw as it passes, and the tendency to fracture, which, in the case, as it is, is the most likely to occur, is resisted by the screw, and prevented from dropping the square on the floor. The worst place for it to strike would be on one end, and here the screw would be resisted in the best possible way. The arms are made widest at the centre, to resist vibration.

To determine the size of T-square, as in the case of the bobbin, the wire to go over the head, I have found that the method here given looks well. Let the altitude of all the curves be equal. That is, the distance from *a* to *b* and from *c* to *d* are the same. Any perfecting arm should be the strongest, and finished with a pad or curved piece, as *a*, to join the body of the work, so that the arm may be made thinner, and the appearance of a tree with curves at the junction. In the designing of the T-square head no thought was taken of this principle, but the pattern was whittled out until it appeared to satisfy the designer, and it was afterwards found that the area of the brass was on a line from the centre of the screw, and so it will be found with any good form of T-square. The T-square head is a good architectural style. They have been made by hand right at first, and the laws of right have been discovered afterwards.

Do not attempt to find out the right and wrong ways in repeated attempts, for there is no such thing as right and wrong about it. Just as you have got a thing to look right in one way you make your drawings. You will be a good deal bespoke behind them. If your view of the drawing-board looks better to you with the lower and left hand and lines made twice as large as the others, make them so, since there is some practical work in designing afterwards. Do not try to draw "nearly" work by the eye, for it is worth no more worth of time and thought and bother-putting times or four times, are over the other, on the same paper, in broken parts, dotted lines and the like.

THE SCIENTIFIC PRINCIPLES INVOLVED IN ELECTRIC LIGHTING.—V.*

By Professor W. Grylls Adams, F.R.S.

(*Continued from p. 6.*)

Magnetic Machines.

THIS same reasoning will apply to the case where a transmitting coil is used in place of the original battery current, a closed circuit armature, as the magnetic field, or a magnet moved in the neighborhood of a fixed coil. In fact, the theory of Ampère requires that a small closed current should be equivalent to a magnetic molecule, and so a collection of equal small closed currents, all going the same way, and occupying a given area, is equivalent to a collection of equal magnetic molecules with their poles in the same direction, and of the same magnet. But a collection of equal small closed currents all going the same way, and occupying a given area, is equivalent to a current round that area.

We may usefully express the efficiency of magneto-electric machines by a formula. Taking C to be the effective work done by a unit current in one second, and R the resistance, the number of turns in a circuit, and O the amount of resistance, the total effective work is $C\nu\delta$; and the work expended in overcoming the resistance, in the circuit is $C^2\delta$; hence, by Joule's and Ohm's laws, if E be the electromotive force,

$$EC = C\nu\delta + C^2R.$$

Hence the efficiency $= \frac{C\nu\delta}{C\nu\delta + C^2R} = \frac{1}{1 + \frac{R}{\nu\delta}}$.

Thus, for a given resistance, the greater the number of turns of the machine, the greater is the efficiency, and the higher the resistance, the less the efficiency. This formula shows that machines and lamps of high resistance can only be efficient when the machines are revolving at high speed.

We may represent the efficiency of batteries or magneto-electric machines in connection with lamps, electromotors, such as a dynamo-electric machine, by a diagram from *La Lumière Électrique*, in which the electromotive force of the battery or excited machine is measured on a horizontal line, and either the current or the energy expended is represented by vertical lines, the total electric energy by the area of the rectangle (vi.), as the sum of the effective work (iv.), and the loss of energy by heating, &c. (v.).

FIG. 3.

i. Electromotive forces.
ii. Strength of current.
iii. Energy converted into electricity.
iv. Effective work in the external circuit.
v. The efficiency.
vi. Energy set converted into useful work.

It will be seen that when the efficiency is $\frac{1}{2}$, the greatest amount of effective work is produced, and this amount of work is $\frac{1}{4}$ the total electrical energy. Since the electromotive force is proportional to the current, the greatest effective work is produced when given the effective work and efficiency at different speeds.

In the case where the fixed and the movable parts of the machine are electro - magnets, the following laws are found to hold, which we have—

I. The action of the currents on one another.

(1.) The action of the fixed magnetic core on the movable coil, and of the movable magnetic core on the fixed coil.

(2.) The action of the two magnetic cores on one another.

Here the values of *a* *b* of the form $a + bn + \frac{c}{n}$ are constants, and depend on the magnetic properties of the cores.

Each of these actions arises from the influences of the equal currents on one another, and, therefore, will be proportional to the square of the current, and to the number of turns of the coil in a unit area, so that—

If n proportional to n C^2 $(a + bn + cn^2)$

and the efficiency—

$$P = \frac{1}{1 + \frac{S.R}{C^2}} = \frac{1}{1 + \frac{R}{n\,(a + bn + cn^2)}}.$$

The most important part of the action is such machines depends on the action of the two magnetic cores one upon another. The reactions between the fixed and the movable cores produce great disturbance, in consequence of the cores not taking up their full magnetism instantly, but requiring time for their full magnetisation. In consequence of this, in all dynamo-electric machines, it is necessary to allow the rotation to go on through an angle determined by the retardation of the magnetism of the cores, before the reversal of the current from the coils is to take place, and, moreover, in order to get the greatest current, the springs for making contact with it coils came to be shifted round in the direction in which the rotation is taking place. Faraday attributed this retardation to the time required to develop the molecular currents in the magnetic cores.

Alternate Current Magneto-Machines.

Alternate-current machines, there is no commutator for making the current continuous; but the current from the coil are collected and sent through the external resistance in opposite directions, as in Fig. 4. In the Siemens' machine, a section of these was the "Alliance" magneto-electric machine, which has been adopted by the French Government for lighthouse illumination. Holmes converted this into a continuous current machine, by means of a commutator, which is, in fact, a divided ring, on a portion of which the lighting, like armature. He subsequently removed this commutator, and again converted it into an alternate-current machine.

The four methods of placing the coils on the revolving wheel, in machines for electric lighting, which have been adopted by Siemens, Wallmark, have been named by Mr. Hedges—

1. In Siemens' magneto-electric machine, the coils are wound transversely, with their axes parallel to the axis of rotation around the circumference of the wheel.

2. In Siemens' machine, the wires are longitudinal, and remain about the long axis of the piece on which they are wound.

3. In Siemens' machine, the wires form a belt round a drum.

4. In the De Meritens machine, the wires are wound as in the Siemens, but are divided into separate parts, which are insulated from one another, and passing in succession in front of opposite poles of magnets, give off alternate currents.

The Siemens' Alternate-Current Machine.

A cast-iron disc-ring bobbin is set at right angles to a shaft, and revolves between two sets of electro-magnets, which are set at right angles to the disc, having their axes parallel to the shaft. The bobbins have no iron cores, and so the heating caused by magnetisation and demagnetisation of the iron is avoided. The electro-magnets are excited by a small Siemens continuous-current machine.

This is similar to Wilde's dynamo-electric machine, which he produced in 1866, except that in the coils on his cast-iron disc Wilde placed soft iron cores, and arranged them so as to form eight groups of four each. The current from one of these groups reacted on the succeeding group, and the other groups strengthened or set the current for each group. In Wilde's more recent alternate-current machines, arranged so as to be excited by a separate continuous current machine, there is one which has lately been invented by M. Gramme, in which the bobbin of the continuous-current machine is replaced by a ring, which is wound in two sets with the relative armature which have the alternate currents, so that the two turn with the same velocity, and the continual machine run at the same rate. This is much simpler than having two machines, and it is called a self-acting machine.

In the machine which I have already explained, the greatest amount of effective work or yield obtained from an alternate-current machine, when the lamps are in series, is no more than 50 per cent. of the electrical work given out by the first machine.

Result of M. Mascart and M. Jamin's Experiments.

M. Jamin has found that, in the Alliance machine for electric light and giving alternate currents, the strength of current can be calculated from the law, established for electromotive force, as proportional to the velocity, but replacing the resistance of the coils by the total resistance of eight times as great. The resistance to be added is proportional to the velocity of the machine.

M. Mascart determinations of the efficiency of machines are complicated by the retardation of magnetisation of the magnets, which accounts for the change of position of the commutator for the direction of the current in the armature. If this change be not made, then it would be possible, as in the bobbin in which the wire resistance was high, to get currents in opposite directions when the coil is rotated at different rates. For slow rotation, the galvanometer reading is nearly proportional to the velocity of rotation, but reaches a maximum, and beyond that diminishes rapidly to

* A series of "Centre Lectures" delivered this year before the Society of Arts.

PROVIDENCE JOURNAL.
FRIDAY MORNING, MARCH 31, 1882.

THE ELECTRIC LIGHT.

HOW SHALL THE WIRES BE TAKEN CARE OF?

The Question Discussed before the Senate Judiciary Committee.—An Interesting Report upon Experiments with an Underground Current.

The Senate Judiciary Committee gave a hearing, yesterday afternoon, upon the bill declaring that wires through which dangerous currents of electricity are conducted shall not be maintained above the surface of the ground, except with the written consent of the owners of the land above which the wires are erected. There were about twenty-five gentlemen present, including representatives of at least four of the leading systems of electric lighting, viz.: the Edison, the Weston, the Brush and the Arnoux. The proceedings developed some interesting points in relation to the subject of electric lighting.

Spencer Borden, Esq., of Fall River, agent for the Edison light, first addressed the committee. After some introductory remarks, Mr. Borden read the following extract from an address of Sir William Thompson, as President of the Physical Section of the British Association: "Nothing above two hundred volts ought on any account ever to be admitted into a house or shop or other place where safeguards against accident cannot be made absolutely and forever trustworthy against all possibility of accident." He also read the following report of an experiment made by Mr. Clarke, electrical engineer:

To the Honorable Committee on Judiciary of the the Senate of the State of Rhode Island, in reference to the disposal of wires to be used for Electric Lighting:

In accordance with my promise, made at the last hearing before your committee, at Providence, March 14th, 1882, I have carried out experiments upon an arc light system, operated under a high electrical pressure. The experiments were conducted in a manner to prove, by the practical results obtained, that my statements made at the time of said hearing are true, namely: that, from an electrical point of view, it is perfectly feasible to operate arc-light systems, under great electrical pressure, by means of underground conductors; and that what would be called ordinary insulation is sufficient to prevent disruption of the same and the creation of faults are due to the high pressure. The experiments were conducted at the mills of the Whittenden Manufacturing Company, Taunton, Mass., and every facility for properly conducting the same was placed at my command by the proprietors.

Two Brush dynamos each operating a circuit with eighteen arc lamps, were connected in series and the circuits were connected in the same manner. Thirty-six arc lights were therefore on one circuit operated under a total electrical pressure of at least sixteen hundred volts. The maximum electrical pressure developed under the same conditions would be from a Brush forty-light machine, and would amount to two thousand volts. The electrical pressure developed in this experiment is therefore great enough to bring out defects in the insulating power of the conductors used, and to overcome and disrupt the same if any tendency to do so is an inherent property of the insulating material, for any pressure within the limits that it is possible to construct a practical dynamo machine to exert.

Both the outgoing and incoming portions of the circuit were carried outside the building, and in this portion of the circuit were interpolated the conductors experimented upon.

[Here appeared a diagram of the apparatus described by the following references:]

A and *B* are the dynamos (Brush). *C* is one length (20 feet) of underground conductor as manufactured by the Electric Tube Co. It consists of two copper rods, each equivalent in size to two No. 10 wires, B. W. G. These rods are placed in an iron pipe one inch in diameter, and are electrically insulated from each other and from the iron pipe by means of a compound filling the same. The actual separation of the copper rods is one-quarter of an inch. These rods form a portion of the outgoing and incoming circuit respectively.

D is a portion of those two circuits made of two forty feet lengths of No. 14 iron wire, B. W. G. insulated by a covering of kerite 3-64th of an inch thick. These strands are twisted together and made into a close coil. (I will state that the wire had been in stock for some time and was badly marred. These faults were repaired by dipping the parts in question in the Electric Tube compound and serving with cotton cloth).

E consists of two copper plates between which one thickness of ordinary letter paper is firmly clamped, forming the only insulator between the two.

H is a lead wire introduced into the circuit to prevent injury to the dynamos in case of accidental short circuits or development of faults, occurrence of which would cause the heavy current induced to fuse this lead wire and interrupt the circuit.

P, P, P is the lamp circuit.

The arrows denote the direction in which the current flows.

The tube C and coil of wire D were buried underground, and the ground at D was thoroughly saturated with water. All connections made underground were protected by covering them with the Electric Tube Compound.

On Friday, March 24th, the system was operated for two hours and a half without developing any fault.

This is ample time to practically prove the total inability of the electrical pressure under which arc-light systems are operated, to break down and disrupt even what would be called ordinary insulation. [illegible] It could not disrupt paper four one-thousandths of an inch thick, did not injure the kerite-covered wire which opposed a total thickness of 3-32 of an inch, and produced no effect on the Electric tube, with conductors separated by one-quarter of an inch of compound.

All that remains to be done to make this underground system reliable and durable is to prevent hardening and cracking of the insulating material by protecting it from the air or fresh water and gases by a suitable covering (tarred hemp has been employed with the best results), to provide suitable protection against probable mechanical injury, and to provide means for making tests of the electrical condition of the line and amount of leakage, and to detect the deterioration of any portion of the system and locate the fault.

In the underground line experimented upon, the *Electric Tube* provides insulation and protection from water, air, gases and mechanical injury, and the system, in connection with which this tube is employed, is arranged so as to provide means for testing and locating faults.

At the last hearing I stated that an underground arc light system is in operation in London, and a sub-marine system at Havre.

The following is descriptive of so much of these systems as will be of interest to your committee, bearing as it does upon the point at issue. The first system mentioned is at the Royal Albert Dock, London; and, at the time of installation, there were three seven-lamp and one six-lamp circuits operated by Siemens's dynamos. The underground conductors supplying this system, (the area illuminated is six thousand five hundred feet long and four hundred and ninety feet wide) are constructed as follows: A copper strand covered first with gutta-percha, then with tarred hemp, then with a sheathing of twenty-two iron wires, and this again is served with another layer of tarred jute, and finally there is a coating of Chatterton's compound, (a mixture of Stockholm tar, resin and gutta-percha) so that the underground wires are in every way as carefully protected as is the conducting core of a submarine cable. There is no specially provided return circuit, for the iron wire sheathing of the cable circuits plays that part. This provision for a return circuit is to be deprecated. The distances between the lamps and machines, as measured by the connecting conductors, varies from one hundred and twenty to eleven hundred yards. For original description see "Engineering," vol. XXX., page 276.

The second system mentioned is at the docks, port of Havre, France. The number of lamps on a circuit varies from four to six, with a total number of thirty-three on six circuits. The length of these circuits varies from three thousand eight hundred and twenty-eight, to twelve thousand seven hundred and ninety-two feet. The cable is constructed in the following manner: A central core of seven strands of copper wire is enclosed in a sheath of rubber, over which is placed a series of protective coatings of gutta-percha, rubber cloth, and three thicknesses of paraffined hemp wound alternately in opposite direction; then follows a covering of galvanized iron wire, and finally a thickness of hemp. The necessity of this great precaution in protecting the conductors will be understood when it is remembered that the cable has to pass through five locks, so that for the greater part of its length it is under water. One accident to a circuit occurred by the rupture of a water main behind which the cable was placed. This was easily repaired by splicing.

The description further states:

"During the last six months the installation has been in full work, and has been of great service." See "Engineering," Vol. XXXIII., page 6.

Frequent statements have been made in the newspapers to the effect that, granting the fact that underground conductors can be made so as to withstand the high electrical pressure required to operate a circuit of forty or fifty arc lights, and to remain in good condition for a reasonable number of years, the amount of leakage of electricity will be so great as to prevent the commercial success of such a system; and that for this reason only six lights, or ten at the most, could successfully be operated on one underground circuit.

These statements are now so often made, and are becoming so generally believed by the public, who are encouraged in this belief by the advocates of overhead conductors for arc-light systems, that it seems necessary to state the truth about electricity in this respect, especially since everything that is mysterious, capricious and untrue is readily attached to this much-abused agent, and as readily believed by the public.

The conditions of the problem have been assumed in such a manner as to make the leakage even greater than what it would be in practice, and are as follows: Forty arc lights operated under a total electrical pressure of two thousand volts, are placed at intervals of three hundred feet apart, making the total distance twelve thousand feet, and the entire length of circuit twenty-four thousand feet, or more than four and one-half miles.

The conductor consists of a No. 6 copper wire covered with an insulation of best gutta percha one sixteenth of an inch thick. The outgoing and incoming parts of the circuit are placed close together and are supposed to be surrounded by some good conductor (acidulated water for example.)

The resistance of the insulation of the double cable will be fifty millions of Ohms per mile. This resistance opposes the leakage. The total leakage, expressed in work, will amount to two and seventy-seven hundredths ft. lbs. per minute. A good idea of the insignificant loss is given by knowing that it is only the one-eleven-thousand-nine-hundredths part of one horse-power.

The amount of energy in the lamps will be thirty-horse power, of which the leakage is twenty-eight-one-hundred-thousandths part of one per cent. In order that the leakage may amount to as much as one per cent. the insulation would have to deteriorate to the one-thirty-five-hundredth part of what it is when at its best. Hooper's India rubber is twenty-hundred per cent. better than gutta-percha as an insulator.

As long as the insulation of an underground conductor is fair and without actual breaks or faults, the leakage in that portion of the circuit is not of the slightest consideration, and it is incorrect and misleading to assume that, from a commercial point of view, it can affect the questions arising in regard to underground conductors. When a leak becomes of sufficient magnitude to affect the economy, it is through a break or fault in the insulation, which would, of necessity, have to be repaired.

"I wish to quote at some length from an article which appeared in the "Telegraphic Journal and Electrical Review, Vol. IX.," and which bears directly upon the question of insulation and durability.

"There is undoubtedly a very general impression abroad that high insulation is, above everything, the indication of a sound and good working line, but there cannot be a greater mistake than to suppose this. In certain cases, in gutta percha for example, excessively high insulation is an indication of a poor quality of material, a quality in fact which is not durable. * * * * This is not all, however, for even supposing that high insulation can be obtained consistent with durability, there is nothing whatever gained by a high result as regards its working value, in fact it is a positive advantage to have low insulation, provided the latter is due to the *nature* of the insulating material, and not to a defect in it." (The author refers particularly to telegraph lines, but the same words apply with equal force to electric light conductors). "But it is very necessary for thorough good working that the low insulation should not be due to a *defect*; the latter may improve the working" (of telegraph lines), "but it is much more likely to spoil it by continual variation, hence the problem to be solved in underground lines is *low* insulation (within certain limits of course, for there must be sufficient insulation to enable a good proportion of the transmitted current to be received at the receiving end of the line) consistent with durability."

Thus it will be seen that a very high insulation is not needed in electric-light-underground conductors operated under high pressure, for the loss with extremely low insulation will amount to but a small fraction of one per cent. of the total current; but durability is the object to be obtained.

Respectfully submitted,

CHAS. L. CLARKE,
Engineering Department,
Edison Electric Light Co.,
New York city.

Mr. Borden handed the report to the Committee, and then proceeded to read some newspaper accounts of damage by fire caused by electric light wires coming in contact with telegraph and telephone wires and other conducting substances. As to the matter of danger to life he said, it is evident that if any person should come into contact with both the outgoing and incoming conductors of an electric light system, there would be danger if the current exceeded (according to Sir William Thompson) two hundred volts. An accident of this kind occurred at Hatfield House, in England, within two months, resulting fatally. That was a carelessly-insulated plant, however, and such danger should not be taken as one of the common dangers inherent in the arc-light system in this country, where all responsible companies put up well-insulated wires. The chief danger, I think, would be from the breakage of a wire, as in case of a fire; for instance, a fireman might sever one of these conductors, placing life and property in peril.

Mr. Sidney B. Paine, who assisted Mr. Clarke in making his experiment, replied to various questions asked by members of the committee and others.

Mr. Lyman P. French, of the Brush Electric Lighting Company, suggested that Mr. Clarke's experiment was inadequate, as it occupied only two hours and a half, and as only twenty feet of wire were used.

Mr. Paine claimed that two hours and a half were as good as any extent of time. The system he used would be no more affected by time than the present gas pipe systems. The system was also so constructed that twenty feet would answer as well as a hundred, as in case of injury the fault could be easily discovered and remedied on a long circuit, owing to the peculiar construction of the system.

In reply to a question by Mr. Wilbur, Mr. Paine explained the difference in electro-motive force of an incandescent and an arc light. In the incandescent lights the electro-motive force is from 103 to 110 volts, where there are large machines of 1200 lights. The largest Brush machine at present has a force of 2400 volts.

Mr. Borden explained that if lamps are added in an incandescent system, since the electro-motive force is constant, and each lamp reduces the resistance, the current must increase with lamps added; and that if lamps are added in an arc system, the resistance is increased as lamps are added, and hence the electro-motive force must be increased; therefore, the current remains the same. These facts were easily deduced from Ohm's law, viz.: Current-electro-motive force; resistance.

The question as to whether a person severing an electric light current with an axe with a wooden handle would be likely to be killed was discussed by several of the gentlemen present. Mr. Borden was of the opinion that the effect would not be so great as though the person should sever the wire with a pair of plyers. He did not believe, however, that the wire could be cut with an axe. If he should cut the wire with a pair of plyers, there would be so much danger attending the operation that he would never do it again.

Senator Doyle remarked that he did not think the committee was getting the light it wanted. Somehow or other, the electricians did not seem to come to the point. The committee were in need of something more tangible than anything that had yet been presented.

Mr. F. F. Hale, of the Arnoux Electric Lighting Company of New England, said that all the

dynamo companies or machines of any practical account to-day can be counted on one's fingers. There are not over five or six of any value. The Arnoux is one of them. We put up the first light that was ever exhibited, at Manhattan Beach, in 1878. There is not the slightest feeling among these different companies, except that of business rivalry. There is a field for us all. The public will want these lights, and they are going to have them, and if the Legislature says the wires must go underground, the additional expense must come out of the public, rather than out of the companies. The speaker did not believe that any danger to life occurs from severing these wires. An experiment was recently tried by an electrician at the office of the American Company in the presence of some one hundred and fifty persons. The electrician went within ten feet of the dynamo machine, took a pair of shears and severed the wire, which was then running four lights, and the instant he severed the wire the lights went out; but the experimenter was unhurt. Furthermore, this same electrician picked up both ends of that wire and allowed the current to pass through his body without injury to himself.

Mr. Borden remarked that the electric motive force of one light is fifty volts. If there were only four lights, then the total electro-motive force was only two hundred volts, which is a safe current, according to Sir William Thompson.

Mr. French said that Mr. Borden was laboring under a misapprehension. This test was far in excess of that amount.

Mr. M. L. Ross said that he saw a similar experiment tried in Boston two weeks ago, when a gentleman cut the wire in two with a pair of steel plyers.

Mr. Hale said that the experiment made by Mr. Clarke was purely a laboratory trial. It is not possible that two and one-half hours time, and twenty feet of wire, can test thoroughly and practically the putting of wires under ground. The test of time has got to come in this matter.

Mr. Borden—The ocean cables have lasted ten years.

Mr. Hale—That is another matter. We produced the first light in 1878—four years ago. It may be necessary to renew our wires every five years for all we know. In that case, if the wires go under ground, your streets will be continually turned up. There has not been a single case of any circuit having been used under ground for any length of time. The system was tried in Paris and was abandoned. In London there is no wire under ground that has been used a short time.

Mr. Wilbur—Then it is simply a question of expense.

Mr. Hale—It is a question of expense, but not wholly that. The question of finding a durable insulator is another important matter. I do not believe the insulator that the electric company has got is going to be durable, and I don't know of any that is. So far as has been demonstrated we can work wires under ground, but no extensive system has been operated under ground, and it has not been practically demonstrated that an extensive system can be operated under ground. The Edison Company don't show that they have been doing anything practical.

Mr. Borden called the speaker's attention to Mr. Edison's system of seven hundred lights at Menlo Park, which had been in operation two years.

Mr. Hale's impression was that that circuit was a very short circuit, though Mr. Borden said he believed it was several miles in length. The gentlemen in reply to a question of Mr. Paine, spoke of an underground system that had worked successfully for years, but still contended that the question of the life of the wires was undecided.

Mr. French gave the committee the benefit of his experience with a certain insulator, a specimen of which Mr. Hale had given the committee, and condemned it as worthless. He claimed that up to the present time, the matter of insulating wires for either telegraphic or electric light purposes, and putting them under ground, had been up to the present time more a matter of theory than of practice. Theoretically, he was in favor of putting the wires under ground if it could be done; but the fact has got to be demonstrated. As to the matter of accidents, he said it was a singular fact that there is not anything that exists on the face of the earth that is not coupled in some way with the power to destroy life.

Mr. Borden here interrupted the gentleman with the remark that the Edison Company has thrown down the gauntlet to all the electricians in the world to cause a fire or injury to any person where the Edison system is carried out.

Mr. French was glad if Mr. Edison had accomplished anything practical. He did not believe there was much danger from the electric light. There is danger, unquestionably, he said, but I think the danger from poles falling down and wires knocking bricks off of chimneys is greater than any danger from a shock. There hasn't been a loss of life in some three or four years, that I have learned of. I was President of the Brush Company from its inception in New England till last October, and there has not been one single instance come to my knowledge where an insurance company has been compelled to pay a cent on account of fire caused by an electric light. I know of telephones having been burned out by some carelessness or other cause when an electric light current was directed through them. Mr. French said, in conclusion, that he was not an electrical engineer, and suggested a way by which the committee might get more positive information upon the points to which he had called attention.

After considerable informal discussion upon various points of greater or less importance, Judge Wilbur asked if instead of carrying the wires under ground, they might not be insulated and closed in some way so as to be carried above the surface, near the ground. Opinions expressed upon this subject were, to the effect that the danger would be greater than as though the wires were suspended in the air.

W. W. Douglas, Esq., offered various suggestions and made some interesting statements of facts. He said that the committee ought to consider the amount of danger. If there is only a slight danger, and a danger that can be obviated in some other way, then this General Assembly should not legislate the wires underground. He believed that it had been shown by scientific men of high attainments (for instance Mr. Atkinson), that the danger to life can be prevented by careful insulation of the wires originally; and, if you please, by an inspection of the wires at stated times. There might be an arrangement also by which the current could be cut off in case of fire, so that the firemen could not be thrown into danger by contact with the wires. It seemed to him that it was within the ingenuity of this committee to devise some means which will make the wires perfectly safe without carrying them under ground. It seemed to the speaker that the danger from the electric light current had been extremely exaggerated. We have been given no instances of destruction of life or injury to person anywhere upon the circuit, except at the machine or at the lamp. If you bury the wires a thousand miles deep, that danger still remains, for the lamps and the machines must stay above ground. The danger to the lamp is obviated by the introduction of fusible wire.

Mr. Borden claimed that there was no such device upon any but the Edison lamps.

Mr. Douglas believed that other companies used the device. The gentleman believed that electricity will be carried underground some day, but did not think it practicable yet.

Senator Wilbur—I am informed the committee feel like this in this matter: If the wires conducting electricity through the air are dangerous to life and property, they should be required to be put under ground or in some other way taken care of. I think that suspended in the air these are dangerous to life and property, and I am in favor of placing them under ground. How the other members of the committee feel in relation to the matter I am not prepared to say, but I presume that Mr. Doyle entertains something of the same view, and I think Mr. Arnold is of the same opinion. I merely give that as our feeling now. [Neither Mr. Doyle nor General Arnold dissented from Judge Wilbur's statement.]

Mr. Borden again addressed the committee and had quite a spirited discussion with Mr. Reginald C. Brown, electrician, who doubted the practicability of the Edison underground system.

The committee then arose.

THE METROPOLITAN.

MARCH 25, 1882.

Gas, Water, and Electricity.

Domestic Electric Lighting.—It has always been fully accepted by us as a condition of the success of the electric light for ordinary domestic purposes that it must be brought to our houses in the same way as gas is now supplied, and further, we have at all times conceded that the cost of the light must not materially exceed that which the public have hitherto been accustomed to pay for other artificial illumination. That these facilities for obtaining the light would sooner or later be afforded the public has been only too plainly evident for some three or four years past, and even their parties are prepared to undertake the supply of the electric light on the conditions above specified as indispensable. A very practical illustration of what is now being actually done in this respect is afforded by the installation nearly completed by Mr. Edison's representative on the Holborn Viaduct, where a central station has been established, and arrangements completed for lighting therefrom the public roadway, the City Temple, the Viaduct Hotel Restaurant, a portion of the General Post Office, and a number of shops and warehouses in the immediate vicinity. The electric current is supplied to all these places in a manner exactly analogous to the mode of gas supply, and possibly by the time these lines appear in print the installation will will prove of even greater interest to ordinary householders is that issued by the Domestic Electric Lighting Company whose exhibit at the Crystal Palace, consisting of a very handsome suite of rooms lighted electrically, has been so universally admired. The company is prepared to give estimates for and to undertake the supply of the whole of the machinery, lamps, and connections necessary for the complete installation and working of the electric light for domestic and practical uses. The directors do not bind themselves to any particular system, but only undertake that everything requisite for the successful and economical production of light and power in the simplest, safest, and best manner shall be installed. The installation of the electric light in private houses, and for domestic and practical purposes, forms indeed the chief objects of the company. Whenever sufficient subscribers are found a lighting-station will be set up, and the price to be charged will be at the same, or nearly the same, rate as gas. Therefore any ten or twenty persons who are neighbours can shortly leave the electric light substituted for gas or oil with a much greater illumination, and without those discomforts and inconveniences so frequently experienced where gas is used. The application of incandescent lamps and electric motive power to public streets, clubs, hotels, theatres, concert rooms, workshops, and other public and semi-public places; and the erection and supply of arc-lights for streets, squares, docks, and all open-air positions form a separate branch of the undertaking. As stated above, the directors do not bind themselves to any particular system, but the installation at the Palace (which has already been fully described in these columns) is based upon that of Mr. Edison's, by which not only is there absolute security against risk of fire, but the utmost simplicity and economy are attained. Indeed the entire absence of any danger from fire is a feature of this system, and it is accompanied by an exceedingly simple means of detection, which consists in a piece of lead wire that is included in every branch or circuit is what is termed a protector block, which contains a piece of lead wire that is comparatively easily fused. The current traverses this wire, and if, from any cause, the current becomes too strong, and likely to create heat to an undesirable or dangerous extent, the small piece of wire is fused, the circuit is broken, and the lamps are extinguished.—attention being thereby called, in a very practical manner, to the fact that something is wrong. A new block or plug can be at once screwed in, and the cause of the undue heat having been ascertained, the lamp may be immediately lighted again. It need scarcely be pointed out, however, that after the first day or two of the introduction of the lights into a house, the utility of this system of protection would be very rarely demonstrated in so practical a manner. The current would be adjusted to the requirements of the household, and any "short circuiting" of the wires would be provided against, but the inhabitants would derive confidence from the fact that the in the event of anything unforseen occurring. Most unquestionably the electric light has been brought within the region of practical domestics, and we need scarcely add that we shall watch with considerable interest the progress of any organisation established to promote its use for domestic purposes.

Rogers's Electric Light.—A number of gentlemen interested in the subject of electric lighting assembled on Wednesday afternoon at the works of Mr. J. B. Rogers on the Holborn Viaduct to witness a further series of experiments with that gentleman's system of dividing and subdividing the electric current. In February last Mr. Rogers explained to a somewhat similar company the main features of his system demonstrating its utility for ordinary interior lighting in a very practical manner, and on that occasion we described the principle by which the division of the current is secured. On Wednesday, however, the arrangements were of a much more extensive character, over a hundred incandescent lamps being shown in various parts of the buildings, and in place of the Otto gas engine formerly employed a 7 horse power of Easton's improved horizontal engines has been provided, and appeared to work admirable. In the course of the past few weeks Mr. Rogers has also invented a lamp of his own, which was the only kind used for the purposes of the recent display. The application of the light to ordinary indoor purposes was very satisfactorily shown, and in respect of the distribution of the current Mr. Rogers's method undoubtedly possesses several distinctive features. Of his lamps we shall probably have occasion to speak at greater length on another occasion.

The Electric Light at the City Temple.—The City Temple was lighted throughout by Edison's electric light for the first time on Sunday evening. During the whole service the lights were perfectly clear and steady, and the result of the lighting was regarded as entirely satisfactory. The sermon was preached to a congregation that crowded every available inch of room, and the temperature was ten degrees lower than that registered the previous Sunday. The lighting of this large building, we may remind our readers, forms part of a very much larger installation, now nearly completed, on the Holborn Viaduct, a full description of which will appear in these columns, probably next week.

Engineer, Mechanic & World of Science. Mar 24/82.

DOMESTIC ELECTRIC LIGHTING.

A LECTURE on electric incandescent lamps suitable for domestic lighting was delivered on the 20th inst. at the Crystal Palace, by Professor Silvanus P. Thompson, of the University College, Bristol. So far back as 1841 the principal had been made to construct little electric lamps, in which platinum wire was the thin wire of resistance or thin strip of carbon, which on the passage of an electric current became incandescent. This method of obtaining light from electricity by incandescence was revived in 1878 by Mr. Edison, who at first attempted to construct platinum lamps, which, however, in spite of many ingenious contrivances for preventing the burnt wire overheating, could not be kept from fusing etc. Eventually Edison settled upon a filament of carbon. The carbon filament was prepared and has made by Mr. Swan, of Newcastle. Edison prepared his filaments of cotton thread, Swan from cotton thread. In each case the carbonised fibre was fixed in a small platinum holder, and exhausted as perfectly by mercurial air by a mercurial air-pump. A filament of carbon, however, is very brittle and elastic as steel. Such a fibre had been constructed by Lane-Fox and Sir Henry Bessemer, the difference of detail in the manufacture. These little lamps gave a light of about equal brightness to a candle-light gas-jet. They were described as a revolution in domestic lighting, since, when supplied by means from a central station, they would not only be cheaper than gas, but would be far more readily controlled and regulated. There was no inflammable or noxious products of combustion produced, very little heat, and there was no risk of explosion. The incandescent lamp lent itself to use with extraordinary facility to the requirements of rooms, and would shortly, he believed, become the fashionable mode of lighting. The experience of the working of the system showed that it was practicable to apply them to a large building. The public safety depended that no lamp should be used making electric lighting inoperative in all public buildings. It might also be made compulsory to use electric lamps in coal mines. In a few days the experiment would be tried of lighting the Holborn Viaduct and surrounding houses by Edison's lamps from a central station. This would be but a small sample of the manner in which domestic electric lighting could be carried out on a large scale. The lecturer predicted for this method of lighting results far more important and widereaching than those which any other kind of electric lighting could possibly attain.

Nature May 27th 1884

THE MAXIM SYSTEM OF ELECTRIC LIGHTING BY INCANDESCENCE.

LAST night an interesting demonstration of the Maxim System of Electric Lighting by incandescence took place before a crowded meeting of political, financial, and scientific gentlemen, at the Albany Works, 374, Euston-road, under the auspices of Mr. St. de Rakuch, of New York.

The premises, which are very spacious, consist of two houses of four and six stories respectively.

At the back of the ground floor a 20-horse power nominal engine, supplied by the firm of Messrs. Ransomes, Head, and Jefferies, of the Orwell Works, Ipswich, and exactly similar to the engine which has been driving the electric lights on the Thames Embankment for the last two and a half years past, and of the same firm, was driving, directly and by means of intermediate shafting, a group of three machines.

The arrangements were at first pleasant only for the two machines which are driven direct from the engine, and it is only recently that, a second large machine having just arrived from the United States, it has been decided to add it to the one already working during the interval of the present month, and drive it from a countershaft; the number of lights having, at the same time, been correspondingly increased.

It is, however, contemplated before this Exhibition is over (and the whole of the plant is intended for the Electrical Exhibition which is to be held in Paris at the beginning of August) to still add more machinery and electric plant. Some forty are light regulators, and the machines for working them, both on the Maxim and Weston systems, being on their way from New York for that purpose.

The Maxim system of incandescent lighting which is now successfully and very extensively adopted in the United States of America, and which was exhibited on the occasion referred to as follows :—

A small dynamo-electric machine running at about 800 revolutions per minute, generates a current of electricity, which is caused to circulate in the electro-magnets of a large similar machine, exciting therefore the magnetic field of the latter with which it is thus connected.

The small machine is provided with an extremely ingenious device for controlling the supply of electricity, and regulating the current in order to suit, and accordingly to the number of lights which may be burning. This machine is called the Maxim regulator, and it gives a current of it, it may be said that the brushes collecting the current, generated by the exciter, together with the brush holders, are made to swing round the axis of the machine, and are automatically set to any position between the maximum and the neutral points.

Two pairs of electro-magnets at the top receive a proportion of the currents of the large and small machines respectively, one pair operating the regulating movement, and the other a shunt which will be hereafter described. The regulator is operated by means of an armature attracted with forces varying according to the number of lights in circuit. When the supply of current becomes insufficient by more lamps being turned on, the armature being released in one direction, and attracted in the opposite one by means of an antagonistic spring, a pawl which is suspended from this armature, causes the brush holders to revolve through an intermediate system of gearing being brought into play, thus supplying a greater volume of current.

The opposite phenomenon takes place when the current becomes too great owing to the removal of a certain number of lamps from the circuit.

The delicacy of the working of this regulator is such that—as was illustrated by Mr. Lockwood —the current supply is automatically, immediately, and effectively controlled, either when a large number of lights are in circuit or whe there only remains one.

The other pair of electro-magnets are so connected and adjusted that they only act upon their armature when a large increase of the current passing through them takes place, such as would be the case should a main wire happen to accidentally break, or any other accident occur; in such a case this armature is strongly attracted, and overcoming the tension of its antagonistic spring, brings its free end in contact with a platinum point, thereby cutting out of circuit the field magnets of the exciting machine, and completely stopping the generation of current until the accident shall have been remedied. This forms a perfect safeguard against any possible injury being done either to the machine or lamps.

The large machine is composed of two distinct parts built into one on the same frame and spindle; they are coupled together, and an ingenious and simple contrivance is provided at the top of the machine, and by means of which the currents supplied by each of the two distinct machines can instantly be disconnected or coupled either in quantity or tension, according to the requirements of the case.

The machine runs at about 900 revolutions per minute. The regulator can be used to regulate and control from one to six of the large machines.

Both machines are of a very highly finished workmanship, and resemble in their external appearance Siemens's dynamo machine.

They have been very carefully studied in all their details, and many of their parts, such as the commutators, the sections of which are made out in the shape of a very elongated or widely open letter V, instead of being in a straight line

DAILY NEWS.

THE ELECTRIC LIGHT.

Mr. J. W. Swan, the well-known electrician, lectured on the above subject last evening at the Royal Institution, directing his remarks chiefly to the mode of lighting known as the "incandescent." He might fairly say that the difficulties encountered in the construction of incandescent electric lamps had been conquered, and that their use was economically practicable. They knew by actual experiment that continuous heating to a fairly high degree of incandescence during 1,200 hours did not destroy a well-made lamp. What the utmost limit of a lamp's life might be they did not know. Probably it would be an ever-increasing span; as, with increasing experience, processes of manufacture were sure to become more and more perfect. Taking it, therefore, as fully established that a cheap and durable lamp could now be made, the further question was as to the cost of the means of its illumination. The cost of producing light by means of electric incandescence might be compared with the cost of producing gas light in this way: 2 cwt. of coal produced 1,000 cubic feet of gas, and this quantity of gas, of the quality called fifteen-candle gas, would produce 3,000 candle light for one hour. But besides the product of gas, the coal yielded certain bye products of almost equal value. He would, therefore, take it that they had in effect 1,000 feet of gas from one cwt. of coal instead of from two, as was actually the case. The one cwt. of coal would give fifty horse power for one hour. Repeated and reliable experiments showed that they could obtain through the medium of incandescent lamps at least 200 candle-light per horse power per hour. But as there was waste in the conversion of motive power into electricity, and also in the conducting wires, he made a liberal deduction of 25 per cent., and took only 150 candle-light as the nett available product of one horse power. For fifty horse power, the produce of one cwt. of coal, they had then 7,500 candle-light, as against 3,000 candle-light from 1,000 feet of gas. That was to say, two-and-a-half times the amount of light which the gas from the same quantity of coal was capable of producing. There remained, however, an allowance to be made to cover the cost of the renewal of lamps. There was a parallel expense in connection with gas lighting in the cost of the renewal of burners, globes, chimneys, &c. He could not say that those charges against gas lighting would equal the corresponding charges against electric lighting, unless they imported into the account—as he thought it right to do—the consideration that unless minute attention be given, far beyond what was actually given, to all the conditions under which the gas was burned—nothing like the full light product which he had allowed to be obtainable from the burning of 1,000 cubic feet of gas, would be obtained. Taking that into account, he thought but little, if any, greater allowance need be made for the charge in connection with the renewal of lamps in electric lighting than ought to be made for the corresponding charges for the renewal of gas burners, globes, chimneys, &c. But it would be seen that even if the cost for renewal of lamps should prove greater than the corresponding expense in the case of gas, there was a wide margin to meet it before they had reached the limit of the cost of gas lighting. He thought, too, it might be fairly placed to the credit of electric lighting, that by this mode there was entire avoidance of the damage to furnishings and decorations of houses, to books, pictures, and to goods in shops, which was caused through lighting by gas, and which entailed a large expenditure for repair, and a large amount of loss which was irreparable. In comparing the cost of producing light by gas and by electricity, he had only dealt with the radical item of coal in both cases. Gas lighting was entirely dependent upon coal—electric lighting was not; but in all probability coal would be the chief source of energy in the case of electric lighting also. When, however, water power was available, electric lighting was in a position of still greater advantage, and in point of cost altogether beyond comparison with other means of producing light. With regard to the cost of plant, there would be a more even balance in the two cases. In a gasworks they had retorts and furnaces, purifying chambers and gasometers, engines, boilers, and appliances for distributing and regulating pressure. Plant for generating electricity on a large scale would consist principally of boilers, steam engines, dynamo-electric machines, and batteries for storage. No such electrical station, on the scale he was supposing, had yet been put into actual operation; but several small stations for the manufacture of electricity already existed in England; and three large stations designed by Mr. Edison were almost completed in America. They were therefore on the point of ascertaining by actual experience what the cost of the works for generating electricity would be. Meanwhile they knew precisely the cost of boilers and engines, and what ought to be the cost of dynamo-electric machines of suitably large size. There were consequently sufficient grounds for concluding that to produce a given quantity of light electrically the cost of plant would not exceed greatly, if at all, the cost of equivalent gas plant. There remained the cost of distribution. Could electricity be distributed as widely and cheaply as gas? On one condition, which he fully hoped could be complied with, that question might be answered in the affirmative. The condition was that it be found practicable and safe to distribute electricity of comparatively high tension. The importance of this condition would be understood when it was remembered that to effectively utilise electricity in the production of light it was necessary that the resistance in the carbon of the lamps should be relatively great to the resistance in the wires which conveyed the current to them. In order to supply the current to the lamps economically there should be comparatively little resistance in the line. Distribution in this manner had the merit of simplicity, and it involved no danger to life from accidental shock; moreover it did not demand great care in the insulation of the conductor. But it had the great defect of limiting within comparatively small bounds the area over which the power for lighting could be distributed from one centre. In order to light a large town electrically on this system, it would be necessary to have a number of supply stations, perhaps half a mile apart. It was evidently desirable to effect a wider distribution than this, and he hoped that either by arranging the lamps in series, so that the same current passed through several lamps in succession, or by means of secondary voltaic cells, placed as electric reservoirs in each house, it might be possible to economically obtain a much wider distribution. Whether by the method of multiple arc, which necessitated the multiplication of electrical stations, or by means of the simple series or of secondary batteries connected with each other from house to house in single series, the lamps being fed from these in multiple arc, he was quite satisfied that comparatively with the distribution of gas, the distribution of electricity was sufficiently economical to permit of its practical application on a large scale. As to the cost of laying wires in a house, he had it on the authority of Sir William Thomson, who had just had his house completely fitted with incandescent lamps, that the cost of internal wires was less than the cost of plumbing in connection with gas pipes. Referring to the use of carbon as the wick of an electric lamp, Mr. Swan pointed out that excellent carbon filaments could be produced from the bamboo, and also from cotton thread treated with sulphuric acid. The sulphuric acid treatment effected a change in the cotton thread similar to that which was effected in paper in the process of making parchment paper. He exhibited an example of a carbon filament produced from parchmentised cotton thread. The filament, he said, was not more than the ·01 of an inch in diameter, yet a length of three inches, having therefore a surface of nearly the one-tenth of an inch, would give a light of twenty candles when made incandescent to a moderate degree. It need hardly be said that the interesting experiments with which Mr. Swan illustrated his remarks were watched with much interest by a crowded audience, including Dr. Tyndall, Professor Abel, Professor Franklin, and other well-known scientific men.

Scientific Am. April 15. 1882.

Electrical Capacities of Heated Bodies.

It is well known that a burning match or a gas flame acts as a discharger of electricity, and the fact has been applied by Sir William Thomson to his portable electrometer in observing the potential of the atmosphere at any point. Recent experiments of Professor Guthrie, F.R.S., have shown that an incandescent platinum wire also acts as a discharger of electricity, and displays a preference for discharging a negative rather than positive charge. If a platinum wire, made incandescent by an electric current, is placed between two gold leaf electroscopes, one charged with positive and the other with negative electricity, it will be found that the negative charge is rapidly drawn off, while the positive charge remains almost unaffected. The wire in this experiment was at a dull red heat; and it is probable that a higher temperature would also have affected the discharge of the positive electricity. Professor Guthrie likewise shows that a red-hot metal ball at certain high temperatures will not accept a charge of positive or negative electricity from the conductors of a glass electrical machine; while at certain lower temperatures it will accept a negative charge, but not a positive one, and at still lower temperatures it will take both a positive and negative charge.

SUNDAY HERALD FEBRUARY 26, 1882.

"Electric Dangers."

To the Editor of the Herald: In the leading editorial published in today's issue of your paper, under the head of "Electric Dangers," you treat upon the subject of dangers likely to arise to lives and property by the running of electric light wires over the roofs of houses or on poles along the streets. This is certainly true in all arc systems, as has been demonstrated in a number of occasions in different cities. But the point to which I beg to call your attention, and in which exists a serious error of fact, is the following paragraph: "The statement has been often made that this danger can be prevented by carrying these electric light wires underground, but, as a matter of fact, it has thus far been found impossible to devise any such method. Telephone, telegraph, and fire alarm wires may, perhaps, be buried without injuring their serviceability, but the means by which electric light wires can be carried under ground, without an enormous loss of developed power, has yet to be discovered." A little inquiry would have proven to you that not only has such a means of carrying electric light wires been discovered, but that it has been perfected and is now being adopted in practical use. Mr. Edison is now preparing to light up a large district in New York city, extending from Wall street north to Spruce street, and east from Nassau street to the East river. In this district there is located a central station, wherein will be placed the engines, boilers and dynamo machines necessary for generating the current for the supply of the consumers. From this central station the copper conductors are carried through the streets, being placed in iron pipes and buried under ground to the depth of 18 inches. In front of each building is located a junction box, from which branch pipes run into the basements, where connection is made with the wires running throughout the house. Thus far over eight miles of conductors have been laid, a few more miles remaining to be adjusted, when the work will be completed and the district, containing several thousands of gas consumers, will be illuminated. Each consumer will be provided with a meter, through which the current will be passed and accurately registered, so that the individual will be only charged with the actual amount of current consumed. Mr. Edison claims for his system of underground conductors both absolute safety and economy, and is positive in his assurances of its perfect success.

W. W. M.

Boston, Feb. 16, 1882.

To the Editor of the Herald: The statement in an editorial on electric dangers in your yesterday's paper, that it has been found impossible to devise any method for carrying electric light wires under ground, and that the means by which they can be so carried, without an enormous loss of power, has yet to be discovered, is entirely erroneous, so far as the Edison company is concerned. All last winter Mr. Edison had, at Menlo Park, seven miles of cables buried under ground, and the lowest resistance of the seven miles was 14 ohms, with 780 lights burning on the circuit, and the loss from leakage, by actual measurement, was less than 1 per cent. That leakage was excessive for the Edison system, because the seven miles of underground cable were not intended nor properly laid for permanent use, but only to demonstrate on a large scale the practicability of the subdivision of the electric current. The Edison company is now equipping a district of a mile square in New York city, where the current will all be sent through subterranean cables laid in the streets, from a single central station where it is generated. In that district we have already wired, for our lamp, 946 houses, aggregating 14,311 Edison incandescent lamps. Beside light the company will also sell electric power for domestic and industrial purposes. Fourteen miles of underground cables are required to equip that one district, and over seven miles are already laid, our work being temporarily suspended on account of frost. The tests made on the cables already laid show that, when the entire 14 miles shall have been interred, the leakage or loss of power will only be a small fraction of what is necessary to supply a single incandescent lamp, or, in other words, we shall lose, in those 14 miles of Edison's patented subterranean conductors, less than 1-140 of 1 per cent. of our current. Will you have the kindness, therefore, to correct the statement in your editorial, which is erroneous, at least so far as the Edison company is concerned?

S. B. EATON, Vice-President.
Edison Electric Light Company, New York,
Feb. 17, 1882.

[The comments made in the above letters are hardly applicable, for we directly referred to arc lights in speaking of underground wires, while the Edison plan seems to be limited to incandescent lights, the wires of which might be carried above ground with relative impunity. Mr. Edison may have devised a method of laying wires for arc lights below the surface of the ground; but surely he and his friends have no right to ask the public and other electricians to accept his assertion, until he has given it a thorough and public demonstration. —ED. HERALD.]

Sanitary Engineer, Sept. 1881.

ELECTRIC LIGHT NOTES.

The Falls at Niagara are illuminated by means of the electric light.

Preparations are being made in Cincinnati to try electricity for street lighting.

There are over one thousand miles of underground telegraph lines in successful operation in Europe.

The *Iron Age* says that in Chicago all suspended telegraph wires must be removed at a specified time in 1882.

An electric light in the Port Henry (N. Y.) iron mines has proved a failure on account of the dampness of the pits.—*Springfield Republican.*

The introduction of the electric light in the Baltimore Post-office is said to give entire satisfaction, and to effect a most agreeable change from the great heat of the gas lights previously in use.

The Albany (N. Y.) Electric Illuminating Company have a contract with that city to furnish 300 electric lamps, which are to be lighted for 50 cents each, the lamps to burn all night and every night in the year.

Sir W. Thomson expresses the opinion "that so far as economy of physical resources of coal, etc., and satisfactoriness of the result in respect to health and comfort are concerned, electric lighting ought to supersede lighting by gas, in towns, in the course of a very few years."

The Springfield *Republican* states that the electric light company of that place have, in operation, 29 lamps, which is the full capacity of the generating force. Duplicate engines have been provided, and the present success seems to warrant the consideration by the company of an increase of capital.

The International Electrical Exhibition in Paris opened on the 10th of August, and on the day following was thrown open to the public. At the time of opening the United States and part of the English exhibits were incomplete. We shall have occasion to notice the various exhibits hereafter.

The *Times* of this city states that all the electrical companies in the United States, except the Edison Co., have combined under the name of the Gramme Electrical Company. It includes the Fuller, Brush, United States, American, Jablochkoff and western companies; and the object of the combination is said to be the protection against infringement of their several or joint patent rights.

At the third annual meeting of the British Electric Company, held on the 13th of July, a 7½ per cent. dividend for the past six months was declared, which, with that paid in the first half-year makes a total dividend of 10 per cent. for the year. It would be interesting to know what part of this represents the natural earnings of the company and what part is the result of rights sold to other companies.

The Prospect Light Company of Niagara Falls have illuminated a portion of the American Fall with electric lights for some time past, but owing to the spray the effect was nothing remarkable. Mr. Rhodes, superintendent of the new suspension bridge, is making an effort to illuminate both the American and Horseshoe Falls by means of 16 electric lights placed at various points on the bridge and Canadian shore. The dynamo-electric machine is to be run by water power.

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American Mechanic April 8, 1882.

Regulations for the Use of Electric Lighting Apparatus.

The following specific regulations have been prepared for the use of the Boston Manufacturers' Mutual Fire Insurance Company by the Inspectors of that company, C. J. H. Woodbury and W. H. H. Whiting:

DYNAMO MACHINES.

Dynamo machines should be located in dry places, not exposed to dyings or easily combustible material, and insulated upon wood foundations. They must be provided with devices capable of controlling any changes in the quantity of the current; and, if these governors are not automatic, a competent person must be in attendance near the machine whenever it is in operation.

Each machine should be used with complete wire circuit, and connection of wires with pipes, or the use of ground circuits in any other method is absolutely prohibited.

The whole system should be kept insulated, and tested every day for ground connections at ample time before lighting, so to remedy faults of insulation, if any are discovered.

Preference is given for switches constructed with a lapping connection, so that no electric arc can be formed at the switch when it is changed; otherwise the stands of switches, where powerful currents are used, should be made of stoneware, glass, slate, or some incombustible substance, which will withstand the heat of the arc when the switch is changed.

WIRES.

Any conducting wire which is warm to the touch, in comparison with another wire, is liable to become a source of danger, and should be replaced by a larger wire. Conducting wires should be secured to insulating fastenings, and covered by an insulation which is waterproof on the outside. Wires—or wires pass through walls, roof, floors or partitions, or where there is a liability to abrasion, or exposure to rats or mice, the insulation should be protected with lead, hard rubber, stoneware, or some other satisfactory material.

Joints in wires should be securely made and wrapped; soldered joints are desirable, but not essential.

Wires should not approach each other nearer than one foot, and twice that distance is preferable in conducting electricity of high tension. Care should be taken that wires are not placed above each other in such a manner that water would be liable to make a cross connection.

The ends of a broken wire should be everywhere provided against by securing the wires on suitable insulators; avoiding danger from an accumulation of lint, by placing them one-eighth to one-quarter of an inch from the walls, ceilings or beams, except where necessary to lead to the lamps, and in all cases avoiding loops of wire, or leading it across the space from beam to beam.*

A cut-out should be placed in the circuit outside of each building, in a well-protected and accessible place.

ARC LAMPS.

The lamp frames and other exposed parts of lamps should be insulated from the cir

*It is important that wires parallel to each other, one above another, upon the same surface of wood, should be avoided in buildings constructed like those insured by this Company, for the reason that water used in washing floors, and water condensing upon walls in blasteries, dye works, paper mills, or petst works, may trickle down from one wire to another, thus making the conditions upon which a cross are may be formed. This danger would be greater from acid or alkaline water decomposing the insulating covering. It would therefore be preferable that all wires to arc lamps should be carried on one surface, and the wires from the lamps upon another; this mode may require a little more wire.

Perhaps the best method would be to keep the main wires upon the walls of the mill, and where they are carried to and from lamps, to place the wire to the lamp upon one beam, and the wire from the lamp upon the next one.

These suggestions are put in the form of a note to the Regulations, because the circumstances vary in different mills, or works, but managers can apply the reasoning on which these suggestions are based, to their respective conditions.

cuit. Each lamp should be provided with a separate hand switch, and also with an automatic switch, which will close the circuit, and put the lamp out whenever the carbons do not approach each other, or the resistance of the lamp becomes excessive from any cause.

The light should be surrounded by a globe, and, when near combustible material, this globe should be protected by a wire netting. The globe should rest on a tight shoal, so that no particles of melted copper or unconsumed carbon can escape. Broken or cracked globes should be replaced immediately. Unless the globe is very high, and closes in as far as possible at the top, it should be covered by some protector, reaching to a safe distance above the light. Flat sheets of metal or wire gauze should not be used for this purpose, because filings will collect upon such places when the lamps are not in use.

The lamps should be provided with some arrangement or device to prevent the incandescens from falling out, in case the clamp should not hold them securely.

INCANDESCENT LAMPS.

The small wires leading to each lamp from the main wires should be very perfectly insulated, and, if separated or broken, no attempt should be made to join them while the current is in the main wires.

The conducting wires leading to each building should be provided with an automatic switch or cut-out, or its equivalent, capable of protecting the system from an excessive current of electricity.

Evening Post, Saturday, 7.11.81.

WHAT ELECTRIC LIGHT COSTS.

Statistics and Comparisons Regarding the Arc Lights and Incandescent Lamps Prepared by Prof. R. P. Thompson.

In view of the recent competitive bidcasts by the gas and electric light companies for lighting certain streets in the city below Thirty-fourth street, the following extracts from a paper recently prepared by Professor Thompson, professor of experimental physics in University College, London, on the comparative cost of arc and incandescent electric with gas lighting will be found of unusual importance and interest. The practical business man, says Professor Thompson, sees that the light is a good one for himself, but the question always recurs, What does it cost? Will it pay? The questions, he says, are difficult ones to answer accurately, as data, especially regarding incandescent lighting, are yet meagre, and the improvements being made daily make the cost for to-morrow less than it is to-day, but how much less cannot be stated immediately. Lighting by the arc, he says, is undoubtedly much cheaper than gas, although the difference is not very apparent in some of the bids now under consideration of the city authorities. The following shows the relative cost of gas and the Lieb light in London, with Brockie-Pell Regulators, which the British light has been in use for two years.

Allowing 5 per cent. for interest on the plant and another 5 per cent. for wear and tear, the cost per hour per lamp is 2.08. The cost of running the lights, including coal, carbons, oil, cotton, labor, and incidentals, is 1.25 per hour. Cost per hour, 27.33 the light. A good deal depends on the price of gas, as per cubic foot. The total cost of gas lights consumed in this same room were as follows, allowing a saving of, approximately, 25 per cent. for interest, wear and tear, and depreciation of fittings, which is the usual allowance made for the latter item in estimating a saving of approximately 25 per cent., or 10 per cent. of the former 2.08 per hour, 1.25 per hour, 27.33 per hour. The cost of the regular candle per hour of the incandescent system is 1.66, or 10 per cent. of the former 2.08 per hour, 1.25 per hour, 27.33 per hour. The cost of mechanical power differs enormously, according to individual circumstances and the scale on which the power is used. Under the best conditions 1 pounds of coal are consumed per horse-power per hour. Under this rule 6 pounds of coal will produce a light of 1,374 candles per pound of coal per hour. Mr. Thompson continues:

Compare this with gas. Since a ton of coal yields 10,000 cubic feet of gas, and since 1 pound of coal produces 1,374 candles per hour of gas; and supposing that with a good burner 5 cubic feet of gas are used per hour, it follows that 5 pounds of coal are used per hour, which is equivalent to 6.41 of gas, and gives a light of 1,374 candles per hour. The latter is equivalent to 274 candles per cubic foot of gas; but since only one foot of gas is exchanged for one candle in the case of the Sugg burner, which is a very good burner, it follows that the economy represented by the usual 16 candles as the light of a burner using 5 cubic feet per hour is equivalent to a consumption of only 80 candles per cubic foot of gas. Hence, 480 lights as cheap as by gas. The items of capital and current, apart from the steam engine, are: Electrical machinery, renews this immense margin to the benefit we have assumed in the previous minutes.

In regard to the Edison, Maxim, Swan and Lane-Fox incandescent lamps, Mr. Thompson says each lamp gives a light of from 16 to 20 candles, and for purposes of comparison he supposes that it replaces gas, light for light. The Edison lamp furnishes 125 candles (20 lamps) per horse-power, "much less than the arc lamp, but still a good result." The same number of gas-jets would consume 4,000 cubic feet, costing twenty-one cents per hour. The same amount of gas in a gas-engine would supply power for 20 lamps at a cost of 2.5 cents's light as it would give of gas-light. By steam the same light would be produced at one-sixth of a penny instead of twopence.

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THE JOURNAL OF GAS LIGHTING, WATER-SUPPLY, & SANITARY IMPROVEMENT. (Feb. 14, 1882.

THE VALUE OF ELECTRIC LIGHTS.

There is so much uncertainty about the illuminating power of electric lights, and the methods by which this power is to be ascertained is so undetermined, that some interest has been excited in a paper on these subjects by Dr. Ingal Higgs, which was read at the Institution of Civil Engineers on Tuesday last. The writer endeavoured to prove the existence of a relation between the illuminating power of an electric light and the heat developed by the resistance of the carbon or other electrodes which are used for the purpose. He stated that with different types of arc lights this ratio might be expressed as about 0·12 heat unit per candle power. A Maxim lamp gave 0·62 heat unit per candle power; and an Edison lamp, giving 11-candle power, developed 0·70 heat unit per candle. The author concluded that theoretically the incandescent was more costly than the arc lighting, in the proportion of 6 : 1. It was also assumed in the course of the paper that the average amount of light required for domestic purposes was equivalent to that of a standard candle at 1 foot distance. Assuming an average distance of 8 feet for domestic lighting, the electric shandelier would have to be of 64-candle power to give the same surface intensity of light in a room 16 feet square, and of slightly more than this ordinary height. The incandescent lamp would give this light at an expenditure of 0·6 unit per candle power, or 38·4 heat units per light-centre, or about four shandaliers of this size per horse power. Dr. Higgs values the equivalent light from a 4-light gas chandelier burning 20 cubic feet per hour of New York gas, costing 10s. per 1000 cubic feet, and calculates that the cost of a horse power of energy would be 0·45 cents per hour in the electric chandelier, while the gas as above would cost 5 cents. It would perhaps have been better, considering that the paper was intended for an English audience, if the author had taken, as his unit of photometric measurement, the light of the standard candle, instead of the foot candle, which is almost unknown in London instead of in New York. In this event the comparison works out differently.

Scientific Amer. April 15, 1882

New Electrical Regulator.

M. Saligney, one of the most active electricians of Paris, has discovered a new regulator which will be one of the curiosities of the next electrical soirée given at the Observatoire on March 18th. Each of the two carbons is supplied with a parallel rod of glass, to which it is attached in a solid manner. These two rods being placed horizontally, are pushed by a spring, and the spark is lighted between them. But between the two glass rods there is a glass stopper which is warmed by the light in such proportion that the rods yield gradually to the pressure of the springs, and the carbons can approach each other as is required for the consumpt of the combustion. A correspondent of *Nature* witnessed preliminary experiments which he states have been a wonderful success.

Electric Light in Hall Cars.

Recently the Brighton (Eng.) Railway Company introduced the electric light on a special train of Pullman cars. Thirty-two Faure secondary batteries were employed to the car, to operate a dozen 8-candle lamps. The illumination was said to have been satisfactory.

THE MECHANICAL NEWS.
JANUARY 15, 1882.

POLYTECHNIC ASSOCIATION OF THE AMERICAN INSTITUTE.

The regular meeting of the Association was held Thursday evening, Dec. 15, Mr. Stetson presiding.

LIABILITY OF FIRE FROM ELECTRIC LIGHT.

Mr. Keith read the rules lately put in force by the Board of Underwriters of New York City, in regard to the manner of putting in electric light apparatus to buildings in that city, to avoid danger from fire. The rules go to an extreme of caution. Mr. Keith explained that the electric light companies already largely exceed the required conductivity, 98 per cent. excess. The smallest, even with the arc system, is No. 8 wire. It conducts the current without being appreciably raised in temperature. Heat is generated in a conductor when it is too small to carry the current freely. No. 16 is large enough; it will only raise the temperature to about 118° Fah. With the incandescent system most companies use larger wire, up to No. 3. These wires are a fourth of a square inch in section. The electric resistance of a small wire absorbs and wastes power which otherwise would drive rapid as light at the lamps.

The case was analogous to passing water through pipes; a small pipe requires more head, or force, to cause the passage of a given quantity of steam, or any fluid, in a given time, and the working pressure at the delivery end is reduced by the wire-drawing.

Mr. Keith averred that the brick, or plaster walls and ceilings of a building are not conditions as regards insulating substance which can be put around the wires. Dry wood is nearly as quite as good.

He thought there was no advantage worth considering in an insulating covering for wires on the ceilings; but such was important in places upon the floors or walls where there is a liability of some conducting substance touching both the inlet and outlet wires.

Where the positive and negative wires run near together they should be well covered by some non-conducting substance, which will absolutely prevent accidental contact with both at one time. The rules were aimed on that.

There is not a particle of danger in touching one wire with any substance or any place. All thought the practice of returning the current by the earth, or connections to water or gas pipes, should be absolutely prohibited. Doing so makes all conducting substances in connection with the earth a return conductor.

Gift of
Calif. Acad. of Sciences

Scientific American.

[NOVEMBER 12, 1881.

Meetings held in the Institute Rooms, Cooper Union Building, New York. Reported regularly for the MECHANICAL NEWS by D. R. Gordon, Secretary.

1 108

The Sun.

THURSDAY, OCTOBER 27, 1881.

A MINIATURE ELECTRIC LAMP.

Five-Hundred-Candle Power in the Area of a Half Dime.

Mr. Edison has just completed and transmitted to Prof. F. G. Fairfield of the New York College of Veterinary Surgeons a new electric lamp which is the smallest and most powerful ever made. The cylinder, or carbon pencil, we only one-tenth of an inch in diameter, the object being to obtain the highest attainable incandescence within the smallest possible space. It requires a battery of about forty cells. The flame will not exceed the dimensions of a silver five-cent piece, but it will give a light of 500 candles, or about the power of 100 candles. The resistance was relatively higher than a 1000, and the electricity was allowed to flow through the lamp with a pressure of 100 volts. Another fine element of their subtle force each object possessed was made to disappear as a substance when incandescent, such the heavy elements that of course a power of 50,000 diameters. At such a power only a few molecules of platinum would be visible, and they appeared as a cloud. Certainly the invention of Edison matter to be called a vacuum of an inch in diameter, and the lamp is a success with the help of the Sprengel pump. Mr. Edison will have a private exhibition of his new lamp at his laboratory in Menlo Park, and by this afternoon showing the molecular condition of platinum before the camera.

Mr. Thompson says that details as to the working of the electric lighting system are still wanting, and that his experience in lighting 800 houses in this city with the Sawyer-Man lamp will be watched with deep interest. Mr. Thompson concludes:

For the present it is safe to assert that even a country house to be lit up by incandescent electric lamps supplied by currents generated on the spot, as gas is now so commonly generated, in a little building in the yard, will be lighted at a cost, in most towns, less than the existing rental given for current gas lighting. And if domestic electric lighting can be made cheaper than gas lighting, public gas lighting on the small scale, there remains to be proven why on the large scale, with a vitrea tion of the expensive gas-manufacturing establishment, lighting should not be accomplished more cheaply by electricity than by gas.

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Menlo Park Scrapbook, Cat. 1038

No. 24. "Thermo Electricity"

This scrapbook covers the years 1875-1881 and 1887-1889 and contains clippings about thermoelectricity. On pages 8-61 are clippings from technical journals, covering the years 1875-1881. Pages 63-77 contain clippings from newspapers (1887-1889), describing Edison's pyromagnetic generator for producing electricity directly from coal. Page 62 contains a copy of Edison's paper on this device, which was read before the American Association for the Advancement of Science and published in the Telegraphic Journal and Electrical Review, September 9, 1887. There are 140 numbered pages.

Blank pages not filmed: 2-7, 58-59, 78-140.

1038

Thermo Electricity.

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Journ. Tel. Oct. 15. '76.
Journal Tel Oct-15. '76

On the Thermo-Electric Properties of Lime Spar, Beryl, Idocrase, and Apophyllite. By M. HANKEL.

When a heated crystal is cooled, it presents at its surface an electric distribution variable with the form of crystal. When it has the hemihedry of tourmaline, the two ends of the same axis are charged with different electricities. Apart from this case, the two ends of the same axis have identical properties, but the ends of different axes may be charged with opposite electricities. In particular, in crystals belonging to the system of prism with square base, the faces parallel to the axis of symmetry are not charged with the same electricity as normal or inclined faces limiting the crystal. Two classes of these crystals may be distinguished, according as the positive electricity is carried to the extremities of the axis or to its lateral faces. To the first class belong:—1. Spars of Scheeberg and Fryberg, formed of a hexagonal prism limited by the primitive rhombohedron or one more obtuse. 2. The majority of emeralds. 3. Idocrases of Wilui (Siberia). 4. Apophyllite. On the other hand, very elongated scalenohedra of Derbyshire spar, emeralds of Elba, and idocrases of Alta, belong to the second.

MIC JOURNAL. [APRIL 1, 1876.

ON THE ALTERATION OF THE THERMAL CONDUCTIVITY OF IRON AND STEEL CAUSED BY MAGNETISM.

By HERBERT TOMLINSON, B.A., Demonstrator of Natural Philosophy, King's College, London.

THE writer has, for several months, been engaged on a set of experiments devised for the determination of the alteration of the electrical and thermal conductivity of iron and steel, with the intention of determining, in absolute measure, such alteration for a given strength of current and imparted magnetism. But as, before the complete determination of the data sufficient for the purpose, a considerable time must elapse, he would venture to offer to the Society, in a preliminary note, some results which have already been obtained by him, as regards the alteration of thermal conductivity produced by magnetism.

In these experiments, the apparatus chiefly employed to impart magnetism consisted of an electro-magnet, with soft iron cores, 1 inch in diameter, and five inches in length, surrounded by cotton-covered copper wire, $\frac{1}{20}$th of an inch in diameter, having a resistance of nearly 1 ohm, and a coil constructed as follows:—a thin tube of polished tin, 1¼ inch internal diameter and 4½ inches long, was covered with vulcanised caoutchouc to a thickness of $\frac{1}{16}$th of an inch, and on this was wound ½ lbs. of cotton-covered copper wire, $\frac{1}{20}$th of an inch diameter, followed by ½ lbs. of wire, $\frac{1}{16}$th of an inch in diameter. Inside the first tube was placed a second, 1 inch internal diameter, connected by ebonite with the first at the two ends, the second tube being concentric with the first, and of the same length, so that, between the inner tube and the outer, should be interposed a layer of air nearly $\frac{1}{16}$th of an inch in thickness. This arrangement was employed to prevent the heat from the magnetising coil reaching the bars placed inside; also, to prevent ingress or egress of heat; the bars used with the coil were covered with vulcanised caoutchouc, so that they lay with their axes coinciding with the axis of the coil.

To measure the heat conducted along the bars two sets of thermo-elements were constructed. The first was made up of two small strips of copper, ½ inch long and ¼ inch broad, of small thickness. To these was soldered about 1 foot of silk-covered german-silver wire $\frac{1}{20}$th of an inch in diameter, the copper strips being also connected with a galvanometer by copper wires, well covered with caoutchouc, one set of each being soldered to the copper strips, so that either one or both the copper strips with the soldered German-silver wires could be employed as a thermo-element. In case it was found convenient only to employ one of these, the other was kept well covered with soluloid. These elements will be called the G. S. elements. The second set consisted of two small thermo-piles, each of twelve elements, of antimony and bismuth, and were each fitted into india-rubber tubes, so that they could be inserted into small wooden boxes, containing water, so as to fit water-tight. Sometimes these, like the G. S. elements, were used separately; at others, were made to neutralise each other's effect on the galvanometer.

APRIL 1, 1876.] 9

To measure the current produced by these elements, a delicate Thomson's reflecting galvanometer, having a resistance of 2 ohms, was employed, the scale being placed 6 feet from the mirror of the needle.

To measure the strength of the magnetising current, a tangent galvanometer, of Gaugain's construction, was used. The needle was suspended by a very fine platinum wire, attached to a graduated torsion circle. The two thick copper wires which conveyed the current were each 27 centimetres in diameter and 14 inches apart. The needle was also provided with a mirror, so that small deflections could be read off as in a reflecting galvanometer.

A magnetometer was also employed to test the magnetising impulse, but, as the readings will not be given in this paper, no description of the instrument is necessary.

To heat one end of the bars two large Leslie's cubes were employed, having each two apertures projecting about 2 inches into the interior of the cubes. The apertures in one cube were 1 inch square and placed in one side of the cube, about 3 inches apart from each other, and half way up the side. In the other cube the apertures were circular, and 1 inch in diameter, and placed in the centres of opposite sides of the cube. Into these cubes bars of square and circular section were respectively inserted, and water filling the cubes was raised to 100° C.

The first experiment was made on a soft iron bar, ½ inch square, in section. The bar was inserted into the Leslie's cube with square aperture, filled with boiling water, and into the other aperture was inserted a brass bar of the same section. The length of the iron bar was about 10 inches, and of the brass one, 18 inches. One of the G. S. elements was fastened on to the iron bar, and the other to the brass, by caoutchouc bands, the elements being insulated from the bars by thin paper. The G. S. elements were made to very nearly counteract each others effect by sliding one or other of them up and down the bars until the heat conducted by the bars to the elements was in both the same as nearly as possible. Underneath the bar was placed the electro-magnet, with a piece of white cardboard lying on the upper extremities of the soft iron cores, so that the cores were about 3 millimetres from the iron bar; the bar was also prepared by a wooden support at the other end. A preliminary experiment had been made for the purpose of ascertaining whether the heat radiated from the electro-magnet would affect the thermo-elements to any appreciable extent, and this was not found to be the case.

The water in the cube was now kept boiling for about nine hours, and after that time had elapsed it was ascertained that the flow of heat from one part of the bars to another compensated the loss from radiation and the light on the scale remained stationary. (It should be observed that, as it was impossible to cause one thermo element exactly to neutralise the other, a slight use of the adjusting magnet of the galvanometer was made so being the light near the zero of the scale.) The current from a single bichromate cell was now sent through the coil of the electro-magnet. In a few moments the spot of light began to move very slowly across the scale in a direction indicating that the flow of heat through the iron bar was being checked, and in about fifteen minutes a deflection of about 25 divisions of the scale was obtained; the current of the cell was then stopped, when the light began slowly to return, and finally settled in apparently the exact position which it held before sending the current through the coil. This experiment was repeated several times on the same day, and on several other days, but always with the same result as regards direction, namely, showing a diminution of the flow of heat from longitudinal magnetisation.

As it was thought, however, that the electro-magnet might when in action perhaps produce an apparent diminution of flow of heat by slightly disturbing the bar in its position in the aperture, though every precaution had been used to prevent the chance of this, the bar in the next set of experiments was securely soldered into the cube, and again tested as before. Here, again, some five or six trials gave the same result, and seemed to show most conclusively that the thermal conductivity of soft iron is diminished by longitudinal magnetisation.

As the method of observation, however, was tedious, and would give no idea of the amount of alteration of conductivity, other expedients were now adopted.

A piece of soft iron, which we will call a c, ½ inch long, ½ inch broad, and 2 millimetres in thickness, was soldered to two pieces of brass, A B, C D of the same breadth and thickness.

A B was 2 inches long and c D, 1 inch. The piece A B was also soldered to another piece of brass a b, having a section ½ inch square, and length about twelve inches.

The whole was placed inside a wooden box, 2 feet long, 1 foot wide, and 2 feet high, lined on the outside with linfoil.

A B passed through a circular hole, 2 inches in diameter, in the middle of one end of the box, and through two corresponding circular holes in a double screen of sheet tin, and thence into one of the square apertures of one of the Leslie's cubes. The electro-magnet was placed underneath a c, and two pieces of soft iron, about 3½ inches in length, ½ inch in breadth, and about 2 millimetres in thickness, were placed on the ends of the soft iron cores, so as to be on the same level with a c, and distant from a and c about 2 millimetres, the pieces of iron being supported from the cores by a piece of white paper. In some experiments the pieces of iron first used were carefully secured to the electro-magnet by elastic straps, and, in others, by weights placed on them. A preliminary experiment, made with the strongest current that was ultimately used with the electro-magnet, showed that neither were the iron pieces on the cores appreciably shifted on magnetising the coil, nor was the heat radiated from the coil sufficient to produce any effect on one of the G. S. elements fastened by elastic bands to the back of C D. The other G. S. element was in this case buried in sawdust, with which the box was now filled, so as to cover completely the bars and electro-magnet. The sawdust also filled the space between A B and C D, and the small portion of the brass bar a b, which was between the box and the Leslie cube, was covered with caoutchouc and cotton wool.

The lid of the box was now put on, and some time

both high and low, with a view of definitely settling this point.

Some experiments were next made with the magnetizing coil described in the beginning of the paper, but the effects produced were found to be so much less for the hard steel than when the electromagnet was employed that it was found necessary to use the thermo-piles, also mentioned above, and instead of employing the compensating magnet to bring the light on to the scale to cause the two piles, as much as possible, to neutralise each other's effects. Accordingly the following arrangements were made:

Two bars of hard steel, each 3½ inches long and ½ inch in diameter, were soldered at each end to two copper rods, each about 4½ inches in length and ½ inch in diameter. One copper terminal of each rod was inserted into a Leslie's cube, filled with water kept at the boiling point by means of a burner at a distance of 2 inches, and the other terminal into a small wooden box, varnished inside with shellac, and capable of containing about 120 cubic centimetres of water. The bars were well covered with cuanstchouc; and double screens and two thermo elements were so arranged as to send their currents through the galvanometer in opposite directions, the wires connecting them with each other and the galvanometer being well covered with gutta-percha, and passing through small holes in the sides of the boxes. The two compound bars were thus made as exactly similar as possible, and also similarly placed, the only difference being that produced by the magnetizing coil, whose axis coincided with that of the steel bar placed inside it.

Both the small boxes had originally the same quantity of water placed in them, and a previous experiment had shown that so exactly similar was the heat conducted along the bars to the water in the boxes, that when some two hours or so had elapsed, the rise of temperature of the water in each box seemed as measured by an ordinary thermometer, marked off in degrees centrigide, to be exactly the same, namely, 10° C.

But as the same experiment had shown that the pile in one of the boxes was very slightly more powerful than the other, the water in the other box was diminished very carefully by means of a small siphon, formed of india-rubber tubing, of very small bore, which was kept cleared by a pin-hole cut at one end, the tube passing through holes cut in the large box, through the sawdust, and through a small hole cut in the lid of the small box, so as to dip into the water. The little siphon was always kept charged, and, by means of the pinch-cock, any desired small quantity of water could be extracted from the box.

By this means it was found easy to make one pile so neutralise the other that a very slight use (if any is necessary) of the adjusting magnet was required, even when the magnet was near its most sensitive position with respect to the galvanometer needle.

On sending a current through a coil around the steel bar, it was in a minute or so seen that the conductivity of the hard steel was diminished by the longitudinal magnetization, and the amount of diminution was roughly determined by finding the amount of water necessary to be extracted from the box to again bring the light to the same slow rate of motion (about two divisions per minute) which it had before passing the magnetising current, and comparing this with the original amount of water in the box. The decrease of flow did not amount to 1 per cent. of the whole, even with the strongest battery used (current shown by the tangent galvanometer, 25°).

This plan was found to be highly successful for determining whether there was a diminution or not, but not equally so for determining the amount of decrease, owing to the great difficulty in this method of quickly making the light move at the same rate after magnetization as before. Another method was therefore tried, which promises to give better results.

The two piles, P_1 and P_2, were joined up with the galvanometer and a shunt s, so as to obtain equilibrium, according to Poggendorff's method of comparing the electro-motive forces of batteries.

The same quantity of water was now put into each box, and the pile P_1, being slightly more powerful than P_2, the shunt s was adjusted until there was little or no motion of the light on the scale.

The magnetising current was then passed through the coil, and the shunt again adjusted, until the piles neutralised each other.

It can be shown that if r_1, r_2 be the units of heat imparted to the water in the two boxes in the same time, $\frac{r_2}{r_1} = \frac{S}{S + s}$ when the piles neutralise each other, where s is the resistance of the portion of the circuit in which P_1 is placed.

If, then, dr_2 be the diminution of flow caused by magnetisation, and ds the diminution of shunt resistance necessary to again make one pile neutralise the other,

$$\frac{r_2 - dr_2}{r_1} = \frac{S - ds}{R + S + ds}$$

$$\therefore \frac{dr_2}{r_1} = \frac{R \times ds}{(R + S - ds)}$$

and thus the per centage of diminution of flow may be determined.

A few resistance coils were very roughly constructed for use in the shunt, and an attempt made to ascertain the actual amount of diminution of conductivity of the hard steel. This, again, appeared to be comparatively small, but as the coils used were not suitable for the purpose, the result is not given. But the writer has little reason to doubt but that, with resistance coils suitable for such thermo-electric experiments, he will be able to measure, with fair accuracy, small variations of thermal conductivity in this way.

It should be added that similar experiments to these were made with soft iron bars, both with and without copper terminals, but the results of the experiments, of which altogether upwards of a hundred have now been made, show that in every case the thermal conductivity of soft iron is diminished by temporary longitudinal magnetisation, and increased by transverse magnetisation, whilst in the case of steel, of different degrees of hardness, at any rate, for the temperatures employed, magnetisation evidently produces the same kind of effect as with the soft iron. The amount of the alteration in the case of soft iron must have reached

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In these experiments, the apparatus chiefly employed to impart magnetism consisted of an electro-magnet, with soft iron cores, 1 inch in diameter, and five inches in length, surrounded by cotton-covered copper wire, ⅛th of an inch in diameter, having a resistance of nearly 1 ohm, and a coil constructed as follows:—A thin tube of pasteboard, 1¼ inch internal diameter and 4½ inches long, was covered with varnished caoutchouc to a thickness of ¼th of an inch, and on this was wound 3 lbs. of cotton-covered copper wire, ⅛th of an inch in diameter, followed by 3 lbs. of wire, ⅛th of an inch in diameter. Inside the first tube was placed a second, 1 inch internal diameter, connected by ebonite with the first at the two ends, the second tube being concentric with the first, and of the same length, so that, between the inner tube and the outer, should be interposed a layer of air nearly ¼th of an inch in thickness. This arrangement was employed to prevent the heat from the magnetising coil reaching the bars placed inside; also, to prevent ingress or egress of heat; the bars used with the coil were covered with vulcanised caoutchouc, so that they lay with their axes coinciding with the axis of the coil.

To measure the heat conducted along the bars two sets of thermo-elements were constructed. The first was made up of two small strips of copper, ½ inch long and ¼ inch broad, of small thickness. To these was soldered about 4 feet of silk-covered german-silver wire, ⅛th of an inch in diameter, the copper strips being also connected with caoutchouc, one end of each being soldered to the copper strips, so that either one or both the copper strips with the soldered German-silver wires could be employed as a thermo-element. In case it was found convenient only to employ one of these, the other was kept well covered with sawdust. These elements will be called the G. S. elements. The second set consisted of two small thermo-piles, each of twelve elements, of antimony and bismuth, and were each fitted into india-rubber tubes, so that they could be inserted into small wooden boxes, containing water, so as to fit water-tight. Sometimes these, like the G. S. elements, were used separately; at others, were made to neutralise each other's effect on the galvanometer.

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As the method of observation, however, was
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A piece of soft iron, which we will call a C, 4 inch
long, 1 inch broad, and 2 millimetres in thickness,
was soldered to two pieces of brass, A B, C D of the
same breadth and thickness.

A B was 2 inches long and C D, 1 inch. The
piece A B was also soldered to another piece of
brass A E, having a section ½ inch square, and
length about twelve inches.

The whole was placed inside a wooden box, 2
feet long, 1 foot wide, and 2 feet high, lined on
the outside with tinfoil.

A E passed through a circular hole, 2 inches in
diameter, in the middle of one end of the box, and
through two corresponding circular holes in a
double screens of sheet tin, and thence into one of
the square apertures of one of the Leslie's cubes.
The electro-magnet was placed underneath B C, and
a piece of soft iron, about 3½ inches in length, ½
inch in breadth, and about 2 millimetres in thickness, were placed on the ends of the soft iron cores,
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The lid of the box was now put on, and some time

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Tel. Journ. Sept. 1. 77

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Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—I trust you will allow me space in the next issue of your valuable journal to finally reply to the statements contained in M. Clamond's second letter.

The lecture to which M. Clamond refers at the beginning of his letter was probably the one I read in March, 1875, before a provincial scientific society, on thermo-electricity, in the course of which I showed and explained the pile; but as to assigning him, or claiming honour for my father, I am not aware of right of doing either the one or the other. I have just read through that portion of the paper referring to M. Clamond, and I find that not even the name of the Isle company is mentioned.

In the next paragraph of M. Clamond's letter there is not the slightest particle of truth, for the articles on and notices of our thermo-pile which you inserted in your journal were, as you are aware, not written by us; and, with the exception of one of them, we had no idea that they were going to be published.

M. Clamond says he does not beat his positives in the moulds. It is of very little consequence whether they are heated in them or placed in them just before casting, as the tin would be oxidised precisely the same, for it is impossible to put this tin plate in contact with heated iron moulds heated to dull redness without almost instantly oxidising its surface.

The next part of M. Clamond's letter I will answer fully later on, merely remarking here that although ribbed discs are mentioned in his first patent, yet they were simply for the purpose of keeping the bars from lateral movement, and were not fitted or intended to support the weight of the bars above them.

With regard to the long positives—as we have stated from the first—our object in view in using them is to gain mechanical strength, and the gain in this direction far more than compensates for the slight loss in electromotive force. In one series of experiments the long positives showed an increase of strength equal to 30 per cent.

Messrs. Clark, Ford & Co. have, in a report which will be found at the end of this letter, given some further results obtained with the composite pile of short and long positives. It will be noticed that the weight of copper deposited by the latter in the twenty-two hours' test is only 27 per cent. less than that deposited by the short.

M. Clamond, in an unguarded moment, has published a certificate from H. Rousselon, according to which, in June or July of 1875, he is said to have fitted five-clay cylinders inside his piles at M. Goupil & Co.'s works, and says the certificate: "M. Clamond's thermo-electric piles have since that time rendered constant and regular service."

The inference to be drawn from this is—firstly, that prior to the fitting of the cylinders the piles did *not* render constant and regular service," and, secondly, that M. Clamond permitted the late company to come to great trouble through the fusing of his piles, while he knew the first thing to make them "render constant and regular service" was to fit cylinders.

I know as a positive fact that M. Clamond did not tell the board of directors anything about these inside

SEPTEMBER 1, 1877.] THE THE TELEGR

have been due to a bad contact at one of the terminals, as no sensible alteration in the relative thermo-motive force of the two series occurred.

"We consider the above results, on the whole, to be very satisfactory, as proving that the thermo-pile may be left for a considerable time without any attention.

"We are, dear sirs, yours faithfully,

CLARK, FORD, & CO.

"Cecil and Leonard Wray, Esqrs."

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—It has often come under my observation that although the mirror apparatus for cable signalling is capable of being worked with a far greater speed on long submarine cables than Sir William Thomson's Siphon Recorder, yet the latter apparatus is nearly always preferred on account of the greater facility for checking errors, &c. I think that the generality of cable clerks prefer "mirror" to "recorder" working, as it is much less tiring and so little delay is caused, I say at all.

Now, if while working a mirror, the signals could be duly recorded by means of a Siphon Recorder, would not a great advantage be gained? All the newspaper could be checked from the recorded signals, and the speed of working would be materially increased.

Could not the signalling coil which moves the siphon of the recorder be in circuit with the secondary coil of an induction-coil? the primary coil of which would be in circuit with the mirror apparatus in connection with the cable, and through which, of course, the current on charge, or at the end, may be, transmitted from the distant station, would pass.

The *primary* coil would be of low resistance, so it would not make any material difference in the total resistance of the circuit.

The *secondary* coil would be formed of a great number of turns of fine wire, and could be provided with a shunt, supposing the induced current should be too strong. Instead of employing a shunt, the primary coil could be made moveable, so that its sliding in or out of the secondary coil could produce an increase or diminution of induced current.

But there is, apparently, a very great drawback to this plan, namely, the "kick" of the siphon, produced by the secondary induced current, or, to speak, which increases the secondary coil directly the battery current ceases to flow through the primary coil. For, by Lenz's law, "An inducing current at the moment it ceases produces a direct current"; *i.e.*, a current in the opposite direction to the first induced current, but in the same direction as the inducing one. So that, according to this, supposing the letter *a*, which consists of one "dot," was signalled from the distant station, it would be recorded like the letter *a*, which consists of one "dot" and one "dash." And again, there is another disadvantage arising from the "retardation" caused by self-induction in the primary coil.

This last effect is mentioned by Mr. G. K. Winter, F.R.A.S., in his paper on the "Use of Electro-magnetic Induction in Cable Signalling," which appeared in your Journal of September 15th, 1874. In the same paper he mentions a plan of his in which an inducing coil is placed at the extremity of a cable from which the current passes through the primary coil, the secondary coil, in circuit with mirror apparatus, being traversed by the induced current.

Now is not this plan somewhat analogous to the one I have mentioned? Mr. Winter describes a method for eliminating the "magnetic retardation" in the

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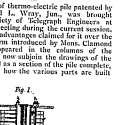
WRAY'S THERMO-ELECTRIC PILE.

THE new form of thermo-electric pile patented by Messrs. C. and L. Wray, Jun., was brought before the Society of Telegraph Engineers at their opening meeting during the current session. A *résumé* of the advantages claimed for it over the better-known form introduced by Mons. Clamond has already appeared in the columns of the JOURNAL*s*. We now subjoin the drawings of the elements as well as a section of the pile complete, fig. 1.) showing how the various parts are built

Fig 1.



together. Before, however, entering into a short description of this, it may be well to look for a moment at the construction of the bars themselves. Figures 2 and 3 will serve to show how the bars are formed, representing as they do horizontal-

Fig 2.

Fig 3.

vertical and longitudinal horizontal sections. *f f* are the negatives which are formed of an alloy consisting of two parts of antimony and one of zinc; *i i* indicate the positive metal—sheet-iron—at the heated end. *t* is the outer part at the cool end; while *p* shows the elongation or tongue which forms so distinct a feature in the casting of the bars. The effect of it is to raise very materially the breaking strain, and so get rid of the liability to fracture, to lower the internal resistance, and strange to say increase the electro-motive force.

Returning to figure 1, a vertical section is shown of a pile of 225 couples, built in three sections of 75 couples each. *a a* is the heating chamber, formed of an earthenware cylinder, against which the bars abut; this can very speedily be raised to a red heat, and so distributes the caloric uniformly, while it at the same time effectually protects the ends of the bars from fusion or oxidation. *b b* a Bunsen or other suitable burner, inside which is a cylinder of wire gauze similar to that employed in the safety-lamp. This prevents explosions when the light is applied, and at the same time by causing a more equable distribution of the gas tends to render the heating of the bars uniform—a point, it is needless to again urge here, of vital importance in any practical form of thermo-battery. It is to attain the same end that the disc *d* is placed at the lower end of the chamber. This disc screws up and down the pipe *c*, and thus regulates with much nicety the admission of air for combustion through the openings *e e*. The draught is further controlled by a perforated earthenware cover on the top of the cylinder. *f f f* represent the better-known form introduced by Mons. Clamond has already appeared in the columns of the JOURNAL*s*. We now subjoin the drawings of the elements as well as a section of the pile complete, fig. 1.) showing how the various parts are built upon the insulating annular discs, *c c c*. These discs are again supported on blocks, which thus carry the weight of the several layers of bars. Through these blocks run the binding rods *k k*, which serve to give additional stability to the entire structure.

We forbear entering into a comparison of this with the other forms of thermo-piles previously in existence, for any attempt at comparison would speedily cease to be such, and would merely resolve itself into an enumeration of the advantages which Messrs. Wray's form undoubtedly possesses over every other. We are not aware whether it has yet been brought into practical use; if not, it certainly ought to be without further delay, for, looked at theoretically, it is difficult to see what further improvements can be effected in it.

Elect Mus Augt. 76.

'Improvements in Thermo-Electric Apparatus.—Charles James Wollaston, 8, Park Place, Maryleboue, Middlesex, January 6, 1875—No. 58. This invention relates to apparatus for obtaining electricity in a convenient and economical manner from heat generated from the combustion of fuel.

Report Presented by Count du Moncel on the Thermo-Electric Battery of M. Clamond.—In this battery the thermo-electric element is of iron, and the negative element is of antimony and zinc. In M. Clamond's arrangement, as in those of Noe, the elements are connected circularly by intercalating, between a kind of crowns, insulated from each other by plates of ammonites, and having their polar extremities placed in connection with a commutator, fixed tangentially to the cylindrical surface of the apparatus, and contrived so as to cause these crowns to be grouped either for intensity or for quantity, as may be requisite. The apparatus has been employed for six months at the galvano-plastic works of M. Goupil at Auteuil. The gas consumed

2 amounts to 23 frs. per kilo. of copper deposited. This paper is accompanied with several illustrations.

New Balance of M. Mendeleef.—Requires the ac companying diagram.

ON THE NATURE OF THERMO-ELECTRICITY.

The nature of the electricity which arises when two different metals are connected in a circuit, and the places of contact of the heterogeneous metals have different temperatures, has been the subject of a good deal of speculation. In a recent number of *Poggendorff's Annalen*, M. Kohlrausch advances an hypothesis in regard to it, the salient features of which we shall here endeavour to present.

"It is usual," he observes, "to place the cause of thermo-electricity in an electro-motive force at the places of contact of the different conductors, but difficulties are met with whenever it is sought to pass to definite conceptions here. The voltaic contact forces (which in the ordinary voltaic pile are accepted as the cause of the galvanic current) have evidently helped towards this hypothesis, and the next step consisted in explaining thermo-electricity as a modification of voltaic forces through temperature. But we soon perceive that in that case the ideas hitherto held as to these forces must be given up, or if this be not done, that we must again keep separate two kinds of contact forces.

"In this state of things, the remark is perhaps not superfluous, that for a theory of thermo-electricity, we do not at all require the immediate action of contact surfaces, and that we may reach a perfect agreement with known facts, if we suppose the electro-motive force to be in the interior of the separate conductors. The places of contact have then only a secondary influence. This conception we shall here develop.

"In every thermopile, when in action, there is, with the difference of temperature, necessarily a streaming over of heat from the warmer to the colder junction; because every conductor of electricity also conducts heat. . . . Hitherto the difference of temperature of the junctions has been regarded as the cause of the electro-motive force; but with equal right we may make the attempt to accordingly suppose, that *with a heat current* of determinate amount depending on the nature of the conductor, an *electric current is connected*, provided that other electro-motive forces are first excluded."

This idea is, indeed, not entirely new. Some years ago M. L. Hermann arranged experiments that were based upon it, and were meant to confirm it, but without success. M. Kohlrausch has not taken it up, and subjected it to a purely theoretical discussion.

Starting with the supposition that when a certain quantity of heat passes through a surface element in the interior of a conductor, a certain quantity of electricity is carried away with it, from the latter being proportional to it and dependent on the nature of the substance, M. Kohlrausch develops the formula for the electro-motive force of two metals, which have different thermo-electric constants, and different falls of temperature, and this formula shows (what experiment confirms) that the electro-motive force only depends on the temperature of the junctions, and is proportional to the difference of temperature.

M. Kohlrausch demonstrates that in a homogeneous uncrystalline conductor of varying temperature, a continuous electric current cannot arise, because there is soon an accumulation of free electricity, which compensates the electro-motive force of the heat current. On the other hand, electricity has been observed in crystalline bodies, e.g., in tourmaline, during the motion of heat in their interior.

Every theory of thermo-electricity, however, must explain not only the electro-motive forces, but also the so-called Peltier phenomenon, that is, the development of heat at the soldered junction of two metals when an electric current is sent through them. The necessary supplementing of the above hypothesis forthwith, says M. Kohlrausch, "is almost offered by itself, for we have only to add the supposition that *by an electric current heat is moved*. This supposition comes to agree with the known quantitative facts regarding the Peltier heat, when the reciprocity of joint conduction of electricity and heat is extended also to the amount of this." M. Kohlrausch shows that this propagation of heat in a conductor cannot, on account of the equality of the thermoelectric constants, produce any action. At a junction, on the other hand, where these constants are different, there will be manifested, according to the direction of the current, heat production or absorption.

We may give this hypothesis a very simple expression if we take into consideration the proportionality, rendered highly probable by Wiedemann and Franz, between conducting power for heat and for electricity. That is, the heat-giving power of each electric current in any body is proportional to the electromotive force of the unit heat current in the same body.

While all the known facts of thermo-electricity are deducible from this position, there are, further, two quite unimportant consequences, which are peculiar to it, viz., first, an electric difference between two points of a body of varying temperature, and second, a difference in the heat developed by an electric current in an unequally warm conductor, according to the direction of the current.

In favour of the views here given, the following may further be marked: that the propagation of heat and electricity in a metal are nearly allied phenomena, follows from the proportional behaviour of all metallic conductors, that have been experimented with, with regard to both conductions. At least we have in heat and electricity two somewhat related things which fill the same space, and the movement of one of them has a moving influence on the other. . . . There is a moving conductor, according to the direction of the current.

Further, the remarkable fact that the most active thermo-electric bodies are very bad conductors, speaks in favour of some connexion of thermo-electricity with conduction of heat and electricity, for a mere coincidence can here have no place.

Lastly, it is to be noted that that excitation of electric properties, which is exerted by the same of pyro-electricity, appears to stand near our conception of thermo-electricity. The crystals in question are found electric only during their heating or during their cooling, that is to say, when

they are traversed by a heat current. It is possible that thermo and pyro-electricity are merely different expressions of one and the same reciprocal action between heat and electricity.

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REPORT ON CLAMOND'S THERMO-ELECTRIC BATTERIES.

By the Count TH. DU MONCEL.

The thermo-electric battery, the principle of which was discovered by Seebeck in 1821, is the most constant source of electricity possible to obtain, since the energy of its current depends solely on the differences of temperatures at which the extremities of the diverse elements composing it are maintained. The first thermo-electric batteries constructed for industrial purposes were those constructed by Nobili, and Bacquerel, with a combination of metallic alloys. To them, also, we look for the first practical realization of a battery in excellent possible size and with maximum of power. The pairing of pure elements—positive and negative metals, when they are taken as the most opposite ends of the scale of electro-motive properties, does not furnish the most energetic effects; the most convenient effects are mainly dependent on metallic alloys. Melloni first made an energetic battery whose electro-negative element was an alloy of antimony, zinc, and bismuth, while its electro-positive element of nickel, copper, and zinc. In mixing these metals proportional to their chemical equivalents, he obtained a maximum action. On the other hand, E. Becquerel, from personal researches, used antimony and cadmium for one element, and German silver for the other. From this latter combination very energetic results were obtained, and in this manner the thermo-electric batteries manufactured by Ruhmkorff were constructed. Then Pouillet, of Boston, and Clamond, have studied the question as to the best arrangement for giving highest temperatures, and for obtaining a great number of elements easily disposed for potential or for quantity as required. To Clamond must be attributed the first fixed arrangement in use. He employs as the positive battery of iron and sulphuret of lead, or galena, of little conductibility, and these he heated by a gas, coke, or petroleum stove. The results were, from the first advantageous; but shortly after it was seen rendered useless from the burning of the galena, its cracking, and the enormous increased resistance of the couples. Hence the galena was abandoned, and a zinc and antimony alloy used in preference, with iron for the other electro-positive element. Undoubtedly by taking copper, nickel, or German silver, a higher electromotive force would be obtained; but experience has shown that when copper or German silver is dissolved in the alloy for account of the positive action of the apparatus) iron is retained. The pairing between the iron and alloy was effected in this way.—The iron was doubled back, in the shape of, as it were, a hinge, and on that portion the alloy was allowed to run a plate of from 1 to 2 mm. thick. The alloy became a frame around the iron flange. The splitting of the material—which is always very weak place in parallel layers, in ordinary alloys, under the influence of alternate heat and cold—is prevented by having it used conveniently heated moulds. In these batteries the elements are arranged circularly for potential, or so as to form a crown, separated from each other by asbestos plates. Their polar ends are connected by means of a commutator, for the suppression of the electric action of the apparatus, and are so disposed as to allow of their being grouped in potential or quantity series, as required.

The thermo-electromotive force set up at the contact of a conductor with a wire carrying a current has been made the subject of a recent investigation by M. Bergman, of St. Petersburg. It is known that a change of structure takes place in a conductor by the passage of a current through it, and M. Bergman finds this change capable of producing a thermo-electric force. After reducing to zero the current in a Wheatstone bridge, formed of iron wire traversed by a powerful current, the author heated one of the arms very gently and ascertained a deflection of the [illegible] the battery changed the direction and amount of the deflection, thus proving the existence of an electromotive force in the bridge itself. *Cosmos.*

SCIENTIFIC SERIALS

Poggendorff's Annalen der Physik und Chemie, No. 6.—Paul Groth. Ueber Lichtcurven. On the reflection of light from the outside of isotropic bodies, and the change of its polarization which takes place thereby. Extract from an Inaugural Dissertation contributes a memoir On the Absorption of Electrical Currents, in which, following up the experiments of Riess, he examines Faraday's theory of electrical induction by polarization of the medium, and describes in detail the apparatus with which he has experimented, tabulates his results, and agrees with Riess's conclusion that there is no direct influx of electricity.—The next article comprises a series of communications from the Mineralogical Society of the University of Strasburg, in which Fuchs discusses the crystalline form and thermo-electric properties of sesquiliquate of potassium and chromium. Its chemical formula is very variable: $(K_2O, Na_2O, Fe_2O)\,As_2O_5$. Light thrown upon the constitution of the hexahedral forms of the species, are displayed in hexahedral tin bisulphide of the form Sulphuric acid forms pyritic and cubic-octahedral forms with parallel sides, plane, one-part of the crystal is negative towards copper, while the other half is positive.—Dr. Hunze treats of the chemical composition of leadhillite. Prof. Limpricht read years ago sketches of a mineral from Iglesias, in Sardinia, under the name of Bleilasur, and with the formula $3PbSiO_3 + 2PbCO_3 + 3H_2O + 3H_2O$. Hillside Mountain, near Leadhillsdale. The author points out that two minerals are incidental, and that the formula of leadhillite is $PbCl + 3PbO_2$. As no leadhillite has hitherto been found, $PbCl_2 + 3PbO_2$. In the next paper, by the same author, is copious and laborious researches on the constitution of silicates by means of hydrofluoric acid. The chemical compositions and crystalline forms are given of the following minerals, viz., Prehnite, diphosphitbleiweiss, diphosphitbleiweiss, dichromsaures blei, diphosphitbleiweiss, dimorphosphitbleiweiss, &c. All these bodies belong to the monoclinic system.—Dr. A. Arzruni gives a short note on Optical researches on the natural rock-salt from Stassfurt, followers by crystallographic and optical researches on compounds derived from boracic acid. Zoffner points out the connexion between the aggregation and position of the molecules in crystals, and concludes that they are cooled successively.—Dr. Hunze treats of researches on the action of hydrochloric acid on fossil remains. Papers are Dr. Andrews on ozone and Prof. Wright on the polarization of the radiant light.

3500. C. A. Faure, of Middlesex. *Improvements in the construction of thermo-electric batteries or piles, and in the application of the electric currents so derived therefrom to the production of motive power.*—Dated February 29, 1856.—The novelty of the invention consists in arranging two plates or cylinders in such a manner that there will be an opening or space between them, through which a current of air, steam, or water may pass, one of lead or "galena," one of the plates or cylinders is kept hot by artificial means, and the other cooled by the application of water. The two plates or cylinders thus form the poles of the thermo-pile, which are connected together by a suitable conductor, and which receives the electric current passing through the "galena," and transmits it to a magnet around the cores of which a number of separate insulated strands of wire are wound, each strand being separately connected with the poles of the battery or thermo-pile, thereby producing electro-magnetic power, which actuating on armature through a suitable joint or "break" and "make" contacts, a reciprocating motion to a shaft is given which may be employed for driving purposes.

publish.

On the Thermo-electrical Properties of some Minerals and their Varieties.

By A. Schrauf and E. S. Dana.

The interesting investigations of Hoor, the late eminent mineralogist of Berlin, have during the past two or three years excited considerable interest in this subject. Hoor started with the first fact announced by Hankel, that some crystals of pyrite and cobaltite are electrically positive, and others negative, and endeavored to explain the opposite character on the assumption that it was connected with and conditioned by the right and left hemihedrism, characteristic of both species. This touches an important point in physics, and if it could be sustained, Hoor's hypothesis would be very valuable. Schrauf and Dana, however, after the examination of a large number of minerals, comprising nearly all the metallic sulphides, have come to the conclusion that cause of the variation of electrical character must be sought elsewhere. They attribute it, not to an opposite molecular condition shown in hemihedral crystals, but to a change in chemical composition.

They call attention in the first place to the series published by Luboek, where for example platinum occupies a varying position according to its degree of purity. Moreover, they urge that the single case, observed by Stefan, that some specimens of granular galena are positive, while others of crystallized galena are negative is strong evidence against the influence of hemihedrism in general, as nothing of the kind can be assumed here. The force of their argument, however, lies in the fact that they have found several other well-defined cases of minerals, having varieties, and that among minerals crystallizing holohedrally. Chemical analyses were here desirable to show how far the material under investigation varied in composition. In the absence of these, the specific gravity was resorted to as an indicator of the chemical character. This afforded decisive results: the plus and minus varieties showed a decided difference in density, implying a corresponding change in composition. This was true in all cases investigated, including cobaltite and pyrite, showing where the explanation of the electrical character was to be looked for.

[1876.]—**Thermo-Electric Generator.**—This consists of a number of small bars of an alloy of bismuth and antimony and zinc in equal proportions, each bar being about one inch in length, ⅛in. in breadth, and about ⅛in. in thickness. The bars are arranged in a series with positive and negative poles so disposed of linked iron, and connected together, so that the electricity of a particular battery cannot expend a neutral element within which is placed a five-bay pipe, perforated with minute holes, through the lower part of this pipe common fighting for other ores is admitted along with a recruited portion of air. The ore is thus in fact the Bessemer furnace of the gas escaping there in the form of matte, which is afterwards roasted and smelted in the usual manner. The different kinds of lead, the different grades of silver, and the different qualities of copper, which are produced within the central furnace, are collected separately in the inner ends of the bars. The outer ends of the bars are connected with the other, and a current is thus established in the direction of the electric current. The intensity of which the pile is composed, which may consist of 100, 200, 300, 400, or any number of pairs, as may be described, the power of the pile depending on the number of elements employed. The instrument is very portable, and its become of great utility and importance, as it not only saves economical in cost than the usual methods of working. Moreover, other chemical batteries do not require to charging by replacing of [illegible] the requires to be renewed, as the use a stream of electricity as long as the [illegible] continues (the current is maintained) as long as the [illegible] remains in action, or the current. The larger piles such as for 500 or 1,500 bars, are loaded with a 500 or 1,500 cells of [illegible] series of connexion. The inventor is No. 27, Newington Causeway, and Archangle-street, London.—*The Builder*, 1876.

[1876.]—Thermo-electricity.—[illegible] do not know which form was established of facts, and how not at present the terms of pitch exchange, which would require to be healthy and strong, passed with drawings to be of *any service*.—Sigma.

The Comacho Electric Machine.

The Comacho magnetic machine, with its concentric iron tubular magnets, may be seen at 171 Queen Victoria street. There can be no doubt of the advantage of this form of magnet; but experiment on the resistance of the circuit, weight lifted, electro-motive force, and consumption of zinc, etc., would form an interesting subject. The machine, with five cells of a bichromate battery, works three or four sewing machines. Attempts to work it with the thermopile have hitherto failed. This is very likely, because the elements of the thermopile are coupled up in considerable series, so that, considering the resistance of each element, the whole resistance must be great compared with the resistance of the wire round the magnets. A thermopile should be made of low resistance by coupling a number of elements together in parallel circuit, and then taking some ten or twelve, or more, of such series coupled in succession. It is no doubt worth considerable experiment to attain a successful result from the thermopile, as in that case, by merely turning on the gas, a lathe or sewing machine be made to

The Clamond generator is a thermo-electric battery which may be very advantageously used for electrotyping, electric light, telegraphy, and various other purposes. This generator has already been described at length in our pages; Four batteries of one hundred elements each, and one of two hundred and sixty were exhibited. Besides these, in which gas is the prime agent in the production of the electric current, there was a large model of an apparatus arranged for burning coke. It consisted of two hundred elements [illegible]

On the Nature of Voltaic Electricity.

The nature of the electricity which arises when two different metals are connected in a circuit, and the places of contact of the heterogeneous metals have different temperatures, has been the subject of a good deal of speculation. In a recent number of *Poggendorff's Annalen*, M. Kohlrausch advances an hypothesis which seems to the writer a brilliant effort and likely to endure for a time at least.

"It is usual," he observes, "to explain the cause of thermo-electricity in an electro-motive force at the places of contact of the different conductors. But these forces are met with wherever it is sought to pass to definite conceptions here. The voltaic contact forces (which in the ordinary voltaic pile are accepted as the cause of the galvanic current) have evidently helped towards this hypothesis, and have at first step consisted in explaining thermo-electricity as a modification of voltaic forces through temperature. But we soon perceive that in that case the latter hitherto held as to these forces must be given up, or if this be not done, that we must again keep separate two kinds of contact forces.

"In this state of things, the remark is perhaps not superfluous, that *fact a theory* of thermo-electricity, we do not at all require the immediate action of contact surfaces, and that we may reach a perfect agreement with known facts, if we suppose the electro-motive force to be in the interior of the separate conductors. The places of contact have then only secondary influence. This conception we shall here develope.

"In every thermopile, when in action, there is, with the difference of temperature, necessarily a streaming over of heat from the warmer to the colder junction; because every conductor of electricity has a conducting heat. Hitherto the difference of temperature of the junctions has been regarded as the cause of the electro-motive force, but with equal right we may make the attempt to lay, as the cause, the other inseparable condition. We accordingly suppose, *in a with a heat current* of determinate amount depending on the nature of the conductor, *an electric current is connected*, provided that other electro-motive forces are first excluded.

"This idea is, indeed, not entirely new. Some years ago M. L. Hermann arranged experiments that were based upon it, and were meant to confirm it, but without success. M. Kohlrausch has now taken it up, and subjected it to a purely theoretical discussion.

Starting with the supposition that when a certain quantity of heat passes through a surface element in the interior of a conductor, a certain quantity of electricity is carried away with it, from the latter being proportional to it and dependent on the nature of the conductor, M. Kohlrausch develops the formula for the electro-motive force of two metals, which have different thermo-electric constants, and different falls of temperature, and this formula shows (what experiment confirms) that the electro-motive force only depends on the temperature of the junctions, and is proportional to the difference of temperature.

M. Kohlrausch demonstrates that in a homogeneous unequally crystalline conductor of varying temperature, a continuous electric current can not arise, because there is soon an accumulation of free electricity, which compensates the electro-motive force of the heat current. On the other hand, electricity has been observed to flow in the direction of a homogeneous, during the passage of heat in their interior.

Every theory of thermo-electricity, however, must explain not only the electro-motive force, but also the so-called Peltier phenomenon—that is, the development of heat at the soldered junctions of two metals when an electric current is sent through them. "The necessary supplementing of the above hypothesis for this end," says M. Kohlrausch, "is almost offered by itself, for we have only to add the supposition that by *an electric current heat is moved*. This supposition comes to agree with the known quantitative facts regarding the Peltier law, when the reciprocity of joint conduction of electricity and heat is extended also to the amount of it. M. Kohlrausch shows that this propagation of heat in a conductor can not, on account of the equality of the thermo-electric constants, produce any action. At a junction, on the other hand, where these constants are different, there will be manifested, according to the direction of the current, heat production or absorption.

We may grow this hypothesis a very simple expression if we take into consideration the proportionality, rendered highly probable by Wiedemann and Franz, between conducting power for heat and for electricity. That is, the heat-ideal to the electro-motive force of the unit heat current in the same body is proper.

While all the known facts of thermo-electricity are deducible from this position, there are, further, two quite unimportant consequences, which are capable of being—namely, first, an electric difference between two points of a body of varying by an electric current if the temperature in the heat developed according to the direction of the unequally warm conductor, second, a heat current in a homogeneous conductor, as.

In favor of the views here given, the following may further be remarked: that the propagation of heat and electricity is a most law nearly-allied phenomena, of follows from the proportional between all the metallic conductors, that have been examined with, with regard to both conductivities. At least we have in heat and electricity two somewhat related things

* In Bois-Reymond, "Berner Schriftbuch," Oct. 19, 1874, p. 228.

which fill the same space, and, however it is to be conceived, we may expect that the movement of one of them has a marking influence on the other.

Further, the remarkable fact that the most active thermo-electric bodies are very bad conductors, speaks in favor of some connection of thermo-electricity with conduction of heat and electricity, for a mere coincidence can here have no weight.

Lastly, it is to be noted that that excitation of electric properties of a kind is denoted by the name of *pyro-electricity*, appears to stand near our conception of thermo-electricity. The crystals in question are found electric only during their heating or during their cooling—that is to say, when they are traversed by a heat current. It is possible that thermo and pyro electricity are merely different expressions of one and the same reciprocal action between heat and electricity.

Self-Movement of Electricity.

The Return of Thermo-Electric Currents.

According to our contemporary, *L'Electricité*, M. Exner, of Vienna, has discovered that a bismuth antimony pair immersed in a gas incapable of acting chemically on either of these metals, yields no current when one junction is heated. Also that if two bars of copper are soldered together to form a "pair," no current is produced when either junction is heated or (as would be expected in a circuit of one metal), not even when both strips are exposed to the action of chlorine, but that if one strip only is exposed to chlorine one and then one junction be warmed, a thermo-electric current is set up. According to Exner, therefore, all so-called thermo-electric currents are due to chemical action. It would be easy for some of our ardent young physicists to put to the test this very remarkable announcement, and see whether it is Herr Exner, or all the authorities on thermo-electricity from Seebeck to Tait, on whom we are to rely for the facts.—*Nature*.

the heated gases pass upwards to the top; finding no means of escape there, they curl over, and descending outside the iron tube, i.e., between it and the elements, they finally make their exit by means of the channel already referred to. The elements are thus heated partly by radiation from the iron tube and partly by the heated gases on their way downwards to the chimney. Not only is the danger arising from the gas jets impinging on the elements thus removed, but the consumption of gas is said to be reduced by one-half. Should a bad connection occur, it is short-circuited by a piece of wire, and a defective element can readily be cut and replaced by a sound one.

A small gas regulator fits keep the pressure of gas, as far as may be, constant; is employed with each machine. The consumption of gas in small-sized elements is stated to be about one foot per hour for each volt of tension. Where gas is not available for heating purposes, coke or charcoal is found to answer very well. Paraffin oil might probably be employed with advantage, although thus far it does not seem to have been successfully used as a source of heat in the thermo-piles.

Iron screens are sometimes employed to surround the pile, their object being to cool the external surfaces of the elements by causing a current of cold air to pass over them. They likewise prevent, to some extent, the fracture of the iron which takes place if the pile cools too rapidly. The subject of screens and other mechanical appliances for cooling the external surfaces of the thermo-electric elements, such as currents of water, the use of water, evaporation of moist surfaces, &c., have thus far been imperfectly investigated, and throw open a wide field for investigation, standing the labours of M. Clamond.

The electro-motive force of a therme-electric element, such as those employed in Clamond's pile, is such that as elements may practically be regarded as equivalent to one Daniell's cell in this respect, that is, they give about one volt.

The following table, published by the Thermo-Electric Generator Company, and found by experiments conducted by the author to be very correctly tabulated, gives the electro-motive force, internal resistance, and consumption of gas for the piles usually manufactured by them:—

	Size.	Electro-motive force.	Internal resistance.	Consumption of gas per hour (cubic feet).
For tension	40 bars, 60 " 120 " 150 " 250 " 380 " 500 " 80 " 60 " 100 " 200 " 400 "	2 volts 3 " 6 " 7 " 12 " 19 " 24 " 4·5 " 3 " 5 " 10 " 20 "	170 ohms 13 " 3·6 " 3·6 " 0·63 " 0·25 " 12·25 " 1·25 " ·6 " 1·7 " 2·01 " 4·0 "	— 3 " 5 " 6 " 9 " 23 " 37 " 6 " 6 " 9 " 21 " 37 "
For quantity				

* The assistance is that of the piles in their hot state; when they are cold it rises about 25 per cent.

For tension { 340 bars / 680 " } 17 volts, 375 ohms, 175 lbs. / 34 " 12·75 " 270 "
For quantity { 190 " / 400 " } 10 " 750 " 175 " / 20 " 4·0 " 270 "

CHARCOAL PILE.

For tension { 100 bars / 190 " } 5·0 volts, 170 ohms, 33 lbs. / 9·5 " 2·8 " 50 "
For quantity { 100 " / 190 " } 5·0 " ·63 " 33 " / 9·5 " ·17 " 50 "

The following, extracted from the circular published by the company, give some of the prices which are charged:—

For the tension or small-sized bars:—

2 volts	£5	0	0	40 bars.
3 "	4	0	0	60 "
6 "	6	10	0	120 "
12 "	13	0	0	250 "
24 "	20	0	0	500 "
30 "	25	0	0	600 "

For the quantity or large-sized bars:—

2 volts	£8	0	0	60 bars.
10 "	20	0	0	200 "
20 "	32	0	0	400 "

The coke-piles are charged as follows:—

10 volts (quantity)	£6	0	0	100 bars.
20 "	12	0	0	200 "
17 " (tension)	20	0	0	340 "
34 "	40	0	0	680 "

It is found that the electro-motive force of the several layers of elements varies, owing to the fact that some are more fully exposed to the heat than others. The middle layers seem to give the best results, although when first heated the upper bars are stated to give the greater electro-motive force.

So extremely sensitive are the thermo-electric piles, that it is all but impossible to find one in such a state of equilibrium as to give no evidence of a current. If it be so, the passage of the hand into the interior of it, breathing upon it, or even the approach of the body, immediately sets up an action; and whilst they are at work, the effect of a distant fire, or the opening of a window, will produce a sensible effect upon them. When two or more piles, therefore, are employed, they should, in order to secure the best working, be kept as far apart as possible, and allowed free radiation.

Electro deposition is one of the many uses to which thermo-electric piles may be turned, and plating. As an instance of what has been done, a battery of 375 elements (whose internal resistance was 4·5 ohms, and electro-motive force 11·6 volts) deposited about 180 grains of copper per hour, but then the electro-motive force was sufficient to have created a similar deposit in several successive cells, so that no practical results as a theoretical possibility of the work to be effected by them in this respect.

The mechanical power obtained from thermo-piles by electro-magnetic engines has not yet been put to any practical use, nor can it be looked for as ever likely to be worked from an economical point of view. The electric light furnished by them is powerful and constant, but a very large number of elements has to be employed in order to secure this.

For laboratory use they are very handy, and by utilising the waste heat of kitchen fires they might doubtless be employed to considerable advantage for domestic purposes.

THERMO-ELECTRIC GENERATOR COMPANY, LIMITED.

LONDON—97, New Street, Cloth Fair, Aldersgate Street. Close to Aldersgate Railway Station.

PARIS—66, Boulevard de Courcelles.

The labours of Electricians have long been directed to the production of Cheap Electricity on a practical scale, but it has been the good fortune of M. CLAMOND, of Paris, after years of experiment and labour, to reach the long-desired success by perfecting his Thermo-Electric Pile or Battery.

The Piles or Generators are constructed of metals having great electric properties. The Electricity is given out without any intermediate agency. Fuel alone, such as Gas, Coke, Charcoal, is consumed. The economy in maintenance is very considerable in comparison with other Batteries, and the current obtained is constant and free from polarization or exhaustion.

The superiority of the Clamond Pile over other batteries for Electroplating and Electrotyping purposes has been practically demonstrated by its adoption in France in the Ministry of War, the Mint, Bank of France, School of Mines, &c., &c.; in the ateliers of Messrs. Gueret, Chevenard, and other Industrial Institutions; whilst the value and economy in Telegraphy have been placed beyond question, by the result of many months working at the Exchanges Telegraph Company's Office in Bartholomew House, where the Pile has superseded all other Batteries previously in use.

M. CLAMOND, the inventor, has received, at the annual meeting of La Société d'Encouragement pour l'Industrie Nationale, on the 29th June, 1877, its Grand Gold Medal, in recognition and appreciation of the value of his important discovery.

M. CLAMOND also received the Grand Diploma of Honour from the "Exposition Maritime et Fluviale," that year, in recognition of his invention.

The following are some of the purposes to which this system is adapted, viz.:—

TELEGRAPHY.
ELECTRO-PLATING and ELECTROTYPING.
DEPOSITION of METALS and CHEMICAL ANALYSIS.
PRODUCTION of LIGHT.
TORPEDOES and other NAVAL and MILITARY REQUIREMENTS.
The LABORATORY and LECTURE ROOM.
HOSPITAL and SURGICAL PRACTICE, and BATHS.
ELECTRIC CLOCKS and BELLS.
MINING.

By way of illustration of the capabilities of these instruments, the following may be taken as a standard of efficiency.

ELECTROTYPING, ELECTRO-PLATING, AND GILDING.

A Machine of 100 bars, with a consumption of 5 cubic feet of gas, deposits about one ounce of Silver per hour. The same apparatus, coupled for quantity, will deposit about one ounce of Copper in the same time.

400 bars, large, consuming 2 lbs. coke per hour, will deposit about four times the above quantities.

PRODUCTION OF LIGHT.

Arrangements are now in progress for producing light, suitable for Light Houses, Beacons, Theatres, &c., by large sized Batteries, which, will effect very considerable economy over all other means hitherto employed in this direction.

The Board specially draw the attention of manufacturers and others interested in the various applications of Electricity to the Thermo-Electric Piles, and invite them to inspect the Batteries, which can be seen in operation at the Company's Works, 97, New Street, Cloth Fair, Aldersgate Street (by Railway Station), on Mondays, Wednesdays, and Fridays, between the hours of 2 and 4, where prices and full particulars can be obtained, and all necessary references and testimonials supplied.

London: Printed for the Proprietor by John & Charles Adams Hill, Factory Cornwall, E.C. June 1, 1878.

SOCIETY OF TELEGRAPH ENGINEERS.

Mr. C. Y. WARNER, F.R.S., the President, in the chair. London, November.

THERMO-ELECTRIC BATTERIES.

THE adjourned discussion on Mr. Latimer Clark's paper on "Thermo-electric Batteries," was resumed by the author, who took advantage of the opportunity to explain certain improvements which had been introduced in the manufacture of those batteries, since his paper was read, by Messrs. Cecil and Leonard Wray, Jones. These improvements claimed an advantage over the form produced by M. Clamond; 1, in the castings of the bars; 2, in the method of building up the batteries so as to reduce weight and strain upon the lowest plates; 3, in the heating arrangements; 4, in the regulation of the draught; and 5, in the arrangement of the coke furnace by which the bars could be removed without the withdrawal of the entire fire.

With regard to the bars the alloy employed is the same, or nearly so, as that employed by Clamond, viz., for the negative metal, two parts of antimony to one of zinc, whilst for the positive steel bars are used. Messrs. Wray overcame, to a very great extent, the brittleness, or rather the liability to break when touched, of the alloy, by elongating the tongue of the short iron, which is then made to extend a distance of about two-thirds of the entire length of the bar. The positive metal thus extended is placed in a mould, in which the alloy is cast under pressure. The effect is to heighten the breaking strain, to increase the electro-motive force, and decidedly to lessen the resistance. Hitherto the bars which compose the battery have been built up, one row upon the other, by means of clamps, which exercised such excessive row of bars or elements increased the weight of that beneath it, and from this cause the elements of the battery became screwed. Messrs. Wray now set them in a vertical manner by giving to each row of elements an independent support. It is, however, in the heating arrangements that their improvements are most conspicuous. The power of this form of battery depends upon the subjection of the elements which constitute it, at certain points, to temperatures of as opposite a character as possible; thus one end of the bars has to be subjected to as intense a heat as they can sustain, and the other end to as intensely cold an atmosphere as can be produced. Various have been the means adopted to produce a pile which should stand this intense heat, and the action of the gases forming the products of combustion of whatever is employed to heat the pile, but hitherto they have been unsuccessful. Messrs. Wray proposes to reduce, if not entirely to obviate, this by employing an enclosure over-lapping the outer bars of the pile and the chimney heated by the flame. By regulating the flow of air and the draught they are also able to keep under control the heating and cooling process, so as to make it more gradual and uniform. On the whole the improvements suggested by Messrs. Wray are of a very practical character, and are highly spoken of.

NEW LIGHTNING PROTECTOR.

A paper was also read by Mr. Andrew Jamieson on a new form of "Lightning Protector," for submarine cables. The idea, which has been very prettily perfected, but nothing electrically new in it (vide Art. 14), nevertheless, mechanically is not improved on in the means at present adopted for the protection of cables, which usually consisted of plate protectors, vacuum tubes, and one sole platinum wire. These are usually so arranged that the atmospheric charge entering from the open line wire shall pass through the plate protector first, then the small platinum wire, and finally through the vacuum. The probability is that the intensity of the charge would be carried off at the first-named protector; but failing this, if of such power as to injure to the cable, it would so heat the fine platinum wire as to fuse it, whereby the line would become interrupted until an officer was sent to replace the melted wire, and as this is usually at the shore end of the cable, it unfortunately occupies some time to do so. Mr. Jamieson connects his open wire to a corrugated barrel within a corrugated cylinder, the corrugations intermeshing each other, and so forcing innumerable points by which the intensity of the atmospheric charge may be carried off. He then connects the barrel of what may be regarded—having reference to previous arrangements—the plate protector, to a spring which normally rests against a small pillar, and which is in connection with another spring similarly arranged. Each of these springs is withheld from touching the pillar in question by a piece of fine platinum wire attached to its end, the other end of each piece of wire being connected with the cable. The result is that supposing a charge to have passed through the barrel, it will pass into the first-named piece of platinum wire, which will fuse, and the tension of the spring having been thus removed it will fly back to its pillar of platinum wire. Thus the cable is saved from interruption and still protected, the lineman's journey to the cable but is saved, and if necessary the arrangement may be repeated *ad libitum*. The discussion was carried over for the next meeting.

At a recent session of the French Physical Society, papers of which the following are abstracts, were presented:

RESISTANCE OF THE BATTERY IN ELECTRIC BATTERY.

M. Rolland has studied by Thomson's method the resistance of the clamond thermo-electric elements. His observations are represented by a curve having for abscissæ the times, and for ordinates the resistance of the element. During the first twenty minutes the curve rises, describing several sinuosities and then becomes parallel to the axes of abscissæ. When the heating ceases the curve rises at first very rapidly and then descends oscillating. M. Rolland remarks that the method employed supposes the electro-motive force to be constant, and that consequently the curve may be the result of the variation of the resistance and of that of the electro-motive force. The progress of the temperatures similarly observed on a copper-iron pile is represented by an analogous curve.

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Arthon.

THERMO-ELECTRIC PROPERTIES OF LIQUIDS.—By using an improved apparatus, which he describes at a recent meeting of the Royal Society, Mr. G. Gore, F.R.S., has discovered several exceptions to the effect he formerly obtained, viz., that acid liquids are thermo-electro-positive, and alkaline ones thermo-electro-negative; and, reasoning upon the results obtained in his most recent experiments, concludes:—

SCIENTIFIC AMERICAN SUPPLEMENT, No. 120. APRIL 20, 1878

CLAMOND'S IMPROVED ELECTRIC THERMO-PILE

THERE improvements relate to the casting and forming of the thermo-electric elements themselves, and to the manner of grouping them together into a pile or a decimeter.

The current obtainable from a thermo-electric element or pair depends, of course, on the two metals employed, the difference of temperature maintained between the two ends of the element—between the bar, that is to say, between the junction of the metals and the free ends, and the resistance of the bar. With a given pair of metals the strength of current available depends solely on the difference of temperature kept up and the resistance of the bar; the greater the difference of temperature and the less the resistance of the bar, the greater is the quantity of electricity obtained. But with the metal bars employed in thermo-piles electric resistance may be neglected. A certain proportion or relation must always exist between the section and the length of a bar, in order that the maximum effect may be established at any very great differences of temperature. The result is that when intense heat is employed it has been found to be the most economical disadvantage, pierced with holes, and embedded in the thermo-electric alloy. Each single element is thus formed of a flat cylinder, compounded of the inner and outer portions of the two metals.

Figs. 1, 2, and 3 represent a vertical and a horizontal section through the pile; *a* and *a* are interior and exterior protecting tubes or envelopes covering the pole tubes, *c*, *c*, which form the junctions with the thermo-electric alloy. To obtain good contact between the alloy and the pole tubes, the latter are made of riddled or pierced metal—of sheet metal cloth, so that the molten alloy may permeate them; *b* is the cord or asbestos, and *d* the cement which closes the ends of the annular chamber thus formed. The poles, *e*, *f*, are then soldered to the ends of the single cylindrical elements, which are built up one upon the other, by means of clamps, which exercised such excessive row of bars or elements increased the weight of that beneath it, and from this cause the elements of the battery became screwed. Messrs. Wray now set them in a vertical manner by giving to each row of elements an independent support. It is, however, in the heating arrangements that their improvements are most conspicuous. The power of this form of battery depends upon the subjection of the elements which constitute it, at certain points, to temperatures of as opposite a character as possible; thus one end of the bars has to be subjected to as intense a heat as they can sustain, and the other end to as intensely cold an atmosphere as can be produced. Various have been the means adopted to produce a pile which should stand this intense heat, and the action of the gases forming the products of combustion of whatever is employed to heat the pile, but hitherto they have been unsuccessful. Messrs. Wray proposes to reduce, if not entirely to obviate, this by employing an enclosure over-lapping the outer bars of the pile and the chimney heated by the flame. By regulating the flow of air and the draught they are also able to keep under control the heating and cooling process, so as to make it more gradual and uniform. On the whole the improvements suggested by Messrs. Wray are of a very practical character, and are highly spoken of.

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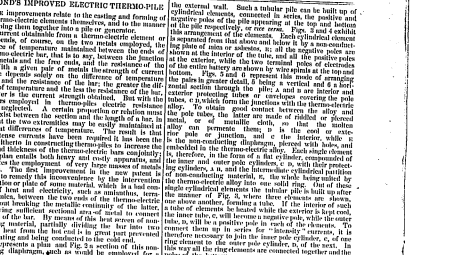

CLAMOND'S IMPROVED ELECTRIC THERMO-PILE.

like partitioned metal plates, a form which permits of their sectional area being increased without increasing their length. Great differences of temperature with a very small distance between the poles, and consequently a much greater conductivity of electricity with less metal employed and less heat expended, are thus obtained. This diaphragm, or the paired plates, *d*, *d*, forms, to some degree, the function of a porous vase in a voltaic cell, while the uniting of two bipoles in contact in such a manner as to permit the passage of electricity, prevents them mixing too quickly.

Fig. 4 represents another mode of making elements suitable for the construction of small thermo-piles for domestic purposes. The frame is a section of a group of elements, *yy* being a perforated plate or flat cylinder of porcelain, Parian, earthenware, or other non-conductor of heat and electricity. *p p* are perforations into which a thermo-electric alloy, say, zinc and iron or zinc and platinum, is cast; *r r* are wires of German silver, or other thermo-electric metal, being cast into the alloy at their upper ends, the lower pole, the other end passing through a hole in the material of the diaphragm, and being bent over at *s*, where it is likewise cast into the alloy. If preferred, the wire may be coated with asbestos paper, or other insulating material, as shown at *r r*, and cast into the alloy itself. In either case the end of the wire is curved into the form of a loop, so as to afford a sufficiently extended surface to the metal to insure good contact. Fig. 5 shows how the thermo-electric junctions are formed and connected with each other in series. The perforations in the diaphragm may with advantage be formed like a double cone, as shown at *p p*, Fig. 6, so as to retain the alloy more firmly in its place. The plates, *d*, *d*, or earthenware diaphragm is laid with its face of the mould or hearth on the upper plane placed with holes, *p p*, resting in sand, and *r r* in the holes in the perforated plate, *y*. Holes are arranged opposite to *p p* to be filled at once by the fusion of the separate bars of the diaphragm, with its accompanying pile of metal alloy. In casting the diaphragm, which is composed of a circle, or more segments placed together, may form a cylindrical battery. Small piles so formed can be heated over an oil-lamp, gas flame or lamp chimney.

The thermo-electric elements from into a pile or large hollow upright tube, while the heated junctions are round the internal wall, and the cool junctions are round the external wall. Such a tubular pile can be built up of cylindrical elements, one above the other, the positive and negative poles of the pile appearing at the top and bottom of the pile respectively, or they may be built up of flat and 4 exhibit arrangement of the elements. Each cylindrical element is separated from that above and below it by a non-conducting plate of mica or asbestos, *n*; all the negative poles are shown at the interior of the tube, and all the positive poles at the exterior, while the two terminal poles of the series of the entire battery are shown by wire attached to the top and bottom. Figs. 5 and 6 represent this mode of arrangement in a somewhat larger detail. Fig. 5 is a vertical and a horizontal section through the pile; *a* and *a* are interior and exterior protecting tubes or envelopes covering the pole tubes, *c*, *c*, which form the junctions with the thermo-electric alloy. To obtain good contact between the alloy and the pole tubes, the latter are made of riddled or pierced metal—of sheet metal cloth, so that the molten alloy may permeate them; *b* is the cord or asbestos, and *d* the cement which closes the ends of the annular chamber thus formed. The poles, *e*, *f*, are then soldered to the ends of the single cylindrical elements, which are built up one upon the other, by means of clamps, which exercised such excessive row of bars or elements increased the weight of that beneath it, and from this cause the elements of the battery became screwed. Messrs. Wray now set them in a vertical manner by giving to each row of elements an independent support. It is, however, in the heating arrangements that their improvements are most conspicuous. The power of this form of battery depends upon the subjection of the elements which constitute it, at certain points, to temperatures of as opposite a character as possible; thus one end of the bars has to be subjected to as intense a heat as they can sustain, and the other end to as intensely cold an atmosphere as can be produced. Various have been the means adopted to produce a pile which should stand this intense heat, and the action of the gases forming the products of combustion of whatever is employed to heat the pile, but hitherto they have been unsuccessful. Messrs. Wray proposes to reduce, if not entirely to obviate, this by employing an enclosure over-lapping the outer bars of the pile and the chimney heated by the flame. By regulating the flow of air and the draught they are also able to keep under control the heating and cooling process, so as to make it more gradual and uniform. On the whole the improvements suggested by Messrs. Wray are of a very practical character, and are highly spoken of.

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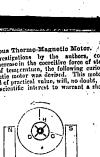
electric currents may be obtained from a charcoal fire, from the waste heat of a furnace, or from gas. Where gas is employed as the source of heat, the apparatus is arranged as shown in Fig. 10, which consists of a thermo-electric tube having its interior heated by a flame or brazier. The heating surface is increased by being vertical, and is protected against the immediate contact of the flame by a return flue which causes the products of combustion to re-traverse the interior before finally passing off by the chimney. The tube is surrounded on the outside by an envelope of cold water, so as to act as a refrigerator to the outer poles. Two other sources of heat are utilized by the inventor, namely, the steam boiler and then at a high temperature, and waste steam. Fig. 7 shows the arrangement of the tubular poles, *c f*, being made to harbour steam boiler tubes, as in the Field boiler. Fig. 8 shows the second plan in which the tubes receiving steam to be condensed are enveloped by the thermo-electric tubes, which are isolated from them by rings of constrictions or other material.

The manufacture of Clamond's new pile in England is in the hands of Latimer Clark, Muirhead & Co., Westminster, London.—*Telegraphic Journal.*

A Curious Thermo-Magnetic Motor.

During investigations by the authors, concerning the increase in the coercitive force of steel by changes of temperature, the following curious thermo-magnetic motor was devised. This motor, though devoid of practical value, will, no doubt, be of sufficient scientific interest to warrant a short description.



In the figure, a disc or ring of thin steel, D, is mounted on an axis, so as to be quite free to move. The edges of the wheel are placed opposite the poles H and S, of a magnet. In this position the wheel of course becomes magnetized by induction.

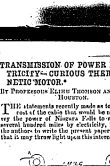
If now, any portion of the wheel, as H, be suddenly heated, the disc will move in the direction shown by the arrow. The cause of this motion is as follows:—The section, H, when heated, has its coercitive force thereby increased, and being inpowerfully sensitized by the induction of the pole S, than the portion, C, (near finitely adjacent to it) the attraction exerted by the pole, S, on the latter portion is thereby sufficient to cause a movement of the disc in the direction shown by the arrow. If the portion C be heated instead of H, a slow motion in the direction shown by the arrow will also result.

To assure success, the disc must be sufficiently thin to prevent its acquiring a uniform temperature. If the source of heat be at the same time applied at diametrically opposite portions of the disc, as at H and D, adjacent to the poles, the same effect will be produced. Since the amount of heat expended is practically the same in either case, the former is the more economical when compared with the latter. It will be readily understood that this motion is of no value as such, but may be regarded as an interesting example of the interconvertibility of force.

TRANSMISSION OF POWER BY ELECTRICITY.—CURIOUS THERMO-MAGNETIC MOTOR.*

BY PROFESSEUR ELIHU THOMSON AND EDWIN J. HOUSTON.

THE statements recently made as to the size and cost of the cables that would be needed to convey the power of Niagara Falls to a distance of several hundred miles by electricity, have induced the authors to write the present paper, in the hope that it may throw light upon this interesting subject.



As an example of some of the statements alluded to we may cite the following words. That much by a certain electrician, who asserts that the thickness of the cable required to convey the current that could be produced by the power of Niagara, would require a copper cable of 4 inches in diameter. Another writer, in the report of Lake Superior, another statement estimates the cost of the cable at about 50 dols. per lineal foot.

As a matter of fact, however, the thickness of the cable required to convey such power is of no particular moment. Indeed, it is possible, should it be desired, to employ even the total power of Niagara through a cable of *less than one inch in diameter*. The cable not exceeding one-half of an inch in thickness. This, however, is an extreme case, and the conditions of practical working would not require such ratios as to size.

The following considerations will elucidate this point:—Suppose two machines connected by a cable, one at each end, to work. One of these machines is for the purpose of driving the other, it, used as an electrical motor, is receiving power by the current transmitted to it from A by the cable C. The other terminals, 2 and 2, are either put to earth or connected by a separate conductor. Let us suppose that the electromotive force of the current at the terminals of A were, by the excitation of B, a number of volts which we will call *e*, that of A, the electromotive force of the current which flows is evidently the difference of the two. Let the resistance of A and B together be equal to unity, and that of the cable of any equal convenient between the 01 of this unit. Then the current which flows will be $C = \frac{e}{1+1} = \frac{e}{2}$. If, now, an additional machine, A', like A, and an additional motor, B', and an additional mile of cable be introduced into the above circuit, the electromotive force of the latter and the resistance will be doubled, the current strength remaining the same as C. Or $\frac{2e}{1+1+1} = \frac{2}{3}$. Here it will be seen that the introduction of the two additional machines, A' B', has permitted the length of the cable, C, to be doubled without increasing the strength of the current which flows, and yet allowing the original E. M. F. at the terminals of A, and a double tension at B. If we power or, in other words, a *double resistance* in the external circuit without *increase of current*. Moreover, one, the number of machines at A to, say, one thousand, and of those at B to A proportion, and the distance between them, or the length of the cable, one thousand, or in the case we have supposed, make it one thousand miles, the diameter remaining the same. Then, although the *same current* will flow, yet *we have a thousand times the expenditure of power at one end of the cable and a thousand-fold recovery of the other end, without increase of current.* And the same would be true for any other proportion.

Since the electromotive force is increased in proportion to the increase of power transmitted, the insulation of the cable and machines would require to be proportionately increased.

As an example it may be mentioned that a Gramme electric machine used for the purpose of A in the figure, may have a resistance of, say, 40 ohms, and produce an electromotive force of, say, 100 volts. Such a machine might require from three to five horse-power when used in connection with a similar motor, B, for recovery of the power transmitted.

If the resistance of the motor B be, say, 40 ohms, and the cable transmitting the current a distance of one mile be 1 ohm, then the current $C = \frac{100}{40+40+1} = \frac{100}{81}$. If, now, one thousand machines and one thousand motors, and a thousand miles of cable, each of the same relative resistances, be used, the current $C = \frac{1,000 \times 100}{1,000 \times 81}$, which is manifestly the same value as C. If our supposition of the power used to drive the machine be correct, then these five thousand horse-power would be expended in driving the machines, and possibly about 50 per cent. of this amount recovered. Then we have from 1,500 to 2,000 horse-power delayed a distance of 1,000 miles. What diameter of copper cable will be required for such transmission? Since this cable is supposed to have the resistance of one ohm for one mile, and since a mile of wire of one inch diameter is .0 of such line. It, however, its diameter be only 500 miles, then the resistance per mile may be double, or the section of the cable be decreased one-half, or its diameter will be less than one-fifth of an inch.

For the consumption of 1,000,000 horse-power a cable of about three inches in diameter would suffice under the same conditions. However, by proportionately increasing the number of machines, the cable could be proportionately reduced, until the theoretical minimum, which we have given in the first part of this paper, might be fulfilled. The enormous electromotive force required in the above combination would, however, necessitate such perfect insulation of the cable that the practical limits might soon be reached. The increased power required to be conveyed in any one direction would, of course, require a proportionately increased speed of the motor; it may be hardly conceivable that any one would avail advantageously use the enormous expense of speed we have referred to.

Stripped of its theoretical considerations, the important fact still remains, that with a cable of very limited size an enormous quantity of power may be transmitted to considerable distances, and converted into its equivalent of mechanical work by means of power generated by the force of steam, and therefore be regarded as practicable, always, however, remembering that a loss of about 50 per cent. will be almost unavoidable.

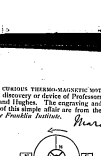
It may be mentioned that Dr. C. W. Siemens and Sir William Thomson have recently made statements that are in general accordance with the views here expressed.

THERMO-ELECTRICITY.

—We have at various times and in various places discussed the question, What part will Thermo-Electricity play in the future as regards Electric Lighting? The answer at present is not altogether satisfactory; yet we may fireplace could be so utilized as to provide at least a sufficiency of electric light for an ordinary room. As is not to this point that we desire now to call attention, but to the waste of power in using the current from one dynamo-electric machine for the coils of the electro-magnets of the other. The following quotation will be read with interest, and probably suggest all that we intend to suggest at present:—"I desire of last June, with a thermo-electric pile, consisting of thirty pairs of bismuth and antimony, 1½in. square and ¼in. thick, with the radiation of red hot iron at one extremity and ice at the other extremity, a soft iron electro-magnet, under the inductive influence of the electricity thus generated, supported ninety-eight pounds weight, the most powerful thermo-electric magnet I have heard of; but it must be observed that this is no maximum, for whoever employs a larger elementary battery will, no doubt, obtain greater effects, not only as regards inductive influence on soft iron, but all others in which the influence of temperature may be exerted. There is an ample field for investigation open for those who leave leisure on this subject. Who knows but hereafter electro-magnetism may be employed as a prime mover, and that a thermopile may be the exciting cause?" (P. Watkins in Phil. Mag., Sept., 1837.] It may be that we shall have to record a speedy answer to this question.

A CURIOUS thermo-magnetic motor, devoid, probably, of practical value, but having some scientific interest, has been devised by Prof. Houston and Thomson *Journal* of the Franklin Institute). A disk or ring of thin steel is mounted on a vertical axis so as to be quite free to move with its edges opposite the poles of a horse-shoe magnet. The wheel of course becomes magnetized by induction. On heating a section of its edges to move, The reason is, that the heated section has its coercitive force increased, and so, being less powerfully magnetized by the induction of the adjacent pole, than the part next it, the attraction exerted by the pole on this latter part is sufficient to cause motion. A constant source of heat given continuous rotation. The disk must be sufficiently thin to prevent its acquiring a uniform temperature. The best may be applied at diametrically opposite parts, with similar effect. What renders the motor of little value is the amount of heat required, being so enormous as compared with the force developed.

A CURIOUS THERMO-MAGNETIC MOTION is the joint discovery or device of Professors Thompson and Hughes. The engraving and description of this simple affair are from the *Journal of the Franklin Institute*.



During investigations by the authors, concerning the increase in the coercitive force of steel by changes of temperature, the following curious thermo-magnetic motor was devised.

In the figure, a disk or ring of thin steel D is mounted on an axis, so as to be quite free to move. The edges of the wheel are placed opposite the poles H and S of a magnet. In this position the wheel of course becomes magnetized by induction.

If now any section of the wheel, as H, be suddenly heated, the disk will move in the direction shown by the arrow. The cause of this motion is as follows: The section H has its coercitive force thereby increased, and being thus powerfully sensitized by the induction of the pole S, than the portion C (near finitely adjacent to it) the attraction exerted by the pole S on the latter portion is thereby sufficient to cause a movement of the disk in the direction shown by the arrow. If a constant source of heat be applied at H, a slow rotation in the direction shown is maintained.

To insure success, the disk must be sufficiently thin to prevent its acquiring a uniform temperature. If the source of heat be at the same time applied at diametrically opposite portions of the disk, as at H and D, adjacent to the poles, the same effect will be produced. Since the amount of heat expended in producing motion of the disk is so enormous when compared with the force developed, it will be readily understood that this motor is of no value as such, but may be regarded as an interesting example of the intercovertibility of force.

Annales der Physik und Chemie, No. 3.—In Wied. Annalen, they modify, but by Sir W. Thomson and M. Le Roux, with regard to the thermo-electric behaviour of stretched wires. Here Cohn has recorded a number of experiments which he made on an integral di-suretion. He finds that the intensity of the thermo-current between a stretched and unstretched wire of the same metal, depends (apart from all *permanent* properties), not only on the pre-ent tem-ture of the latter, but also, in very sensible degree according to the material used, on the upper and lower limits between which, since the last energies relense from tension, have been raised (the *maximum* alone, not the *time*, being here determined). In a thermo-chain of two similar wires, stretched with equal weights, but of which one (a) has last borne a greater, the other (b) a less weight, the current flows from *b* to *a*. In iron and steel the previous ten-ion even affect the direction in which the thermo-current varies with increasing or decreasing tension. Taking the direction of the current which arises with the *first* weak stretching, it is opposite for hard and soft wires, and the di-cendence above referred to is then established. Here Cohn thus formulates his general conclusion: "A stretched wire behaves, *ceteris paribus*, differently, according as it has before been stretched more weakly or more strongly, and this different continues till the next alteration of the tension."—Herr S. Weber contributes a useful notice on the electro-

LES PILES THERMO-ÉLECTRIQUES

A LUMIÈRE DE M. CLAMOND

Les piles thermo-électriques imaginées par M. Seebeck, en 1821, n'avaient été considérées pendant longtemps que comme des générateurs d'une grande constance, susceptibles d'être employés avec beaucoup d'avantage dans les expériences scientifiques, mais incapables d'être appliqués en pratique en raison de la faiblesse de courant qu'ils produisaient; l'application que fit, il y a quelques années, M. Marcus du pouvoir thermo-électrique considérable des alliages métalliques avait été faite, dès l'origine, par M. Seebeck, qui indique même l'usage d'anti-moine et de zinc comme un de ceux qui donnent couramment employés mais on n'est qu'à une époque d'emploi des piles thermo-électriques ont été appliquées, et la combinaison qui donne les meilleurs résultats est celle que M. Ed. Becquerel a indiquée et dans laquelle l'argentan est remplacé par un alliage, pour les mêmes raisons scientifiques cette combinaison donne les meilleurs résultats. Pour les mêmes raisons industrielles elle ne pourrait pas être facilement employée d'abord parce que le prix de l'appareil serait excessivement élevé, ensuite parce que la grande résistance du système ne pourrait pas être vaincue par une température aussi basse que celle à laquelle peuvent être exposées les autres alliages. De notre côté, nous avons employé le fer et le zinc avec limes de fer adoptés par M. Clamond, quoique ne donnant pas par elle-même une force électro-motrice aussi considérable, peut cependant donner meilleurs résultats par la plus grande différence des échauffements que l'on peut lui communiquer.

talliques (1) et la possibilité de les chauffer à une température élevée sans détériorer la pile, firent entrer la question des piles thermo-électriques dans une nouvelle phase, qui fut exploitée avec succès par plusieurs physiciens et en particulier par MM. Farmer, Bunsen, Ed. Becquerel, Clamond, Noé, etc. On put alors obtenir des piles dont l'intensité électrique pouvait être comparée à celle des éléments à acide, et ces piles furent même employées avec beaucoup d'avantages pour la galvanoplastie et l'électrotypie; mais, de tous les appareils de ce genre, ceux qui donnèrent les plus grands effets furent sans contredit les piles de M. Clamond.

Dès l'origine de son invention, c'est-à-dire en 1870, M. Clamond avait prévu qu'il pourrait un jour obtenir avec ce genre de pile de la lumière électrique et voici ce que j'en disais dans mon *Exposé des applications de l'électricité*, t. I, p. 426, publié en 1871 : « MM. Mure et Clamond construisent en ce moment, dans ce système, des batteries de 1500 grands éléments, qu'ils prétendent être de la force de 50 éléments Bunsen. Si, comme tout le fait espérer, la dépense se produit dans les mêmes conditions que dans le cas étudié (chauffage au coke), la dépense sera environ de 30 centimes par heure, et la pile thermo-électrique pourra ainsi devenir une source économique de lumière électrique. »

Ce résultat toutefois ne put être obtenu par suite des mauvaises conditions d'installation de la pile, et parce que la galène que M. Clamond employait alors s'altérait au feu. Néanmoins ces expériences purent le convaincre que le problème pourrait un jour résolu, et c'est en effet ce que nous voyons aujourd'hui. Toutefois, pour arriver au résultat si important que nous avons pu constater, il a fallu que M. Clamond se livrât à de nombreuses expériences et à de nombreuses recherches, et ce n'est qu'après neuf années qu'il a pu résoudre complètement le problème. Aujourd'hui une pile Clamond, disposée un peu comme un calorifère et dont les dimensions ne dépassent pas 1 mètre 50 cent. de hauteur sur 80 centimètres de côté, peut fournir quatre foyers de lumière électrique valant chacun de 15 à 20 becs de gaz en n'exigeant pour toute dépense d'action électrique qu'une combustion d'environ 9 kilogrammes et demi de coke par heure. C'est, comme on le voit, un résultat vraiment merveilleux et d'autant plus important qu'un appareil de ce genre ne nécessite pas la présence d'un mécanicien ou d'une personne compétente. L'appareil peut être placé dans une cave et disposé même de manière à pouvoir être employé comme calorifère, et toute personne est susceptible de pouvoir le faire fonctionner, puisqu'il ne s'agit, pour cela, que de le chauffer comme un calorifère ordinaire.

Mais disons sur quel principe repose cet ingénieux appareil.

Si deux métaux différents se trouvent soudés ensemble par une de leurs extrémités et qu'on chauffe cette partie soudée, le mouvement de la chaleur, se produisant d'une manière différente dans les deux métaux, détermine une force électro-motrice qui fournit un courant électrique que l'on peut recueillir aux extrémités des deux lames. Les métaux simples dont la réunion donne les effets thermo-électriques les plus marqués sont le bismuth et l'antimoine, mais, comme nous l'avons dit, les alliages et certains minerais métalliques donnent des effets beaucoup plus énergiques. Dans l'origine, la pile de M. Clamond se composait de barreaux de galène soudés à des lames de tôle; mais il dut bientôt y renoncer, et il eut recours à un alliage composé d'antimoine et de zinc, tout en conservant la lame de fer comme lame électro-positive. En disposant ces éléments en couronne, en superposant plusieurs de ces couronnes l'une au-dessus de l'autre et en projetant la flamme d'un foyer central sur les différentes soudures de ces éléments à l'intérieur des couronnes, il put obtenir, avec une pile de dimension assez petite, un courant électrique d'une valeur égale à celui de deux éléments Bunsen. Mais, dans ce système, la force électro-motrice du couple était en rapport avec la différence de température des deux extrémités de chaque barreau, et il fallait, en conséquence, que ces barreaux fussent un peu longs pour obtenir un effet énergique. D'un autre côté, il arrivait

(1) La découverte du pouvoir thermo-électrique considérable des alliages métalliques avait été faite, dès l'origine, par M. Seebeck, qui indique même l'usage d'anti-moine et de zinc comme un de ceux qui donnent couramment employés mais on n'est qu'à une époque d'emploi des piles thermo-électriques ont été appliquées, et la combinaison qui donne les meilleurs résultats est celle que M. Ed. Becquerel a indiquée et dans laquelle l'argentan est remplacé par un alliage. Pour les mêmes raisons scientifiques cette combinaison donne les meilleurs résultats. Pour les mêmes raisons industrielles elle ne pourrait pas être facilement employée d'abord parce que le prix de l'appareil serait excessivement élevé, ensuite parce que la grande résistance du système ne pourrait pas être vaincue par une température aussi basse que celle à laquelle peuvent être exposées les autres alliages. De notre côté, nous avons employé le fer et le zinc avec limes de fer adoptés par M. Clamond, quoique ne donnant pas par elle-même une force électro-motrice aussi considérable, peut cependant donner meilleurs résultats par la plus grande différence des échauffements que l'on peut lui communiquer.

souvent que l'appareil reçoivait des coups de feu et que le métal fondait autour des parties des lames de fer qui y étaient soudées; c'est ce qui fait que M. Clamond n'avait pu employer ce genre de pile pour les grands effets qu'il cherchait à réaliser. Il dut donc modifier entièrement la disposition primitive de sa pile, et, après de nombreux essais, il arriva à la disposition dont nous parlons aujourd'hui et qui est tout à fait remarquable; néanmoins les premières piles de M. Clamond sont encore employées aujourd'hui dans les ateliers de M. Goupil et autres où elles fonctionnent toujours d'une manière satisfaisante. Nous laissons maintenant la parole à M. Clamond pour décrire sa nouvelle invention et exposer les nouveaux principes sur lesquels elle est basée.

TH. DU MONCEL.

NOTE DE M. C. CLAMOND

SUR SA NOUVELLE PILE THERMO-ÉLECTRIQUE

Présentée à l'Académie des sciences

Par M. TH. DU MONCEL, en séance du 5 mai 1879

La nouvelle pile thermo-électrique que j'ai l'honneur de présenter à l'Académie réalise, dans l'ensemble et les détails de sa construction, des dispositifs très-importants qui ont complétement changé le rendement obtenu jusqu'alors de ce genre d'appareils et en font des puissants générateurs d'électricité capables de produire économiquement la lumière électrique.

Les piles thermo-électriques construites jusqu'ici étaient un assemblage de prismes ou barreaux qui, après avoir été fondus dans des moules spéciaux, étaient ensuite réunis et soudés les uns aux autres.

La chaleur était communiquée aux soudures chaudes des couples, par le contact de flammes, combiné parfois avec le rayonnement de surfaces chauffées par ces mêmes flammes. Les prismes se refroidissaient progressivement sur toute leur longueur, par le rayonnement et le contact de l'air, on obtenait la différence de température nécessaire entre les deux séries de soudures.

Les appareils ainsi compris présentent dans leur principe même des imperfections radicales au point de vue du rendement.

1° Ils entraînent la nécessité de donner aux couples une certaine longueur pour qu'ils puissent se refroidir suffisamment et maintenir la différence de température indispensable entre les deux séries de soudures. Cette longueur crée une résistance électrique considérable du couple et, partant, une faible intensité du courant produit.

2° Ils comportent une consommation inutile du calorique; car le calorique qui, par le rayonnement et le contact de l'air, s'échappe des surfaces latérales du prisme, se trouve ne pas avoir parcouru toute la longueur du barreau, et, par conséquent, ne donne pas le maximum d'utilisation dont il est susceptible au point de vue de sa transformation en électricité.

3° L'emploi des flammes ou des surfaces rayonnantes rend le chauffage des couples très-difficile à régler et n'est guère pratique qu'avec le gaz pour combustible et des appareils de petites dimensions. De plus, comme les surfaces de chauffe, représentées par les sections des couples ou des appendices polaires dont ils sont quelquefois munis, sont très-faibles, une petite proportion du calorique développé par la combustion est seulement recueillie, les produits de la combustion se dégageant à une très-haute température.

Dans le nouveau système, je me suis attaché à éviter les vices précités. A cet effet, l'appareil est composé de trois parties entièrement distinctes.

1° Le collecteur qui est un assemblage de pièces de fonte de fer légères, de formes telles qu'elles présentent une suite de carneaux dans lesquels circule l'air brûlé provenant d'un foyer quelconque. Ces pièces offrent une très-grande surface au mouvement des gaz chauds qu'elles n'abandonnent qu'à une température très-voisine de la leur; elles emmagasinent une petite proportion du calorique développé par la combustion et seulement recueillie, les produits de la combustion se dégageant à une très-haute température.

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2° Le diffuseur de calorique qui forme l'extérieur de l'appareil et est constitué par des lames métalliques présentant à la circulation de l'air ambiant une surface considérable.

3° Le système thermo-électrique proprement dit qui est placé entre le collecteur et le diffuseur, de manière à ce que les séries opposées des soudures participent aux températures différentes de ces deux organes. L'écoulement de la chaleur se produit du collecteur au diffuseur en traversant les couples, parallèlement à leur longueur, sans perte appréciable de calorique par les surfaces latérales; réalisant ainsi le maximum du rendement de transformation dont les substances employées sont susceptibles.

Le système thermo-électrique est combiné de manière à rendre sa construction économique et pratique, sa manipulation facile et sûre, et sa résistance intérieure aussi faible que possible. La longueur des prismes est très-faible et n'est pas la plus grande des trois dimensions.

Les lames métalliques qui les relient présentent un dispositif particulier qui a pour effet de répartir les points de soudure ou contacts sur toute la section du barreau. Enfin, dans des moules dont l'emploi est très-simple, on coule d'un seul jet, un grand nombre de ces couples qui, par l'opération même, se trouvent réunis en séries et constituent une chaîne flexible, aussi longue que l'on veut, dont les extrémités sont les deux pôles d'une pile élémentaire thermo-électrique.

Ces chaînes, pressées entre le collecteur et le diffuseur, desquels elles sont convenablement isolées, peuvent être reliées les unes aux autres par leurs extrémités libres, ce qui permet de réaliser à volonté tous les accouplements et combinaisons que l'on se propose.

En résumé, l'appareil peut être assimilé à un calorifère chauffé par un foyer ordinaire dans lequel est brûlé un combustible quelconque et dont les parois, par suite des systèmes de construction précédemment exposés, transforment en électricité une portion du calorique qui s'écoule au travers. L'extérieur du calorifère, présentant une très-grande surface diffusante, rend ces appareils éminemment propres au chauffage et leur permet de remplir la double fonction d'éclairer et de chauffer.

Le coefficient de transformation des alliages thermo-électriques énergiques est beaucoup plus élevé qu'il n'était communément préjugé, et je me propose de faire ultérieurement à ce sujet des communications fixant quelques-unes de ces données.

Pour le moment, en prenant l'appareil au point de vue de son rendement pratique, c'est-à-dire considérant le poids de combustible brûlé sur la grille et les données numériques du courant produit, voici quelques chiffres d'après les expériences que M. G. Gabonellas a faites depuis deux mois; expériences qui concordent d'ailleurs avec les miennes.

Ces expériences ont été faites sur un appareil dont la surface de chauffage est de 20 mètres carrés, qui mesure 1 mètre de diamètre et peut faire marcher simultanément deux lampes, système Serrin, avec un pouvoir éclairant variant de 30 à 50 becs carcels pour chaque lampe, le foyer ayant été soumis à différentes conditions de tirage et de chauffage.

La résistance intérieure d'un demi générateur est :

R = 1,5 ohms.

La force électro-motrice en chauffe normale est :

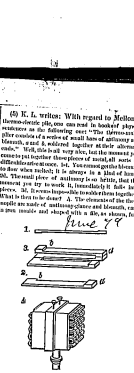
E = 109 volts.

Ce qui pour la pile entière représente une force électro-motrice de 218 volts. Cette force électro-motrice équivaut à celle de 121 couples de Bunsen fraîchement montés (1,8 volt par Bunsen). La consommation en chauffe normale est en moyenne de 9 kilogrammes de coke à l'heure.

L'équivalent du courant résultant des données précédentes, est de 1,333 unités électro-mécaniques, lesquelles représentent 136 kilogrammètres par seconde.

C. CLAMOND.

(5) R. L. writes: With regard to Mellon's thermo-electric pile, one can read in hundred of physics treatises as the following one: "The thermo-electric pile consists of a number of small bars of antimony and bismuth, 2 and 3, soldered together at their alternate ends." Well, this is all very nice, but the moment you come to put together these pieces of metal, all sorts of difficulties obtrude themselves. Yes, but you must get the bismuth to flow when melted; it is always in a kind of lump. Oh. The small piece of antimony is on bottom, but the moment you try to work it, immediately it falls into pieces. Ah, I have a capsule to enable it to run together. What is that to be done? A. The elements of the thermo-couple are made of antimony-zinc and bismuth, cast in pans ironite and shaped with a file, as shown, full



size, in Fig 4. The bars of antimony must be tinned on both heads, at 6, with very fusible solder by means of a small soldering iron. The bars of antimony and bismuth may be held together between copper screws, and the spaces between the bars filled with pieces of wood, which may be allowed to remain to impart greater solidity to the pile, but they must not extend beyond the joints. The vertical rows of the pairs each are then soldered, and these are united when all of the pairs are complete. The end pieces of each row must have an offset at right angle to the bar, as shown in Fig 2. Fig. 3 shows the combination of the end pieces of two vertical rows. When the pack of 20 or 25 pairs is completed, lay it in a wood or square case of brass, having first soldered to the middle of the first and last bars short copper wires, which pass through two loop lined holes in the case and are provided with permanent binding screws. The vacant spaces are then filled with plaster of Paris, which is allowed to expand away so as to leave the ends of the bars bare, and these are then blackened. In making this instrument a great deal of patience is required, as a breaking of a number of the bars is unavoidable.

NOË'S THERMO-ELECTRIC PILE.

By ALFRED NIAUDET.

THIS thermo-electric pile is constructed in various forms of which the figure represents the most simple and the smallest.

The elements are in plan placed horizontally and radiate like the spokes of a wheel; the heated junctions lie towards the centre, and the cold junctions towards the outside, as shown in fig. 1.

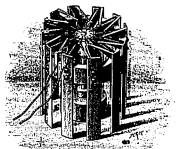


FIG. 1.

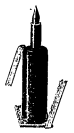


FIG. 2.

The two metals are 1st, German silver, and 2nd, an alloy of antimony, which melts at a temperature a little above the fusible point of antimony; but the exact composition of which has not been made public.

These two metals are soldered together (at least at the hot junction) without the intervention of any other metal; the wires of German silver have fixed at their extremities little capsules of brass which serve as moulds into which the other metal is cast. One of these little capsules is visible in fig 2, which represents a single element of the natural size; it remains attached to the element and forms part of the apparatus.

In the same capsule a little lug of copper penetrates, the extremity of which is equally held in the cast metal, and by means of which the heat is conducted to the hot joint.

The opposite extremities of the lugs of copper are joined and arranged in a little circle and heated by a peculiar flame from a lamp burning methylated spirit, or by a Bunsen burner.

In order to concentrate the heat of the flame the latter is covered by a circular disc of mica, which is held by the copper lugs.

Each cold junction is slightly different: here the fusible metal is soldered to a plate of copper, to which are soldered the German silver wires of the following element.

The plate of copper exposes a large surface, and has for its object the cooling of the junction by radiation in the first place, and by contact with the air in the second.

These plates of copper can be plunged into water at their upper extremities, so that the cooling of the cold junctions can be more effectually done; but practically this expedient is not always adopted.

The cooling by the influence of the air is simpler and is practically found to be sufficiently effectual.

These piles have been tested with great care by M. Waltenhofen of Prague; he has compared them with those of M. Marloye, and finds them to be very superior to them.

The results of experiments by M. Stephan, show that the thermo-electric elements of Marloye have an electro-motive force of one-eighteenth of a volt; but that this maximum corresponds to a temperature very near the fusing point of the metal of which the elements are composed.

Under similar conditions, M. Waltenhofen has found that the elements of Noë; have an electro-motive force of one-ninth to one-tenth of a volt.

Practically, these maximum values must not be expected, and when several elements are connected together, these maxima are never obtained, because all the elements do not become heated to the same degree, and about one-sixteenth of a volt for electro-motive force, and one-fortieth of a Siemens' unit (*) for resistance represents about the power of the pile.

A very useful addition to the apparatus, consists in the addition of a gas regulator for the prevention of the overheating of the pile. This is liable to happen from an increase on the pressure of the gas supply, an increase in the heat being thereby produced, which may fuse the metal of the elements and thus destroy the pile.

The regulator is particularly useful with the large piles, composed of a great number of elements, but can be dispensed with in the smaller piles of the kind illustrated.

With a small pile of 12 elements, an electric bell can be rung and similar experiments made; with 20 elements, water can be decomposed in a voltameter.

With 40 elements, a Planté secondary pile can be charged, or an induction coil worked; in fact, these answer for all the usual physical experiments made with an ordinary battery, and for small industrial operations, such as plating with gold, silver, or nickel, &c.

A great advantage of these piles consists in the fact that they attain their full power in one or two minutes, and the moment they are no longer wanted, the gas can be put out and all expense ceases.

In fine, and this point is important, *the pile does not deteriorate or change from constant use.* This is not the case with those which hitherto have been made, and which, after a time, considerably increase their resistance, so that the strength of the current they give, becomes at last so weak as to render the pile useless.

(*) Waltenhofen—Dingler's Polytechnisch. Journal, 1877. Vol. 22 ; page 169.

SUDRE'S THERMO-PILE.

ONE of the most important of the new French thermo-piles, designed for the electric lighting of large shops, offices, halls, and theatres, is that of M. Jean Marie Sudre, a detailed notice of which we are compelled, from want of space, to defer until our next. It will be remembered that Clammond's pile failed because of the heat source coming in contact with the thermo-electric joints themselves, and gradually consuming them. In Sudre's pile this danger is obviated by interposing a guard material between the heat source and the junctions. The heat source may be steam or hot liquid, heated air or gas circulating in flues past the protected hotter thermo-electric junctions. A large heating surface is offered to the circulating medium. Coke or coal is burned in the pile, which requires no skilled attendance except occasional stoking. Three electric lights, steady and brilliant, can be produced from it, and, as the waste of an intermediate dynamo-electric machine is suppressed, at a cost much less than the cost of gas. Any lamp may be used, but an improved form of Serrin is at present preferred. This thermo-pile is about to be introduced into England by Mr. Applegarth.

SUDRÉ'S THERMO-PILE.

In designing his new form of thermo-pile, M. Sudré has had several objects in view. The characteristic points in the invention are: 1st. Low internal resistance of the couples under a very small volume, and the arrangement of these couples in chains in a particular manner, so as to facilitate their grouping together, and mounting; 2nd. The arrangement of the couples between heating and cooling surfaces; 3rd. The peculiar method of conducting the heat to the one set of metallic junctions; and 4th. The peculiar method of cooling the other set of junctions.

In designing the form of the bars of which the couples are composed, two points have to be considered—1st. The resistance; and 2nd. The tendency of the bar to become equally heated from end to end. *Now*, as M. Sudré points out, the resistance of a bar varies as $\frac{\text{length}}{\text{sectional area}}$, and if this proportion be preserved constant, the resistance will remain the same; but the greater the length of the bar, the slower will the heat diffuse itself along the bar. But if the bar be made very long and correspondingly large in sectional area, great bulk will be obtained. The problem then is to determine what dimensions the bars should have to give the best effect consistent with smallness of volume. M. Sudré finds that for differences of temperature of from 12° to 120°, the bars should be 10 to 12 millimetres long, and for temperatures ranging up to 200°, from 20 to 30 millimetres long.

In short couples the method of soldering the points of union of the two diverse metals is a matter of the greatest importance. The junction should be made so that the one metal (in the form of a plate) should be in contact with the whole of the surface of the section of the bar, but at the same time should not penetrate to any depth in the latter, for the effect of its so doing would be to much diminish the electro-motive force of the couple. To obtain this double object, the extremity of the plate forming a couple is cut in the form of a comb (fig. 1), the teeth of which are twisted on themselves, as shown by fig. 2, so that whilst the surface of the twisted metal remains the same, its length becomes much reduced. The twisted cut portions form the connections on to which the bars are cast.

The plate with the twisted prolongations is best, as shown by fig. 2.

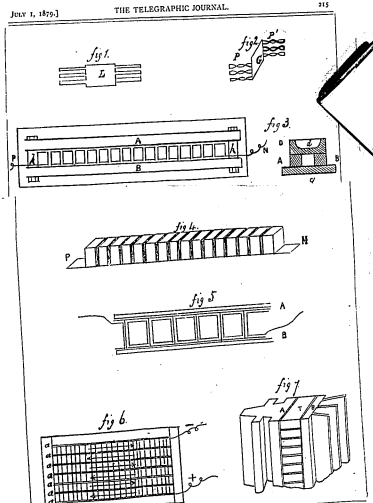
Each side of the full part a of the plate is coated with silicate of soda or other heat resisting material.

The mould in which the alloy bars are cast is shown by fig. 3. It is composed of a base c, two side pieces A B, maintained parallel by two cross pieces x and x', and of a cover D, carrying a longitudinal furrow pierced with holes, d, equal in number to the number of couples to be contained.

The plates being prepared as described, are placed in the mould between the two side pieces A B; the cover D is then placed on the top and the melted alloy run in, so that the series of plates become bedded in blocks of the alloy, as shown by fig. 4.

The chains of blocks so formed are arranged in the following manner:—

Two metallic plates, A and B, fig. 5, which are represented as pieces but which may be cylindrical or curved, are covered on one side with a thin layer of an electrically insulating substance such as enamel. Between these two isolated surfaces is placed one or more of the thermo-electric chains, in such a manner that the extremes of the couples rest upon the enamel surfaces. If several chains are arranged side by side between the two same plates, then they must be arranged so that the opposite poles of two contiguous chains are side by side;



Prof. Bunsen, by the employment of different metals from those hitherto tried, found that he could increase the strength of the current, and M. Marcus, of Vienna, using alloys instead of simple metals for the positive and negative element, reduced the cost, while increasing the power of the battery. From a thermo-electric battery constructed on his principle, and also from a modified form, devised by Wheatstone, a current sufficiently strong to produce brilliant sparks, decomposse water, &c., was obtained. This was in 1865, and but little progress has, until now, been made in this branch of science, with the exception of the improved forms of thermo-pile devised by Noë and by Messrs C. and L. Wray, although the utilisation of heat—especially solar heat—for the production of electricity has long attracted the thoughts of many experimenters.

M. Clamond has for some time been at work upon the subject, and has so far succeeded that his thermo-electric battery has been employed since 1872 in M. Goupil's factories. These batteries are formed of iron, as the electro-positive element, and an alloy of antimony and zinc for the negative; they are soldered together and arranged in a circular form, which can be built up as high as may be desired. The junctions of the metals are heated in the interior, but the electromotive force being proportional to the difference of temperature between the two extremities of each bar, it was necessary to make the bars long if a strong current was desired, and then the results were less satisfactory, owing to the increased internal resistance of the melting of the metals where they were soldered, &c.

It is these hindrances to its extended use which M. Clamond has sought to obviate in his latest form of battery, which is composed of three distinct parts. The *collector* consists of a number of pieces of cast-iron so arranged that the heated air can circulate within them; a large surface is thus exposed to the heat, which the iron collects and communicates to the couples. The *diffuser* is the outside of the apparatus, and is made of sheets of metal. The *thermo-pile proper* is placed between these two, and is so arranged that the junctions of the metals are alternately at the temperature of the collector and the diffuser. Heat passes from the collector to the diffuser along these couples, which have no great length. In some forms which are very easily worked, a number of these couples are made into a flexible chain of any desired length, the extremities forming the poles of the battery. These chains, insulated from the other parts of the apparatus, can be united to each other by their free ends, so that a variety of couplings and combinations may be made. The model now in use for lighting a workshop in Paris is about 25 metres high, and 1 metre in diameter, the exterior form being that of a polyhedron, to the sides of which the thermo-electric chains are attached; these are composed of small cubes of zinc and antimony joined together by plates of tin, to which they are soldered. Each half of the apparatus has 30 chains of 100 couples each, or 6,000 couples in all. To the outer surface of these chains are fixed the sheets of copper which form the diffuser or heat distributer.

Another model, made for the recent exhibition at the Albert Hall of the various systems of electric lighting, is square and much smaller, though of the same power.

Each half of the cylindrical battery can be made to supply a powerful electric light, while the square one can produce four lights of half the brilliancy. The electromotive force is, according to prolonged experiments, 216 volts, about equal to 120 Bunsen cells, while the resistance is 31 ohms. The large battery consumes only 9 or 10 kilogrammes of coke an hour, and the smaller one even less, about 6½ kilogrammes. Moreover, the large surrounding adopts it admirably for use in heating, as well as for lighting, and it can thus be made to serve the double purpose of giving warmth and light.

M. Sudré has also designed his thermo-pile with a view to obtaining one of small volume and having a low internal resistance; the other peculiarities of his battery consist in the manner in which one set of junctions are heated while the other set are cooled. He has also determined what is the best length for the bars forming the couples, in order that the necessary difference of temperature at the two extremities may be maintained, while yet making them as small as possible. This he finds should be from 10 to 30 millimetres, according to the difference of temperature required. His manner of soldering together the two different metals is also novel and ingenious. In order that contact may be made with the whole surface of the bar, he cuts the plate, forming one metal, into the shape of a comb, twisting the teeth of this comb together, thus retaining a large surface, which yet has only a short length. The bars are fastened on to these twisted parts and the uncut part of the plate is coated with silicate of soda. The couples are formed in a mould in which the plates are fixed, the melted alloy is then run into the mould so that a block is formed of the alloy and the plates, firmly united. These chains or blocks are then placed between two plates, coated on one side with enamel or other electrically insulating substance; several chains may thus be arranged side by side, each chain being both calorically and electrically insulated. The parts of the chain are electrically insulated by the thickness of the plates, but heat can flow across the couples. The chains are next placed between a collector and a diffuser; the collector is filled if the source of heat be gas, in order to expose a greater surface. The diffuser is also ribbed for the same reason when the heat is merely allowed to radiate into the air. The whole battery is so arranged that the collectors form the inside of a circle within which the heated air is circulated.

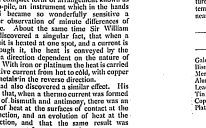
THE RISE OF THE THERMO-PILE.

It is giving a short sketch of the development of the thermo-pile, we shall first say a few words on the history of thermo-electricity in general.

As early as 1707, the thermo-electric properties of tourmaline had been pointed out by a German writer, who, under the initials of J. G. S., published a book entitled "Curious Speculations During Sleepless Nights." Indeed, in ancient days, Theophrastus had shown that tourmaline, like amber, could be electrified by friction; but he does not appear to have had the idea that the electrification might be due to the *warming* produced by friction. In 1759, Alpinus, in Germany, called attention to the same fact, and pointed out that electricity of opposite kinds was manifested at opposite ends of the crystal. In 1760 Canton observed similar phenomena with the topaz; and, towards the close of the century, other observers, notably M. Haüy, showed the thermo-electric properties of various other substances.

It remained, however, for Professor Seebeck, of Berlin, to discover, in 1821, that when the junctions of two metals forming part of a circuit was heated, an electric current flowed through the circuit; Seebeck is, therefore, justly regarded as the discoverer of thermo-electricity. The apparatus he employed to illustrate this consisted of a simple frame of antimony and bismuth, with a suspended magnetic needle placed within. The approach of the flame of a spirit lamp to either of the junctions produced a deflection in one or other direction.

Professor Jas. Cumming, of Cambridge, extended Seebeck's experiments, and, in 1823, ascertained that the unequal distribution of heat in the circuit was the cause of thermo-electricity, and he drew up a table of positive and negative thermo-electrics. He also made an important discovery in what is called the thermo-electric *inversion* of various metals at different temperatures, a fact now constantly made use of in the construction of thermo-piles. It means that a metal which is thermo-positive to another at one temperature may be negative to it at a higher or lower temperature. This may be seen from fig. 1, which was given by Sir William Thomson, in



the Bakerian lecture for 1856 (Phil. Trans.). In 1830 Dr. Botto, of Turin, made a thermo-electric battery of platinum-iron pairs; and, in 1831, Nobili devised the compact form of arrangement known as the thermo-pile, an instrument which in the hands of Melloni became so wonderfully sensitive a machine for observation of minute differences of temperature. About the same time Sir William Thomson discovered another fact, that when a metal circuit is heated at one spot, and a current is passed through it, the heat is conveyed by the current in a direction dependent on the nature of the metal. With iron or platinum the heat is carried by the positive current from hot to cold, with copper and other metals in the reverse direction.

Peltier had also discovered a similar effect. His theory was, that, when a thermo-current was formed in a circuit of bismuth and antimony, there was an absorption of heat at the surfaces of contact at the warmer junction, and an evolution of heat at the colder junction, and that the same result was obtained if a current from any exterior source were passed through such a circuit.

Sir Wm. Thomson, who thoroughly investigated the subject, pointed out that this explanation was incomplete, for, when a junction is at the neutral point, no Peltier effect can occur; the two metals being thermo-electrically identical.

The following table, prepared by Professor Tait, gives the temperatures at which certain metals are neutral to each other:—

Iron	-	-	-	+	357 °F.
Tin	-	-	-	+	45
Brass	-	-	-	+	27
Lead	-	-	-	-	—
Zinc	-	-	-	—	31
Copper	-	-	-	—	68
Cadmium	-	-	-	—	69
Aluminium	-	-	-	—	113
Silver	-	-	-	—	115
Palladium	-	-	-	—	181
German Silver	-	-	-	—	324

Professor Tait has also observed that the thermo-electric lines of the various metals, for varying temperatures, are approximately straight lines, a fact which greatly simplifies the calculation of electromotive forces for any desired combination.

In 1837 Dr. Andrews, of Belfast, found that fused salts could be employed as thermo-electric, and constructed a battery with platinum wires, dipping into fused salts.

The first patent taken out in this country for a thermo-electric battery, was that of Moses Poole, in 1843. Poole used two pairs of German silver and iron rods, cemented in plaster of Paris; the lower ends were heated in a sand-bath, while the current of cold water was kept flowing over the upper ends. This battery was used for depositing metals.

In 1852 Mr. J. Roberts and C. Watt obtained patents, the former (among other things) for using hot air to excite the battery; the latter, for a combination of antimony and bismuth pairs.

We should also mention that, in 1847, Alexander Bain had employed a thermo-pile for regulating clocks, by means of a plate or lens, driven by trainwork, and containing a slot through which the sun's rays passed at certain times of the day. In 1853 H. Kemt employed the pile for thermometric measurements.

The first application (and perhaps the only one) of the thermo-pile to telegraphic use, was made by Mr. C. F. Varley, who, in a patent obtained in 1856, described a pile to be used in conjunction with Inductum coils, for telegraphing over short lines.

In 1862 Dr. Matthiessen read a paper before the Royal Society, in which he pointed out that some substances, such as silver, copper, and bismuth, have their conductivity increased by having heated for a considerable period, while others, such as tellurium, have their conductivity diminished by like treatment. Dr. Matthiessen had previously investigated this and kindred subjects most laboriously, and had drawn up the table given below—namely, and had drawn up the table given below—namely, the first really accurate one published, most either the first really accurate one published, most either, in experimenters having observed the fact that, in measuring the electro-motive force of any pair of junctions produced by a given difference of temperature between the opposite junctions, the mean temperature of the circuit should be constant, or nearly so.

THERMO POSITIVE :—

	Silver and copper = 1.	Microvolts per degree Centigrade.
Galena	+ 21'96	+ 45'0 65
Bismuth	+ 7'32	+ 4'18
Mercury	+ 2'32	
Aluminium	+ 1'28	
Lead wire	+ 1'02	
Tin wire	+ 1'00	— 0'1
Copper	+ 1'00	— 0'1
Platinum	+ 0'72	— 0'9

THERMO NEGATIVE :—

Silver	... ...	—	370
Graphite	... ...	—	705
Zinc	... ...	—	727
Iron (piano wire)	... ...	—	5·20 — 1·73
Antimony	... ...	—	5·87 — 23 to 28
Antimony 2, Zinc 1...	...	—	2770
Tellurium	... ...	—	79·70 — 102
Selenium	... ...	—	29100 — 897

The above table is extracted from Dr. Matthiessen's paper in the Philosophical Transactions for 1858.

Referring to the left-hand column of figures, it will be seen that he takes silver as his zero metal, and, calling the effect of a silver-copper pair 1, he measures the electro-motive force of all the other couples by this standard, these above silver being considered thermo-positive metals, and those below it thermo-negative. The mean temperature was 19° to 20° C.

The right-hand column is a table calculated from this by Professor Jenkin, showing approximately the thermo-electric force of each couple in micro-volts for each degree Centigrade. Professor Jenkin, however, takes lead in his zero instead of silver. The tensions above lead are, therefore, positive, and those below are negative, and to obtain the power of any positive and negative couple we must add the two together; thus bismuth and antimony have a force of 44 + 23 as compared with that of silver and copper, or a tension of 68 microvolts for each degree Centigrade.

(To be continued.)

SUDRE'S THERMO-ELECTRIC GENERATORS.

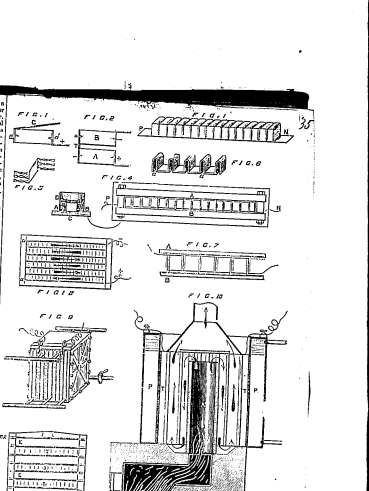
THE Abbé Moigno has described in the *Cosmos* a series of magneto and dynamo machines he has had the effect of inducing some experimentalists to devote a little attention to the possibility of devising a thermo-electric generator, which, while comparatively simple in itself, would dispense with the steam-engine or other motor that adds to the cost of the electrical power by the machines at present in use. If report can be credited, M. Sudre, of the Boulevard St. Denis, Paris, has obtained results so satisfactory with his thermo-electric pile that he has taken out patents in the chief countries. The following are the characteristic points of the invention :—1st. The construction of thermo-electric couples having a feeble internal resistance under a very small volume, and their disposition in chains for facilitating assemblage and dismounting. 2nd. The maintenance of the differences of temperature necessary between the two soldering-points of each couple by placing these couples between two surfaces with which they are electrically connected. One of the surfaces is designed to heat the warm soldering, and makes part of a metallic system called the "collector," which has the effect of collecting and storing the caloric from the source of heat, and communicating it to the couples across the isolated foil. The other surface is designed to cool the cold soldering, and makes part of a metallic system (with the employment of liquids sometimes), termed the "diffuser," which has for its object to draw and collect the caloric from the couples, and to cause it diffusing it into the air, or for transporting it to the cold, or of a medium to a point where it is desired to utilise it.

In the construction of thermo-electric couples and chains an isolated thermo-electric couple is ordinarily composed of a piece in metal or alloy, A, Fig. 1, and of a paler piste of iron, copper, German-silver, or similar metal or metallic alloy to each of its extremities. The plates do not ordinarily interfere in the production of the electric force obtained, and it is the bar A, such as that of antimony and zinc, which constitutes in a great measure to the total effect produced. When it is desired to use two metallic or similar alloys, of which the effects are combined, and which are easily fusible, such as the bismuth and antimony, the couple is formed then of two bars A and B (Fig. 2), which are joined together by a cross-bar T, which binds them and is soldered to each. The total resistance of a couple is compressed, by, of the resistance of the plate C (Fig. 1). 2nd. of the resistance of the bar A, ordinarily formed of alloys sufficiently resistant; 3rd, of a particular resistance at the points of contact or soldering, *a*, *a'*, of the pair and end of the bar. *Resistance of the Plate.*—This metallic plate should be of a metal sufficiently conductive, such as copper, iron, German-silver, or zinc, composition, and sufficiently large and thick for presenting but a feeble resistance. It should have also the least length or unfolding possible, and conditions which are realised in the following fashion. *Resistance of the Bar.*—To obtain for the bar A very feeble resistance under a small volume, M. Sudre takes as starting point the formula $R = K \frac{L}{S}$, in which R is a specific coefficient for the matter employed; L, the length of the couple; and S, its section. As the resistance depends upon the relation $\frac{L}{S}$, one should in diminishing these two dimensions into the same relation diminish the volume of the couple without increasing its resistance. The length of the couple depends equally upon the difference of temperature employed, and in the greater as these differences are greater. For the difference of temperatures from 10 to 120 degrees he gives to the couples a length of 6 to 12 millimetres, and for those of 300 degrees a length varying between 18 and 24 millimetres. *Resistance of the Soldering.*—But about couple also the formation of the products of the two points of contact or soldering is of the highest importance. The junction should be made so that the plate should be in contact with the points of the whole section of the bar, and at the same time it is necessary to give little depth in the bar, so as not to diminish too much the electromotive force of the couple; for the difference of temperature really effective is that of the temperatures of the two solderings, and this difference diminishes as we degree to the plates penetrating deeper into the bars approach one another. To obtain this the ends object the extremity of the plates is cut in the form of a cusp, the teeth of which are lodged upon themselves in such a manner as to present a bi-bevelled surface, which holds them, as it were, screwed into the metal. This cut portion is shown in the cut model at the end of the bar in such a manner that the teeth are imbedded in the metal. The ends of each plate should be cleaned at the insertions of the plate which are distributed on the whole section of the bar.

In the case where the couple is composed of two cast bars (Fig. 2) the cross-bar T will carry the couple to each extremity. Having thus explained the condition to be realised and the means of realisation in the construction of a thermo-electric couple, M. Sudre proceeds to explain of employing the bars, as in a single cast of metal or alloy, so that the bars cast simultaneously are found bound and coupled together, and forming a flexible thermo-electric chain, easy to handle, facilitating the mounting of the apparatus, and realising the minimum of resistance desired.

Fig. 3 represents the plates cut and bent twice at the time of using it for the formation of the couple. The centre C is bent, and the two bent parts are cut and twisted as described. On each side of the full part D of the plate is pasted with silicate of soda, or fixed by any other means, a slide plate of a non-conducting substance capable of resisting the contact of the cast metal, such as paper of animalins (or powder), mica, terra-cotta, or other suitable material. The mould (Fig. 4) is composed of a foot G, of two side pieces A, B, maintained parallel by two cross-pieces of a corer D carrying a longitudinal former E, grooved with holes equal in number to the number of couples contained. The plates prepared as we have described are placed in the mould between the two side pieces A, B, as is represented in Fig. 4. Then, placing the cover D on the top and running in the cast alloy, the interior of the mould is filled, and the bent extremities of the plates are bedded in the cast metal. In taking the mould in pieces, we obtain a cast bar, as represented in Fig. 5, composed of as many elementary couples, equal in length, which can be varied at pleasure, and this chain is found to be a thermo-electric chain, the extremities of which, P and N, are the poles. The paper of animalins (or selenite) may be used in various ways: in plates, folded, and bent, as Fig. 6 indicates. The prepared plates are then placed in the slits *a*, and the whole is then placed in the mould the cast of the metal will be placed in forms of a chain, analogous to that of the preceding case. In the case represented in Fig. 2 (where the thermo-electric couple has been formed of two cast bars A, B, the formation of the chain will be in an analogous manner. First of all the bars of metal the less fusible, these A for example, will be cast separately, and will carry at each extremity a cross bar T, cut into a cusp, as before directed. Then prepared, the first series of bars should be of the same form as the best in any two metals, A and B (without the paper in the mouths in lieu of the plates. The fusion of the second metal B in finding the open extremities of the cross-bars will form a thermo-electric chain composed of couples similar to those of the preceding case.

Two metallic plates A and B, Fig. 7, which are represented as plates, but which may be cylindrical or curved, are maintained at their faces by a thin layer of isolating substance of electricity. This substance should be a thin layer of enamel applied on the metal, or a layer of mica if the temperature of the plate is elevated; or it may be a varnish, a leaf of vulcanised india-rubber, or a thin gummy or oily stuff if the temperatures employed are less elevated. Between these two isolated surfaces is placed one or more thermo-electric chains in such a manner that the extremities of the couples which constitute these chains press upon the isolating surfaces. When more chains are used side by side between the two same plates they should be returned each time in such a manner that the opposite poles of two contiguous chains are found side by side; they may be easily coupled in tension. Fig. 8 shows this arrangement, and the manner in which the current flows according to the directions of the arrows. The contiguous chains should be also isolated the one from the other by an isolating band *a*, of asbestos, of vulcanised paper, mica, indiarubber, or other isolated. In the case where the surfaces A and B are curved, and where it is formed between two contiguous chains should be filled up with isolating matter, such as animalins (or selected parts, to avoid the lateral loss of caloric; all the elements of the chains are electrically isolated by the relating thickness of the plates, but they are not isolated calorically, so that if by any means the plate A (Fig. 7) is maintained at a high temperature, and that B at a lower temperature, the caloric will flow across the isolated leafs and penetrate the couples, through which it will continue its course from one soldering to the other. The difference of temperature between the two will be within very little of the temperature between the soldering of the couples. As long as A and B preserve their respective temperatures a thermo-electric current will be furnished by the battery formed by the chains, and will be collected as shown by Fig. 8. The plates A and B, Fig. 7, form part of two systems having for their object, one, the "collector," [illegible]



BRIGHT'S TYPE-PRINTING TELEGRAPH.

Kelly's Journal, 1852

THE principle upon which this apparatus, the invention of Sir C. T. Bright, is worked, is decidedly novel: it is briefly that of causing the letters to be printed by inserting different artificial resistance into the line circuit at the sending station.

Fig. 1 shows the transmitting apparatus at the sending station. It consists of a key-board, the keys of which are of ivory or wood, so as to be insulated from each other, and are marked with the letters of the alphabet. Each of the keys is fixed upon a metallic spring a, one end of which is connected to a resistance coil b. The other end of each resistance coil is connected to earth. Immediately beneath the keys, and along the entire key-board, there is a metallic bar c, c, moving on centres d, d; when at rest it is pressed by a spring against the metallic plate e, which is connected to earth. A metallic pin f, attached to the under side of the spring of each key, breaks the connection between c and e when any of the keys is depressed, and contact then being made between f and b, the resistance coil belonging to the key is placed in the circuit.

Fig. 2 shows the working parts and connections of the type-printing instrument at the receiving station; o and h are the coils of a differential relay, and the upper portion of the figure represents a

FIG. 1.

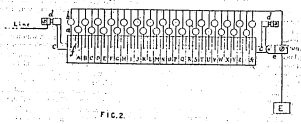
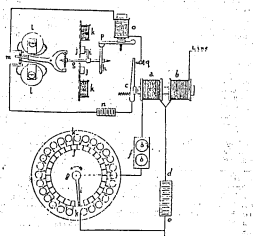


FIG. 2.



local circuit, made or broken by the armature lever c. The lower portion also shows some of the parts comprised in the upper portion, and these are indicated by the same letters. Coil b is connected to the line wire, and to the pole of a battery whose other pole e is connected to earth. Coil a is also connected at one end to d, and at the other end to the adjustable rheostat f, composed of resistance coils which can be adjusted to equal the resistance of the line circuit, and can be varied to compensate for any change in the latter. The other end of f is connected to an axle g, g, upon which is fixed the type-wheel h, and also a metallic arm i, i, which, when the axle is in motion, passes over and makes contact with a series of metallic plates k, k, k, to which are connected a series of resistance coils l, l. Two or more type-wheels may be carried by g, g, so that two or more duplicates of a message may be printed simultaneously. L, L is an electro-magnet, and m its armature; n is a local battery by which L, L is worked, and the axle g, g, rotated thereby when the local circuit is closed by the action of c. A train of wheel-work, actuated by L, L in place of n, is an electro-magnet acting on p. When the instrument is in the position shown in the figure, being inserted at the sending station is completed by the motion of i and h, and i rotate until i reaches the particular plate k, by which the resistance inserted at the line, whereupon the current being balanced, c is separated from the type-wheel axles, and against h by p.

CLAMOND'S NEW THERMO-PILE, having a heating surface of 30 square meters, keeps two Serrin lamps lit, each giving a light equal to from 30 to 50 gas-jets. The internal resistance is only 11 ohms; the electromotive force 218 volts, or the value of 121 Bunsen cells; and the consumption of coke is 2 kilogrammes per hour.

THE RISE OF THE THERMO-PILE

(Continued from page 249.)

BUNSEN, MARBACH, AND STEAN, in 1867, exhibited piles of various alloys, but the first really good thermo-pile appears to have been that which Mr. Farmer, of America, exhibited in the Exposition of 1867. Mr. Farmer employed German silver and an alloy of copper, zinc, and nickel. This pile lost power rapidly, owing to increase of internal resistance, and the bars frequently broke in cooling.

In 1866, three patents were taken out by Lieut.-Col. James Baker, for various forms and improvements of thermo-piles. Baker was the first to employ the "Stellas" form of pairs, and he arranged them round a cylindrical or polygonal stove, with protecting cylinders of thermo-constituting material. This form is the one now most commonly employed. Baker also made a pile with bars of our thermo-electric metal, connected by copper wires.

In 1868, Mr. L. Moore and M. Clamond patented a pile of iron and galena pairs; and, in 1874, M. Clamond obtained letters patent for an improved form of this pile, a detailed account of which we give.

Three patents were taken out in 1872-5, by M. Faure, but are not sufficiently practical or interesting for description. In the latter year, Mr. C. J. Wallaston patented a pile composed of strips of tinned iron and German silver, the strips being set in a perforated fire-tile, and the hot junctions either enamelled or bedded in a non-conducting composition. The heat was supplied by gas, and a governor regulator, controlled either by clockwork or by a peculiar form of galvanometer-needle was used to adjust the supply. Mr. Wallaston also proposed to employ water-cups to cool the outer junctions.

M. Clamond's battery consists of tinned sheet-iron for the positive elements, and an alloy of two parts of antimony with one of zinc for the negative. The alloy, which melts at 800° F., is cast into bars from 1 to 2½ inches in length, and from ⅛th to 1 inch in thickness. The shape and disposition of the elements are shown in fig. 2. Forty-20 of these pairs give an electro-motive force of about 1 volt, and are, therefore, nearly equal to one Daniell cell.

The heat is usually supplied by gas, as in fig. 3, or by coke, as in fig. 4; but, in a recent modification, M. Clamond employs a "collector," composed of pieces of cast-iron, among which hot air circulates; a large surface is thus exposed to heat, the iron communicating the heat to the couples.

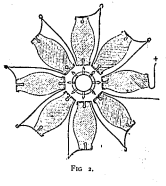


FIG. 2.

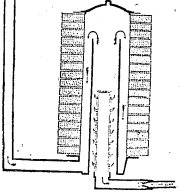


FIG. 3.

M. Clamond's latest achievement is the production of the electric light by means of his thermo-electric battery. For this purpose he has constructed a pile of 6,000 small couples, and with it he produces two powerful lights (or four lights of half the brilliancy). The E.M.F. of this battery is said to be 216 volts, and the resistance 31 ohms. Coke is used as the heat source, the consumption being 10 kilogrammes per hour. A small pile of the same number of pairs, and said to be of equal power, consumes only 6½ kilogrammes per hour.

If a thermo-pile be short-circuited, its effectiveness is reduced, the powerful current flowing through it tending to heat the cool junctions and cool the hot ones. In an elaborate and exhaustive paper upon M. Clamond's battery, read by Mr. Latimer Clark before the Society of Telegraph Engineers in 1876 (to which we are indebted for many of the above facts, as also for the illustrations), it was shown that a battery, short-circuited by a resistance equal to its own, had its E.M.F. rapidly reduced by 17 per cent. The pile may, conversely, be "polarised," by passing a powerful current through it, the effect being to heat one series of junctions and cool the alternate ones, thus leaving the pile in a condition to give out a sensible current. This follows from what has already been said respecting Sir William Thomson's and M. Peltier's investigations.

One of the chief applications of the thermo-pile is the deposition of metals. Mr. Clark states that in practice it was found that a battery of 375 pairs, having a resistance of 2·5 ohms, and a tension of 146 volts, deposited about 180 grains of copper per hour. He also points out, however, that these figures do not represent the effectiveness of the battery, as a similar deposition could have been produced in several successive cells.

In 1876 and 1877, Messrs. Crompton and L. Wray obtained patents for improvements in thermo-piles. These improvements may be summed up as follows. The bars (alloy of antimony, zinc, and iron) are cast under pressure; this increases the E.M.F. A strip of tinned iron is cast in them, extending nearly through their entire length; this adds materially to their strength, and to some extent increases the E.M.F., and decreases the resistance. The successive layers of couples are supported by a metal framework, the weight of the upper layers being thus prevented from falling upon the lower ones. An internal cylinder of earthenware is employed to keep the flame from impinging directly upon the bars, and also to cause the bars to cool more slowly, fractures being thus avoided. The supply of gas and air is regulated, and a wire-gauze chimney is used to prevent explosions.

M. Noë and M. Sudré have introduced important

modifications of the thermo-pile; but as these have been fully described in this Journal (June 15 and July 1, 1879), we need not refer to them here.

The following are some of the principal points to be observed in the construction of the thermo-electric battery:—

1. The materials should not be costly.
2. They should not be liable to fuse.
3. They should be protected from sudden heating and cooling.
4. They should not be acted upon by the products of combustion; or they should, at any rate, be protected therefrom, and from the deposition of moisture.
5. The disposition should be such as to allow a defective pair to be easily replaced.
6. The whole combination should possess strength and solidity.

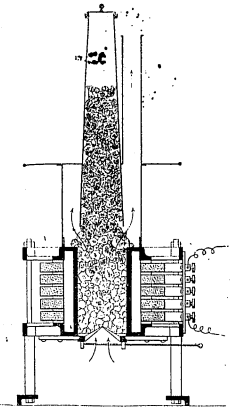


FIG. 4.

The present article is written in the hope that our countrymen will take up the subject and show that this branch of electrical science has not been abandoned to continental inventors.

Journal of the Telegraph.

A New Thermo-Electric Battery.

M. CLAMOND, a French electrician, has succeeded in devising a thermo-electric battery, producing a current sufficiently powerful to yield the electric light. A factory in Paris is now, indeed, lighted by this means. The apparatus consists of three parts: an inner one, composed of pieces of iron arranged in the form of a crown, which can be heated in the interior. This is called the collector, its purpose being to collect the heat and then communicate it to the adjacent thermo-pile proper. This consists of a flexible cloth, of any desired length, composed of cubes of antimony and zinc, soldered together by sheets of tin. In the complete apparatus there are 6,000 of these "couples," outside which are fixed the plates of copper to diffuse the heat of the collector. A large surface is thus exposed to the air, in order that as great a difference of temperature as possible may be maintained between the collector and the diffuser, for upon this difference the strength of the current chiefly depends. M. Clamond has been so successful that with one of his batteries he has been enabled to light two of Serrin's lamps, and with a smaller but equally powerful battery he can light four less brilliant lamps. This is done with the consumption of nine kilogrammes, or about twenty pounds of coke an hour for the larger, and six and one-half pounds for the smaller thermo-electric battery. The apparatus, moreover, gives warmth as well as light, since its large exterior surface causes it to radiate a considerable quantity of heat.

"The production of heat by friction may be readily exemplified by the following experiment due to Tyndall. A glass tube containing water (fig. 310), and closed by a cork, can be rotated rapidly about its axis. While thus rotating, it is pressed by two pieces of wood, covered with leather. The water is gradually warmed, and finally enters into ebullition, when the cork is driven out, followed by a jet of steam. Friction, then, may produce an intense heating of the bodies rubbed together, without any corresponding loss of heat elsewhere."

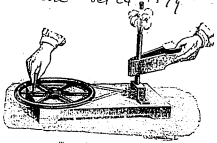


Fig. 310. Heat produced by Friction.

"The relations existing between electrical and thermal phenomena had considerable influence in leading to correct views regarding the nature of heat. An experiment devised by Foucault illustrates these relations, and at the same time furnishes a fresh example of the production of heat by the performance of mechanical work.

"The apparatus consists (fig. 312) of a copper disc which can be made to rotate with great rapidity by means of a system of toothed wheels. The motion is so free that a very slight force is sufficient to maintain it. The disc rotates between two pieces of iron, constituting the armatures of one of those temporary magnets which are obtained by the

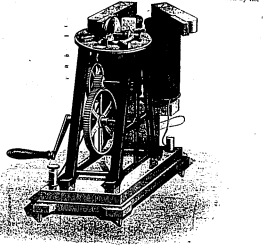


Fig. 312. Foucault's Apparatus.

passage of an electric current (called electro-magnets). If, while the disc is turning, the current is made to pass, the armatures become strongly magnetized, and a peculiar action takes place between them and the disc, consisting in the formation of induced currents in the latter, accompanied by a resistance to motion. As long as the magnetization is continued, a considerable effort is necessary to maintain the rotation of the disc; and if the rotation be continued for two or three minutes, the disc will be found to have risen some 50° or 60° C. in temperature, the heat thus acquired by the disc being the equivalent of the work done in maintaining the motion. It is to be understood that, in this experiment, the rotating disc does not touch the armatures; the resistance which it experiences is due entirely to invisible agencies."

"The most precise determination yet made of the numerical relation subsisting between heat and mechanical work was obtained by the following experiment of Joule.

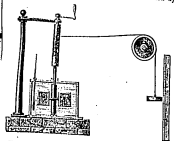


Fig. 313. Determination of the Mechanical Equivalent of Heat.

He constructed an agitator which is somewhat imperfectly represented in fig. 313, consisting of a vertical shaft carrying several sets of paddles revolving between stationary vanes, these latter serving to prevent the liquid in the vessel from being bodily whirled in the direction of rotation. The vessel was filled with water, and the agitator was made to revolve by means of a cord, wound round the upper part of the shaft, carried over a pulley, and attached to a weight, which by its descent drove the agitator, and furnished a measure of the work done. The pulley was mounted on friction-wheels, and the weight could be wound up without moving the paddles. When all corrections had been applied, it was found that the heat communicated to the water by the agitation amounted to one pound-degree Fahrenheit for every 772 foot-pounds of work spent in producing it. This result was verified by various other forms of experiment, and may be assumed to be correct within about one foot-pound."

Sur les appareils thermo-électriques de M. Clamond

Nous avons assisté, rue Saint-Ambroise, dans les ateliers de M. Denayrouse, à une expérience de lumière électrique faite avec un régulateur de M. Saisse et une pile thermo-électrique de M. Clamond.

Nous devons dire que l'effet général a été des plus satisfaisants. La régularité était très-grande et les interruptions excessivement peu fréquentes. Ses petites éclipses n'avaient pas une durée qui pût être gênante même pour les ouvriers d'art travaillant dans ce vaste atelier.

Si, au lieu de nourrir un seul bec, la pile Clamond avait pu donner de la lumière à deux ou à trois, il est incontestable que les petites irrégularités eussent été parfaitement indifférentes à l'œil.

Nous nous sommes retiré fort enchanté de l'expérience, qui se répète, paraît-il, quotidiennement et qui a duré, devant nous, un temps plus que suffisant.

M. Denayrouse nous a annoncé de plus que les chaînes thermo-électriques qui garnissent son poêle ont une durée en quelque sorte indéfinie. C'est un fait que nous n'avons pu vérifier et pour lequel nous devons nous rapporter à la bonne foi de notre informant; mais les chaînes que nous avons examinées nous paraissent en parfait état de service et n'avoir subi aucune espèce d'altération.

M. Denayrouse annonce que la quantité de lumière qu'il produit brûle neuf kilos de charbon par heure, ce qui est considérable par rapport à ce que consomme une machine dynamo. En effet, pour produire la même lumière avec des courants d'induction et un moteur fort ordinaire, on ne dépenserait point quatre kilos à l'heure. Mais il importe de faire à ce propos quelques remarques fort intéressantes.

D'après les calculs et les observations qu'il a faites, la lumière produite ne représente que 6 0/0 du chimique correspondant au charbon consumé.

Il en résulte que l'on peut concevoir facilement que la thermo-électricité n'est point arrivée à ses colonnes d'Hercule.

M. Denayrouse annonce, ce qui ne nous paraît point exagéré, qu'il est certain de produire la même effet avec six kilos de dépense horaire dans un foyer actuellement en construction.

En outre, si l'on place la pile Clamond dans un atelier où il y ait besoin de se chauffer, il est clair que les 91 0/0 qui restent de chaleur produite seront parfaitement utilisés.

La lumière produite ne coûtera dans ce cas que les 6 0/0 de 6,000 grammes, soit 360 grammes, ce qui est un prix parfaitement insignifiant.

Dans le cas où l'on ne pourra pas placer le poêle dans l'intérieur d'un atelier, on pourra monter un calorifère chauffé avec la chaleur perdue de la pile Clamond.

Nous dirons même que nous avons rencontré dans l'atelier de M. Denayrouse deux habiles chimistes belges établis à Nancy qui, ayant besoin de calorifères, ont ordonné qu'on les construisît de manière à pouvoir les revêtir avec les chaînes thermo-électriques de M. Clamond.

W. DE FONVIELLE.

Le degré de précision de nos mesures est mis en évidence par la petitesse des erreurs des quatre fractions qui forment notre quadrilatère de jonction. Ces erreurs, successivement de corrections, lorsque les lignes sont égales, ou résultats d'une, à

$$+0'',18, -0,54, +1'',8, -1'',12,$$

et ne dépassent pas, comme on le voit, les erreurs de ce genre qu'on rencontre dans les meilleures triangulations où les côtés ne dépassent pas 6 à 10 lieues.

Le problème de la position géodésique des deux extrémités est donc résolu, et le méridien de France s'étend aujourd'hui en une extension depuis les îles Shetland jusqu'en Sicile.

Commandant PERRIER,
Membre de l'Institut des Sciences.

La suite prochainement.

LES CONDITIONS CLIMATOLOGIQUES
DU DÉPARTEMENT DE LA MANCHE.

M. Henri Mangon a récemment présenté à l'Académie des sciences et à la Société d'agriculture, une très intéressante étude météorologique sur le climat d'une partie de la Normandie et sur l'influence qu'il exerce sur la maturité des récoltes.

« *Température.* Le climat maritime des côtes de la Manche, dit le savant professeur, est remarquable par sa douceur et sa régularité. La température moyenne des mois les plus froids de l'année est très supérieure à 0 degré. Habituellement, il gèle seulement un peu pendant quelques nuits de l'hiver et il n'est rare que la neige du sol ait la température soit inférieure à 0 degré. L'hiver de 1870-1871 constitue une exception des plus extraordinaires. La moyenne du mois de décembre 1870 a été de + 2°,3 au lieu de + 5°,01, et celle de janvier 1871 de + 2,15, au lieu de 5°,62. La température a descendu à — 8°,5, le 27 décembre 1870, et à — 11 degrés pendant les nuits du 2 et du 4 janvier 1871.

« La chaleur de l'été est aussi modérée sur nos côtes que le froid de l'hiver est peu intense. La température de juillet est de 17°,11. En 1876, elle a atteint le chiffre de 18°,06, et la plus haute température observée a été de 25°,4 le 25 juillet, de 28°,3 à l'ombre en 1870, époque, d'ailleurs, que des changements assez brusques entre le milieu du jour, le soir et le matin.

« Quand un sérieux de la côte, on remarque des figures très légères au branchement de la carte de bleu à brun gris. Les lignes sont bonnes et suivent tous les ans. Le raisin, au contraire, ne se sur les espaliers les mieux exposés, arrive très rarement à maturité.

« *Pluies.* Au point de vue de l'agriculture on ne peut pas caractériser un climat par la température seulement. La distribution par saison des pluies est un élément indispensable à connaître. Dans la Basse-Normandie, la hauteur moyenne annuelle de pluie est de 85^{cm},19, chiffre dépassé dans beaucoup de localités moins exposées, et qui excède de un mètre celui qui exprime la hauteur de la pluie à Paris. Le maximum de la pluie est en juin, pour le mois entier, de 8^{cm},15. Le minimum est en novembre et est égal à 6^{cm},05. En juillet et août la pluie est assez abondante et assez bien répartie pour qu'elle n'ait pas besoin d'être remplacée par l'irrigation. Le mois de septembre est le plus sec. Il est suivi de près par le mois de février. Le nombre de jours de pluie est de 150 environ. Il est plus grand en hiver qu'en été, mais la quantité absolue de pluie n'est pas très considérable dans le Bocage, les orages sont très rares et se distribuent d'une manière régulière entre les différents mois de l'année. Les averses sont donc très nombreuses et peu abondantes.

« Ces pluies fines, et en fréquentes, combinées avec une température douce et régulière, caractérisent et favorisent une région de pâturages. Si l'on ajoute à l'action sur la végétation, qui assure l'alimentation permanente à l'herbage par de l'eau fraîche, on comprendra les causes de la richesse et de l'étendue. »

Après ces documents météorologiques, l'auteur étudie l'influence du climat sur le développement et la maturité des plants de grande culture, a été conduit aux conclusions suivantes :

1° Dans un climat doux et régulier, comme celui où ont été faites ces observations, il y a presque toujours avantage à faire de bonne heure les semis d'automne.

2° On peut calculer avec une grande exactitude, un mois ou six semaines à l'avance, l'époque de la récolte d'a plantes dont on vient de parler, en faisant chaque année la somme de degrés de température observés depuis les semis, en excellant les tableaux numériques des observations moyennes de température.

—o—

CORRESPONDANCE

Monsieur le Rédacteur,

Permettez-moi, à mon tour, quelques observations au sujet de l'article de M. Jousset de Bellesme sur la manière dont certaines chrysalides de certaines espèces de papillons (Attacus, n° du 10 janvier 1880). J'ai publié en 1868 dans les Annales des Sciences naturelles (t. XXVIII, 5e série) un long mémoire sur la glande mandibulaire des insectes. Dans le chapitre consacré aux nymphes, j'ai démontré par de nombreuses expériences sur diverses espèces, entre lesquelles celle du Bombyx du mûrier, que le cocon est destiné à protéger et à diminuer l'évaporation des chrysalides, comme l'avaient admis par Réaumur et bon nombre des naturalistes, la dessiccation est retardée pour les chrysalides ainsi, et non le froid. Quand on les retire immédiatement du cocon, en exposant, au moyen d'instruments délicats, quelles ont toujours à la surface un pli rempli de température ou l'air ambiant, mais privé du cocon, leur surface s'hiver souvent un peu au-dessus de cette température, environ 1°, quelles épuisent une diminution rapide de poids.

Agréez, etc.

MAURICE GIRARD.

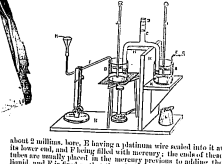
La Nature
LA PILE THERMO-ÉLECTRIQUE
DE M. CLAMOND

Si l'on mesure l'importance d'un problème au nombre des solutions proposées pour le résoudre, le premier rang appartient, sans aucun doute, à la production *économique et pratique de l'électricité*. Les méthodes connues peuvent se diviser en trois grandes classes :

THERMO-ELECTRIC BEHAVIOUR OF AQUEOUS SOLUTIONS WITH MERCURIAL ELECTRODES.

BY C. GOOD, M.A., F.R.S.*

In order to investigate this subject I devised and constructed the following apparatus:—A and B are two thin glass basins, 81 millims. internal diameter (= 5,153 sq. millims. of mercury surface), and 0·6 centims. deep; each containing a layer of mercury about 2 centims. thick, covered by a layer about 3 centims. deep of the aqueous solution to be examined. C is a thin bent glass tube, about 2 centims. diameter, filled with the liquid, and closed by means of a bung at D. E and F are stout glass tubes,



about 2 millims. bore, E having a platinum wire sealed into it at its lower end, and F being filled with mercury; the ends of these tubes are usually placed in the mercury previous to adding the liquid, and the E fixed so that the solution cannot enter it. G and H are terminal wires of platinum, touching the mercury but not the liquid. I and J are thermometers, with their bulbs immersed in the pools of mercury. Each cup is closed by a bung (not shown in the sketch) to prevent loss of liquid by evaporation, also to support the thermometer and keep the tubes steady. The whole is supported on wire gauze placed upon an iron tripod, with a Bunsen's burner beneath, and A is placed on a shelf level with it. K K K K is a wooden frame for supporting the apparatus, and L is a weight to keep it steady. This kind of apparatus was used in all the experiments, and acted very satisfactorily, I devised one of different construction for a similar purpose many years ago. (See *Phil. Mag.*, June, 1870).

The mercury employed was prepared by distilling the ordinary mercur in vacuo, and then shaking it strongly in succession with nitric acid, water, solution of cyanide of potassium, distilled water, and filtering it. Distilled water was used in making all the solutions.

In using the apparatus the mercury was first poured into the basins; the tubes E and F placed, taking particular care that the mercurial column in F made contact with the pool very completely. Two very small holes 1 millim rubber bungs were next inserted in the lower ends of the bent tube C, the tube then put in position, and filled with the liquid. The solution was now put into the basins, the long F inserted tightly, the shallow ones plattened of the exact height inserted in A and B. The contacts to the instrument, and, if necessary, a minute swing of the needle was obtained by repeated suction at proper intervals of time. It was now heated. About seven or eight minutes was usually occupied in bringing the temperature to the required number of degrees, the deflections at the various temperatures being noted. After an experiment had been made, the mercury and solution of both vessels were mixed and cooled, and the experiment filtered, before repeating it with the same liquid.

Care was taken to select solutions which had the least amount and less positive metals were, therefore, not employed. No liquid was used which precipitated any visible film or dulness upon that metal when treated with it. It was found necessary to heat each solution to about 180° F., and keep at, and then cool it previous to making experiments, otherwise the results obtained in repetition experiments were not quite uniform. In a previous research on the thermo-electric properties of liquids ("Proc. Roy. Soc." No. 188, 1878, pp. 513—520), in which platinum electrodes were employed, such previous heating was less necessary, probably because the thermo-electric currents were then stronger. After heating and cooling the liquid, it was freely shaken with the mercury, and then filtered, previous to making experiments with it. With every liquid, one or more repetition experiments were made in order to obtain uniform results and confirm their reliability; the amount of difference of deflection of the needles in such experiments did not exceed one degree. The galvanometer employed was an astatic one, having two coils, each of 50 ohms resistance, the two being connected and used as one of 100 ohms resistance.

I have ascertained by separate experiments of a different kind that mercury, when sufficiently agitated with solutions, neutral to test papers, or salts of the alkali metals, renders some of those liquids feebly alkaline; the effect, however, is so slight, requires such extensive and long-continued contact of the substances, that it appears consistent with the view that chemical action is not the cause of the currents in these thermo-electric experiments.

By arranging the results in a series with the solution at the top, in which the hot mercury was the most positive at 180° F., and that at the bottom in which it was most negative, the following order was obtained. The horizontal line separates those liquids in which the hot metal was positive from those in which it was negative.

	Amount of deflection.
1. Phosphate of ammonium	28·0+
2. Carbonate of sodium	19·0
3. Sulphide of sodium (50 grs.)	13·0
4. Sulphate of ammonium	12·75
5. Carbonate of potassium	12·5
6. Sulphate of potassium	12·0
7. Borax	10·0
8. Nitrate of potassium	10·0
9. Nitrate of strontium	10·0
10. Nitrate of sodium	8·0
11. Phosphate of sodium	8·0
12. Nitrate of barium	7·5
13. Nitrate of sodium	6·0
14. Formiate of sodium (100 grs.)	6·0
15. Ferrocyanide of potassium	5·0
16. Formic acid (30 minims)	5·0
17. Nitrate of ammonium	4·25
18. Formiate of sodium (50 grs.)	4·0
19. Selenic acid (20 minims)	3·75+
20. Formic acid (40 minims)	3·5
21. Sulphate of sodium	2·5
22. Bicarbonate of sodium (10 grs.)	2·5
23. Microcosmic salt (100 grs.)	2·0
24. Boracic acid	2·0
25. Selenic acid (10 minims)	1·5
26. Sulphuric acid (1 in 80)	1·25—
27. Ammonia alum (50 grs.)	2·0
28. Cyanide of potassium (25 grs.)	2·0
29. Hyposulphite of sodium	1·0
30. Ammonia alum (100 grs.)	1·0
31. Sulphuric acid (1 in 20)	0·75
32. Sulphuric acid (1 in 40)	0·75
33. Sulphuric acid (1 in 80)	0·0
34. Cyanide of potassium (5 grs.)	1·0
35. Cyanide of potassium (50 grs.)	4·0
36. Cyanide of potassium (100 grs.)	9·0

To ascertain whether this order agreed with that of a series arranged according to the different degrees of electropositive force of the various couples, I simultaneously employed two apparatuses similar to that already described (but with basins of 75 millims. internal diameter), changing one of them with one solution, and the other with another which was next to it in the above series, connecting them with the two wires respectively of the differential galvanometer, so that their currents circulated in opposite directions through the coil of thin insulated wire, ascertaining which gave the strongest current at 180° F. By this means the following series was obtained, in which the couple giving the strongest positive current is at the top, and that giving the most powerful negative current at the bottom of the series. The horizontal line separates those liquids in which the hot metal was positive from those in which it was negative. The relative positions of the solutions in the two series, although they agree in the main, are not identical; for instance, nitrate of potassium occupies the eighth place in the first series, and the second place in the second series; phosphate of ammonium, sulphate of ammonium, &c., are also changed in position. Such changes were probably affected by the circumstance, that whilst in the first series the electrodes were 81 millims. diameter (=5,153 sq. millims. of surface), and the current from a single apparatus circulated through a continuous double length of wire in the coil of the galvanometer, in the second series the electrodes were only 75 millims. diameter (= 4,418 sq. millims.), and

the current from a single apparatus circulated through a single half length of the coil. The temperatures at which the deflections were noted were also different in the two series. The surface of one electrode in the smaller apparatus was about $\frac{1}{7}$, and in the larger one $\frac{1}{9}$ of that of one of the platinum electrodes in the apparatus already referred to.

	Difference of amount of deflection.
1. Sulphate of ammonium	19+
2. Nitrate of potassium	19
3. Phosphate of ammonium	19
4. Sulphide of sodium (50 grs.)	19
5. Carbonate of sodium	0·75
6. Carbonate of potassium	1·0
7. Sulphate of potassium	1·5
8. Nitrate of strontium	0·25
9. Phosphate of sodium	0·25
10. Borax	0·25
11. Selenate of sodium	1·5
12. Nitrate of barium	0·25
13. Nitrate of sodium	1·0
14. Formiate of sodium (100 grs.)	1·0
15. Microcosmic salt (50 grs.)	0·75
16. Formiate of sodium (50 grs.)	0·75
17. Formic acid (30 minims)	2·0
18. Nitrate of ammonium	2·0
19. Sulphate of sodium	2·5
20. Sulphite of sodium (10 grs.)	0·25
21. Microcosmic salt (100 grs.)	0·25
22. Boracic acid	2·0
23. Ammonia alum (25 grs.)	very slight —
24. Cyanide of potassium (25 grs.)	0·75
25. Ammonia alum (100 grs.)	1·0
26. Hyposulphite of sodium	1·0
27. Cyanide of potassium (5 grs.)	3·0
28. Cyanide of potassium (50 grs.)	12·0
29. Cyanide of potassium (100 grs.)	2·25

Remarks.—Many of the remarks which I have made in a previous paper on the thermo-electric properties of liquids ("Proc. Roy. Soc." No. 188, 1878, pp. 513-518) respecting the cause of the currents, apply to the results obtained in the present research; and I consider that the causes of the currents and of their direction are similar in the two cases.

On examining the results it will be observed that the effects are not, manifestly related to the chemical nature of the solutions; thus, the liquids in which hot mercury is positive include those of acid, as well as those of alkaline reaction; and similarly with the substances in which cold mercury is positive. To what extent chemical action occurred in the experiments and operated as a cause of electric currents, would be a difficult point to examine, because the amount required to produce such feeble currents would be so extremely small; the result of a general examination of the phenomena, however, does not support the hypothesis that the currents were of chemical origin.

The evident cause of the currents was heat, and the direction of them was probably due to molecular changes in the liquid attendant upon alteration of temperature. In nearly all cases the magnitude of the current increased with the amount of difference of temperature; the apparent, but not real, exceptions were those in which the current was concentrated from or occurred.

The strength of the solution manifestly affected the quantity, and in some cases the direction of the current, as may be perceived with the solutions of potassic cyanide (Nos. 1, 2, 3, and 4), selenic acid (Nos. 5 and 6), ammonia alum (Nos. 7, 8, 9, and 10), potassic alum (Nos. 11 and 12), sulphuric acid (Nos. 15, 16, and 17), and phosphate of sodium and ammonium (Nos. 33 and 34). If the cause of the current, in the case of sulphuric acid, was chemical action, the direction of the current would probably not have been reversed by mere alteration of temperature, or by variation of strength of the mixture. If, also, the cause of the currents in general was of a chemical nature, the currents would probably have been stronger generally with the stronger solutions, and would have increased in all cases, with the strength of the solution, until the latter was much more concentrated than those which were employed.

Stirring either portion of the liquid influenced the deflection in 50 cases out of 72, increased it in 40, and decreased it in 10 of those cases. Stirring the cold portion altered the current in 21 cases out of 36, and stirring the hot portion changed it in 29 cases out of 36. Stirring the cold portion also had a greater average magnitude of effect upon the current than stirring the hot portion. Stirring a liquid of acid reaction increased the current in 13 cases out of 20, decreased or reversed it in 3 cases, and had no effect in 4 cases. Stirring an alkaline one increased the deflection in 12 cases out of 24, decreased it in 5, and had no effect in 7. The effects of stirring upon the amount of deflection were greater in alkaline liquids than in those of acid reaction.

INFLUENCE OF PREVIOUSLY HEATING THE SOLUTION.—Having observed, even with solutions formed with water which had been prehaded to expel dissolved air, that unless such liquids be heated further heated to 180° F., and cooled, after the salt, &c., had dissolved, the currents obtained in successive experiments with such a solution were not quite uniform in amount, but always decreased, I examined this circumstance.

Twenty ounces of distilled water were boiled and cooled; the salt to be employed was then dissolved completely in it, and the solution shaken with pure mercury. The mixture was then divided into two equal portions, one of those portions raised to a temperature of 180° F. in a covered glass vessel, and the evaporated water condensed and returned to the mixture, so that the solution remained unaltered in composition; the liquid was then cooled. These preheated and non-preheated portions were employed respectively to charge the two apparatuses already described. The two thermo-pairs were then simultaneously excited, their currents allowed to circulate in opposite directions through the coils of the galvanometer, and the deflection noted when the hot portions of the two liquids had simultaneously acquired a temperature of 102° F. The following is a brief statement of the results:—

Twenty ounces of distilled water and 200 grs. of crystals of sodic phosphate. The non-preheated portion of solution yielded the strongest current; deflection 1°.

Twenty ounces of water and 2 ounces of sulphuric acid. The non-preheated portion gave the strongest current; deflection 25°.

Twenty ounces of water and 200 grs. of boric nitrate. The non-preheated portion yielded the strongest current; deflection 1°.

The same mixture as the last; one portion of the solution was preheated with mercury, instead of being preheated alone. The non-preheated portion gave the strongest current; deflection 1° at 180° F.

In each of these five experiments the non-preheated portion of liquid yielded the current of greatest electromotive force. This accords with the previously stated observation that repetition experiments always yielded weaker currents.

In order to ascertain whether preheating the one portion of salt before dissolving it had the same effect upon the current as heating it after it had been dissolved, the following experiments were made:—Preboiled and cooled 20 ozs. of distilled water, and divided into two exactly equal portions. Took two portions of 50 grs. each of partly dehydrated sodic carbonate; heated one portion to 180° F. for fifteen minutes until it ceased to evolve moisture (it lost 12·4 grs.), and cooled it. Dissolved the two separate portions of salt in the separate quantities of water, and treated the solutions against each other in the two apparatuses. No difference in the direction of current occurred at any temperature up to that of 180° F.

In another experiment of this kind, 200 grs. of ammonia alum were divided and treated as above. The solution of the non-preheated salt gave the strongest current; deflection 72° at 180° F.

Remarks.—The conclusion I draw from these last two experiments and results, combined with those of the previous ones, is that preheating the salt either before or after solution usually lessens the current, both in thermo-electric experiments, and in thermo-electrogenetive liquids.

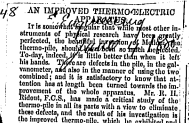
In the several classes of cases described in this paper, it is evident that the currents are not due to chemical action, but to molecular changes and alterations of molecular disturbance, and that the difference of electromotive power in different liquids is not due to differences of chemical action, but probably to differences of molecular arrangement of the solutions. Also that in the class of experiments where the liquids compared had the same chemical composition, but had been differently treated, the differences of molecular arrangement were less, and the currents obtained were consequently more feeble. A difference of strength of current caused by repetition of experiments, or by continuance of heat, also renders manifest the change of molecular arrangement; and the above method may be employed for detecting molecular differences in conducting liquids having the same chemical composition.

In the class of cases in which the differences of molecular arrangement were the least, and the currents the most feeble, the direction of the currents was the most uniform. This is in accordance with the common truth in science that the smallest phenomena are the most constant.

* Abstract of a Paper presented to the Royal Society.

AN IMPROVED THERMO-ELECTRIC APPARATUS.

It is somewhat singular that while most other instruments of physical research have been greatly perfected, the [illegible] apparatus, the thermo-pile, should [illegible] as much. To-day, indeed, it is little better than when it left his hands. There are defects in the pile, in the galvanometer, and also in the manner of using the two combined; and it is satisfactory to know that attention has at length been turned towards the improvement of the whole apparatus. Mr. H. H. Sidnell, F.C.S., has made a critical study of the thermo-pile in all its parts with a view to eliminate these defects, and the result of his investigation is the improved thermo-pile, which he exhibited and described recently to the Physical Society.



As ordinarily made the thermo-electric metal junctions of the pile are too deep. Fig. 1 represents the usual method of soldering the metals, bismuth (Bi) and antimony (Sb), to form the junction J, and the consequence is that one side of the junction is better than the other, the result being that a local current is set up which short-circuits itself through the junction. Mr. Hildust avoids this waste of energy by placing the bars in a glass tube T, and constructing the junctions as shown in Fig. 2, where the bismuth (Bi) is connected to the antimony (Sb) by a little piece of copper (Cu) soldered on. The junctions at one side in the cold, while that at the other is the hot; W W are connecting wires. Again, the ordinary bars are too long and give unnecessary resistance, the mass of matter to be heated too great, and the junctions too little or slender. In the new pile these defects are obviated by making only a single pair, and that of small length, and using

[illegible]

The faults of the galvanometer commonly employed are that the space between the needles, which is the most effective part, is not utilised by the wire; the needles are not of the best shape, and the suspension is troublesome. Mr. Hildust's remedies consist in forming the wire of a flat ribbon of copper wound on one bobbin brought close to the needles, which are flat oblong bars taken from the

[illegible]

heat; and the pile and galvanometer are connected to begin with, when in reality they should not be put in circuit with each other until the pile has been exposed for a short time to the source of heat, so as to prevent the current generated itself abstracting heat from the hotter side of the pile, and conveying it to the cooler side, thereby lessening the difference of temperature between the two junctions and lowering the efficiency of the pile.

As constructed by Mr. Browning, the well-known optician, the new instruments is very sensitive and simple. It consists of a single pair of bismuth and antimony bar $\frac{1}{2}$ in. long, and $\frac{1}{10}$ in. thick; the junction being formed by a circular wafer or fish plate of copper about $\frac{1}{32}$d in. thick, and $\frac{1}{4}$ in. diameter, firmly soldered to the ends of the bars. The external surface of the wafer is coated with bichloride of platinum overlaid with lamp-black fixed with very dilute negative varnish of photography to render it highly absorbent of heat. The pile is supported by stout copper terminals above the galvanometer on the same board, as shown in Fig. 4.

The galvanometer consists of a coil wound with 20 turns of copper ribbon insulated with a coat of shellac varnish, and a pair of astatic needles, 1 in. long, and $\frac{1}{2}$ in. wide, made as already described and supported in an aluminium cradle on a fine wire turning in an agate cup. A contact key K is placed at one side and makes the only contact required, that between the pile and coil in the middle of the apparatus.

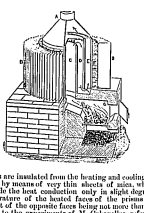
The whole is enclosed in a glass shade having an aperture B at the height of the front of the pile. A glass cone protects the front face of the latter from extraneous radiation, and a glass screen the back face. A directing magnet, N S, placed over the pile, is for adjusting the zero of the needles so as to enable the instrument to be used in any position with respect to the earth's magnetic meridian. In using the apparatus the source of heat being placed in front of the pile, the glass shade is turned round till the aperture is over against the front face of the pile, and after some 30 seconds' exposure contact is made between the pile and galvanometer by means of the key, and the deflection read off and noted.

So delicate is the apparatus that a distinct deflection was obtained from the radiation of a person standing 5 ft. distant, the temperature of the air being about 12 deg. Fahr. The fluno of a common candle affects the galvanometer when placed 3 ft. away. The pile shows that the walls of a room are at different temperatures; and in clear weather the radiation from stellar space is very evident. The new pile is moreover very convenient and portable; according to Mr. Hildust it can be got ready for use in about half a minute, while with the ordinary thermo-pile, the preparatory adjustments generally take up as much time as the experiments themselves.

THE NEW THERMO-ELECTRIC BATTERY OF M. CLAMOND.

In [illegible] to the patents of M. Snider (who is understood to be working in conjunction with M. Clamond), my [illegible] which [illegible] the [illegible] in the new form of thermo-electric battery [illegible] M. Clamond. This, as shown by our illustration, is constructed in the form of a stove, by means of which the apparatus for heating and lighting a building may be combined.

The elements of the battery (exhibited at 5) are constituted by pieces of an alloy of antimony and bismuth, connected by strips or "armatures" of cast iron; "chains" of 50 elements being produced at one casting. The iron strips connect the right-hand face of one prism with the left-hand face of the next in order, so that one set of alternate junctions becomes heated, whilst the other set becomes cooled by the "diffuser" (D). The middle portion of the strip is of about the same size as the side of the prism, and the strips are cut with three projections or teeth, which are twisted cork-screw-fashion, so as to obtain a good hold of the metal. A series of these "armatures" being arranged in a special mould, with their twisted projections bent at right angles, and the middle portions surrounded with asbestos cardboard, the alloy is run into the mould, filling the spaces between these projected middle portions, and the chain is complete. In the battery of 3,000 couples there are 60 chains of 50 couples each, and these chains may be connected either in series or in "multiple arc." The face of the prism is about 3 cm. square, and the thickness is 2 cm.



The chains are insulated from the heating and cooling surfaces (at E and B) by means of very thin sheets of mica, which, it is stated, impede the heat conduction only in slight degree. The mean temperature of the heated faces of the prisms is about 350° C.; that of the opposite faces being not more than 80°.

According to the experiments of M. Colsandlas, referred to in *La Nature*, the electromotive force of a battery of 3,000 elements, in single series, is 109 volts (equal to about 60 Bunsen cells); whilst the internal resistance is 12·5 ohms.

In regard to fuel consumption, the largest battery hitherto constructed, composed of 6,000 couples, consumed from 9 to 10 kilograms (20 to 22lb.) of coal per hour, whilst working two Serrin lamps, the light from each of which varied from 30 to 50 Carcel *bees*. If this expenditure represented the lighting power only, the apparatus would certainly be defective from an economical point of view; but in the case when the thermo-pile can be utilised also as a stove for heating purposes. Nearly the whole of the heat produced by the combustion of the fuel is, in fact, available for such purposes. The measure of practical success that many attend the persevering and praiseworthy endeavours of M. Clamond is, we think, mainly dependent upon the question of the durability of the thermo-pile, which resolves itself into that of the effect upon it of a high temperature continuously maintained, and, what is more formidable, the effect of successive heating and cooling. The combination of the most effective and unobjectionable means of heating and lighting buildings is one of the most important and beautiful problems of practical science; and we shall be glad if M. Clamond, who has done so much in this direction, should succeed in practically establishing a claim to its full solution.

* *The Electrician*, Vol. III., p. 32.

THE THERMO-ELECTRIC FORCES BETWEEN METALS AND LIQUIDS.

Contact electricity has engaged the attention of physicists of late, not only in England, but in France, Germany, and Italy, by Becquerel, Buchwalds, and Pacinotti, and some interesting experiments have been made by M. Bouty, and brought before the French Academy of Sciences.

M. Bouty's experiments consisted in measuring the electromotive force developed when two plates of the same metal were plunged in two portions of the same liquid at different temperatures. To do this he employed the usual method of null-reading method, which consisted in compensating the electromotive force to be measured by a variable difference of potential derived from a circuit of known resistance traversed by a current from a Daniell cell. The arrangement comprised, last, the liquid and plates; these tubes being connected by a long capillary siphon, and plunging one in a bath of cold water, and the other in a water bath of which the temperature could be varied at will; 20d. A Daniell cell was chosen electrometer sensitive to galvanometer, and brought back to zero in each experiment by conveniently regulating the derived electromotive force. Two sensitive thermometers give the temperature of the electrodes, and an easy calculation furnishes the value of the thermo-electromotive force in a fraction of a Daniell. The use of an electrometer avoids the passage of a current in the derived circuit, and the consequent polarisation of the plates.

In general, the two plates are not completely identical, and a slight difference of potential in one direction or the other is observed between them when the baths are at the same temperature, but when a difference of temperature establishes itself the electromotive force in series, in general, very regularly, and returns to its first value when the temperature becomes again the same in both. The most important precaution is the necessary that the liquids should be prepared with distilled water deprived of air by recent ebullition; and also to abstain from raising the t

[illegible]

temperature above 50° or 60° in measuring, in order that the mercury of the electrometer should maintain itself at a fixed level. The agitation of the liquid, while being warmed or cooled is, in fact, accompanied by the production of thermo-electric forces [illegible] sometimes very considerable electromotive forces, which are in all cases observed by M. Bouty of concentric signs to the thermo-electric forces which they partially mask.

In cases where the metal is placed in contact with a solution of a salt of the same metal, for example, copper in contact with a solution of sulphate of copper, the thermo-electric force is approximately proportional to the difference of temperature of the two plates, and does not vary sensibly with the degree of dilutation of the salt. Its mean value for 1° centigrade is 0·000088 of a Daniell cell.

The salts of copper, zinc, cadmium, protoxide of iron, suboxide of mercury, chloride of gold, and chloride of platinum give also perfectly regular results. In all cases the warm metal is externally positive. M. Bouty's observations are summed up in the following table:—

Metal.	Liquid.	EMF for 1° C. at dif- ferences of each temperature.	Mean.
Platinum.	Chloride of platinum	0·000235	0·000234
Copper	Sulphate of copper	0·000088	0·000086
	Nitrate of copper	0·000084	
	Chloride of zinc	0·000077	
Amalgam of zinc.	Sulphate of zinc	0·000081	0·000075
	Nitrate of zinc	0·000069	
	Acetate of zinc	0·000075	
	Chloride of cadmium	0·000075	
Cadmium	Sulphate of cadmium	0·000086	0·000076
	Nitrate of cadmium	0·000074	
Mercury.	Nitrate of suboxide of mercury.	0·000140	0·000140
Gold	Chloride of gold	0·000024	0·000024
Iron	Sulphate of iron (ammoniacal)	0·000251	0·000092
	Sulphate of protoxide of iron	0·000090	
	Protochloride of iron	+0·000077	
	Acetate of iron	+0·000087	
	Tartrate of protoxide of iron	−0·000127	

It may be remarked in connection with these results that zinc and amalgamated is more or less heterogeneous and gives irregular results.

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It will also be observed that salts of the same oxide give very sensibly the same number, and that the numbers relative to copper and to amalgamated zinc are almost identical, hence the fact, long known, that the electromotive force of a Daniell element remains nearly constant in spite of temperature. In fact in the Daniell cell the potentials developed at the two poles act in contrary directions to modify by equal quantities the electromotive force of the element.

The regularity of the above results is not obtained when the cool metal is externally the positive pole. The metals possessing that property are often attacked by the liquid which touches them, and then, it may be said, the electromotive force is never constant; its variations range in certain cases from 1 to 100 or more of a Daniell cell to sometimes several hundredths, and measurement of it becomes uncertain. M. Bouty, nevertheless, gives the principal results of his experiments under these conditions as follows :—

Metal.	Liquid.	Mean E.M.F. for 1° C. (between 16° and 30° C.) Daniell.	Mean Daniell.
Silver	Nitrate of silver	0·000563	0·000592
	Silver bath for galvanoplasty	0·000260	
Iron	Per-chloride of iron	0·000176	0·00056
	Nitrate of iron	0·000409	
	Sulphate of per-oxide of iron	0·000410	
	Iron alum (alum de fer)	0·000134	
Nickel	Chloride of nickel	0·000208	0·00024
	Nitrate of nickel	0·000251	
	Sulphate of nickel	0·000309	

Magnesium and aluminium give values greater than the preceding, but very uncertain.

In most cases the variation of electromotive force ceased to be proportional to the temperature, the foregoing numbers being only means corresponding to differences of temperature of less than 20° C.

It may be remarked that salts of the same oxide form always sensibly the same numbers. The mean relation to the salts of the protoxide of iron is almost nothing, while for the salts of the sesquioxide it has a considerable negative value. Moreover, the electrometer betrays $\frac{1}{10}$ of sesquioxide of iron in a salt of protoxide. The sulphate of protoxide of commercial iron impurified behaves almost like a salt of peroxide.

The Thermo-Electric Power of Bismuth.

M. Exner, in a communication made by him to the Vienna Academy of Sciences, shows that the thermo-electric pile of Melloni is dependent on chemical as much as on thermic action. No current, he states, is generated if a pair of bismuth and antimony is plunged into nitrogen gas, whatever may be the temperature to which the junction is raised. The same result is obtained with many other metals. Not heat only, but chemical action must be brought into play to generate an electric current.

Electricity and Chemistry.

Herr Stroken contributes from experimental inquiry (*Wied. Ann.* No. 5), that the gases chlorine, bromine, and iodine, in regard to thermal behavior, form a group by themselves among bistomic gases. The ratio of the kinetic energy of the progressive motion of the molecules to the total energy is different for them from that for the others. In their molecules the atoms seem to have a different reciprocal action. From the behavior of bistomic gases it is inferred that neither Boltzmann nor Maxwell's supposition as to the nature of the mobility of atoms in the gaseous molecule has a general validity.

Thermo-electric Power of Iron and Platinum in Vacuo.—Professor C. A. Young, of Princetown, N.J., describes, in the November number of the *American Journal of Science*, an experiment on this question. It is stated that Exner a few months ago published a paper, asserting that the thermo-electric power of antimony and bismuth is destroyed by removing them from all contact with oxygen and immersing them in an atmosphere of pure nitrogen. From this he argues that the thermo-electric force in general is due to the contact of the gases which bathe the metals. The following experiment was tried to test the theory:—By the kindness of Mr. Edison and Mr. Upton a vacuum tube was prepared in Mr. Edison's laboratory, containing an iron wire about two inches long, firmly joined to two platinum terminals, which passed through the walls of the tube. The tube was exhausted until the spark from a two-inch induction coil would not pass $\frac{1}{4}$ of an inch in the gauge-tube, indicating a residual atmosphere of about one millionth. The wire was heated to incandescence during the exhaustion, in order to drive off any possible occluded gases. The platinum wires outside the tubes were joined to iron wires, the joinings being covered by glass tubes slipped over them, and a sensitive reflecting galvanometer was included in the circuit. By laying the tube and connected joinings in the sunshine, and alternately shading one or several of the joinings, it was found that the electromotive power of the joinings within the tube was precisely the same as that of those without, and the development of current just as rapid. There was no trace of any modification due to the exhaustion.

THERMO-ELECTRIC BATTERY.* OF M. NOE.

THIS battery is frequently used and has been experimented in Austria and Germany. It consists of different forms, of which the most useful, represented by Fig. 1, appears to us to be the best, since it requires only two Bunsen burners to set in

*Translated by the Alumnium.

action forty thermo-electric elements. There is another model, of sixty elements, with three burners, which offers the same advantages as the one represented. Each circular groove of twenty elements forms a complete circuit. We will confine the description of such a group:—The elements are arranged in a horizontal plane, radially; the heated junctions being towards the centre of the circle, and the cooled junctions at its circumference. The two metals are: 1st, German silver (called *maillechort* in France and *new Silver* in Germany), and, 2nd, an alloy of antimony and zinc which fuses at a temperature slightly higher than the melting point of antimony. These two metals are soldered to each other at the heated junction without the interposition of any other metal. The ends of the German silver wire are cast into a little capsule of brass, which forms the bottom of the mould in which the other metal is cast. This capsule is shown at *a* in Fig. 2, which represents two elements of the actual dimensions; it receives the wire of the element and forms part of the apparatus.

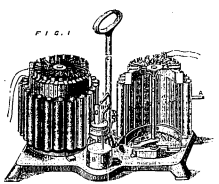
FIG. 1

Into the same capsule penetrates a small rod, *c*, of copper, the extremity of which is also enveloped by the cast metal; and by means of this rod the heat is conducted to the heated junction. The extremities of these copper rods are arranged in a circle around the axis of the battery, and between two plates of zinc, *e* and *f*, they all become heated by the same flame. In this manner the zinc plates are converted into hollow cylinders, which envelop entirely the flame of a spirit (wood-naphtha) lamp, *d*. The zinc plate has the effect of concentrating and directing the heat of the flame so to the copper rods. The object of using the copper rods at the heated junctions can be seen from the following:—The heated junctions of the elements are not sufficiently far from the flame, but only through the intermediary of the copper rod; it is therefore protected against any accident through overheating, *i.e.*, against the fusion of the alloy, which would cause the immediate breakdown of the battery. The result is the same partially, the loss of heat by radiation, when the battery rods are isolated, excepting at their extremities, within a small tube, shown at *i* in Fig. 2. The cooled junction is altogether dissimilar; the brass metal is here soldered to a plate of copper, to which is also soldered the German silver wire of the next element. This plate of copper is of large surface, forming a cylinder, and exposed to the air circulation, with the production of a cooling effect.

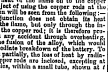
FIG. 2

These batteries have been subjected to careful experimental trial by M. Wallenhofen, of Prague; and the arrangement with the first of Noeren, and has found there to be most superior to it. It was found in the previous experiments at the Imperial Vienna, that the thermo-electric elements of Noeren may obtain an electromotive force of 1-15 volt, but this maximum is obtained only at a temperature close upon the fusing point of one of the alloys of which they are formed. Under similar conditions, M. Wallenhofen found that the Noe elements possess an electromotive force between 1-6 and 1-10 volt in practice, since they cannot be heated to the fusing point of the lead-and-zinc alloy, and when several elements are connected in series, they are never attained, because the elements are never equally heated. For ordinary experiments we may calculate upon 1-25 volt per element. The resistance of each element is 1-10 Siemens unit.

An improvement which is supplementary, but very useful in practice, consists of the addition of a regulator of the pressure of gas, by means of which the battery can be used in accidents which would cause it to be extinguished. It frequently sometimes happened that an unexpected increase in the gas pressure produced some fusion of the metal, and thus deteriorated the battery.

The safety apparatus here referred to, and which is shown in the front part of Fig. 1, consists of a glass bell-jar, open at the top, and closed by a cork. Two tubes enter this bell-jar through one cork; one, B, is a branch from the gas supply, and passes to the bottom of the vessel; the other, B, does not reach the surface of the water. Its use is to lead away any gas passing into the bell-jar, and conducting it to the small gas-jet, L, which, not constantly lighted, is only used to "test" the tubes; the tube B is closed by the water; if it should become too low the gas bubbles through the water and escapes at G, where it is inflamed. The apparatus thus constitutes a safety-valve, preventing the pressure from rising above a certain height; and can be regulated at will. The gas which escapes, when at too great pressure, cannot give rise to accidents.

With a battery of twelve elements, it is possible to work an electric bell; with twenty elements, water may be decomposed in the voltameter; with forty elements, a secondary battery can be charged, or an induction coil worked. In a word, these batteries are the best of the experimental, those for gilding, and small industrial operations, such as gilding, nickelling, &c., being carried into effect. One great advantage of this kind of thermo-electric motor is that it is set in full action in one or two minutes, and all experiments can be made in this short time. Lastly, amongst the current is no longer required, and the battery and thus is kept in order for a long period, the battery undergoing no alteration by use, as is the case of ordinary batteries have exceeded it, and which in a short time cause a considerable internal resistance, and a corresponding diminution of effect.

With these facts before us, we read without surprise the note by Professor O. Stone in our last issue, in which he says of a recently published "Record of the Progress of Astronomy during the year 1879," by Mr. Dreyer, of Dublin, one-third of the memoir is devoted to the result of astronomical work done in the United States.

An article on this subject would be incomplete without a reference to the very perfect work of Messrs. Alvan Clark & Son, of Cambridge, Mass., who appear to have distanced both the English and the Continental opticians in the excellence of their objectives, and who have secured to the United States the honor of supplying the objective for the great equitorial about to be manufactured for the Russian Government, to be used in the Pulkowa Observatory by the distinguished astronomer, Otto Von Streuve. We also notice that of the forty observatories recognized by the Smithsonian Institute, seventeen have telescopes made by this firm. In regard to the work now in progress at the Messrs. Clark's establishment, it may be stated without exaggeration that the world awaits with eager expectancy the result of their labors.

We record with pleasure the very perfect harmony with which American astronomers co-operate and work, which has doubtless been a leading point in gaining the successes that have been attained. This is in strong contrast with the constant bickering among members of the Royal Astronomical Society and many English astronomers, some of whom have not thought it humiliating to charge the Astronomer Royal with ignorance, and a stubborn adhesion to error, and to allege that members of the council of the Royal Astronomical Society suppress the papers of their fellow members from personal and unworthy motives.

Of American astronomers, it might seem invidious to make a personal reference to particular men, but the names of Newcomb, Hall, Eastman, Holden, Stone, Burnham, Draper, Swift and Rutherford are familiar in all civilized countries, and respected wherever the science of astronomy is appreciated.

M. Mascart has been making some observations at the College of France, on atmospheric electricity, with a Thomson quadrant electrometer, the deflections of the needle being transmitted to a pencil. The two pairs of quadrants are kept at equal potentials of contrary sign by two poles of a battery which communicate with the ground: the needle is connected with a vessel letting flow a continuous stream of water into the outer air. Generally the potential of the air, always positive, is found much higher, and more uniform by night than by day. From 9 P. M. to 3 A. M., it varies little, falls at daybreak, reaches a minimum about 3 P. M., and rises rapidly to a maximum about 9 P. M. It is commonly thought that there are two maxima, viz. morning and evening, and two minima, one in the daytime, the other at night. M. Mascart believes that insufficient has been too much neglected.

A NEW ELECTRIC PILE DEVISED BY M. REYNIER.

Translated for "SCIENCE."

M. Emile Reynier, the electrician, and inventor of an electric lamp, which we have more than once had occasion to present to our readers, and which its author has never ceased to improve and perfect, with the view of making its use more satisfactory, more convenient, and more economical, has now arranged a pile, which is at the same time powerful and economical. This apparatus is composed of a glass vessel in the form of an oblong square, in which is immersed a sheet of copper bent upon itself, as shown in Fig. 1. Upon the bottom of this copper hook rests a cup of parchment, into which the zinc plate is placed, as shown in Fig. 2.

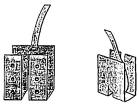

FIG. 1. FIG. 2.

FIG. 1.—THE COPPER PLATE OF THE PILE OF REYNIER.
FIG. 2.—THE ZINC PLATE OF THE PILE OF REYNIER.

This vessel or porous diaphragm has this peculiarity, that it is made up of a conical sheet of parchment, and that corresponding with the rectangular or octagonal form, just as may be chosen, it is folded upon itself (Figs. 3 and 4) as indicated by the tracings of the diagrams (Figs. 5 and 6). The strongly marked lines in the figures represent the folds of the angles, the figures indicating the faces, whilst the lighter lines represent the intermediate folds which insure the stability of the system.

FIG. 3. FIG. 4.

FIG. 3.—DEVELOPMENT DIAGRAM OF THE HEXAGONAL POROUS.
FIG. 4.—DEVELOPMENT DIAGRAM OF THE RECTANGULAR POROUS.

When the different parts are thus mounted, forming the group known as an element (Fig. 7), a solution of caustic soda is turned into the porous cup containing the zinc; into the outer vessel, a concentrated solution of the sulphate of copper. The two electrodes, zinc and copper, being placed in relation by the conductors, a constant chemical decomposition begins. This pile, which M. Reynier qualifies as

USE OF SMITHSON'S PILE FOR THE DETECTION OF MERCURY IN MINERAL WATERS. *By J. Lefort* (*Compt. Rendus*, 30, 141–142).—Orfila objected to the voltaic couple of tin and gold, devised by Dr. Smithson, for the detection of small quantities of mercury, alleging that when it was allowed to remain for some time in the suspected solution, traces of tin were dissolved, which, redepositing upon the gold plate, caused the latter to become whitened even in absence of mercury. The author shows that this deposition of the tin is liable to take place, but that no real error can result, since the metal not being volatile cannot be sublimed. There is, therefore, no sublimate to be submitted to the vapour of iodine, whereby an essential part of the operation in conducted by Smithson is omitted. Such, however, is not the case with arsenical solution; the arsenic deposits upon the gold with great readiness, and the coated foil when heated in a closed tube yields a sublimate, which, although not exactly resembling the mercurial sublimate, becomes red from formation of arsenic iodide when acted on by iodine vapour. The colour of the arsenic iodide under these conditions is very similar to that of mercuric iodide, and it becomes necessary to use the microscope in order to distinguish them. The water from the Rocher spring at St. Nectaire (Puy-de-Dôme) was examined by this process some time ago, and was stated to contain mercury. This statement is now contradicted, it being shown to contain arsenic and not mercury. In a similar manner the presence of arsenic has been detected in the mineral water of Bourbonne; and doubtless this element might be shown to be present in many other waters if they were carefully examined by this process, or by some other method of equal delicacy.

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Philosophical Journal Vol 1st 1878

PROFESSOR C. A. YOUNG, of Princeton, N. J.—On the thermo-electric electro-motive power of Pd. and Pt. in vacuo.—Elsner, a few months ago, published a paper stating that the thermo-electric power of antimony and bismuth is destroyed by removing them from all contact with oxygen, and inserting them in an atmosphere of pure nitrogen. From this he argues that the source of power in general is due to the contact thermo-electric force which bathe the metals. The following of the gases which bathe the metals. The following experiments were tried to test the theory. By the kindness of Mr. Edison and Mr. Upton a vacuum tube was procured in Mr. Edison's laboratory, containing an iron wire about 2 inches long, firmly joined to two platinum terminals which passed through the walls of the tube; the tube was exhausted until a 2-inch induction coil would not pass 1 of an inch in the gauge-tube, indicating a residual atmosphere of about one-millionth. The wire was heated to incandescence during the exhaustion, in order to drive off any possible occluded gases. The platinum wires outside the tube were joined to iron wires, the joinings being covered by glass tubes slipped over them, and a sensitive reflecting galvanometer was included in the circuit. By laying the tube and connected joinings in the sunshine, and alternately shading one or several of the joinings, it was found that the electro-motive power of the joinings within the tube was precisely the same as that of those without, and the development of current just as rapid. There was no trace of any modification due to the exhaustion.—*Silliman's Journal*, p. 47.

We referred in the Philosophical Notes of the issue of November 11 to a paper read before the American Association at Boston by Prof. Young, which contained certain phenomena in thermo-electricity which were alleged to have been observed by Herr Exner. We have since received from Mr. T. Bloom of Belfast a letter in which, on behalf of Prof. Franz Exner of Vienna, he expressly disavows any such discoveries as those which Prof. Young has set himself to refute. We readily accord to our courteous correspondent the opportunity for this disavowal, since any reflections cast even inadvertently upon the accuracy of Prof. Exner's work might unfairly prejudice readers against the general reliability of the researches which he has published in another department of science, and which our readers are aware are just now exciting considerable attention.

ON THE THERMO-ELECTRIC ELECTRO-MOTIVE POWER OF FE. AND PT. IN VACUO.—Professor C. A. YOUNG of Princetown, in a paper on this subject, at the American Association for the Advancement of Science, said that Elsner, a few months ago, published a paper, asserting that the thermo-electric power of antimony and bismuth is destroyed by removing them from all contact with oxygen, and inserting them in an atmosphere of pure nitrogen. From this he argues that the source of power in general is due to the contact thermo-electric force which bathe the metals. The following of the gases which bathe the metals. The following experiments were tried to test the theory. By the kindness of Mr. Edison and Mr. Upton a vacuum tube was procured in Mr. Edison's laboratory, containing an iron wire about 2 inches long, firmly joined to two platinum terminals which passed through the walls of the tube; the tube was exhausted until a 2-inch induction coil would not pass 1 of an inch in the gauge-tube, indicating a residual atmosphere of about one-millionth. The wire was heated to incandescence during the exhaustion, in order to drive off any possible occluded gases. The platinum wires outside the tube were joined to iron wires, the joinings being covered by glass tubes slipped over them, and a sensitive reflecting galvanometer was included in the circuit. By laying the tube and connected joinings in the sunshine, and alternately shading one or several of the joinings, it was found that the electro-motive power of the joinings within the tube was precisely the same as that of those without, and the development of current just as rapid. There was no trace of any modification due to the exhaustion.

THERMO-ELECTRICITY.

Several months ago Herr Exner read a paper before the Academy of Science, Vienna, tending to prove that the current generated at a thermo-electric junction is due to the chemical action between the gas in which the junction is immersed and the metals. This was a most important conclusion, and converse to existing opinions; so that it was expedient to put it to the test. This has been done by Professor C. A. Young, of Princeton, New Jersey, who employed experiments on the thermo-electric properties of a platinum and iron pair *in vacuo*, at the laboratory of Mr. Edison, Menlo Park. The pair was enclosed in a glass bulb exhausted to one-millionth of an atmosphere, and its ends were connected to a galvanometer. On piercing the bulb in the sunlight, and alternately shutting the external and internal junctions an electromotive force equal in each case was generated, a result antagonistic to the conclusion of Herr Exner. Herr Exner has also recently promulgated his opinion that the electromotive force generally supposed to be due to the mere contact of two dissimilar metals is really due to chemical action between the metals and the air or other gas surrounding them. He adduces many experiments of his own in support of this view; but at the Physical Society, on November 13, Professors Perry and Ayrton pointed out that his experimental results were at variance with the results of several independent experimenters, such as Kuyhenek, Hankner, and others, which agree among themselves.

ON A THERMO-MAGNETIC THERMOSCOPE.

BY SIR WILLIAM THOMSON.

This thermoscope is founded on the change produced in the magnetic moment of a steel magnet by change of temperature. Several different forms suggest themselves. The one which seems best adapted to give good results is to be made as follows:

1. Prepare an approximately astatic system of two thin hardened steel wires, *r* & *r*′ & each one centimetre long, one of them, *r* &, hung by a single silk fibre, the other hung bifilarly from it by fibres about twelve centimetres long, so attached that the distance between the two on a horizontal plane should be inclined at an angle of about .01 of a radian (or .57) to one another.

2. Hang a very small light mirror, bifilarly from the lower of the two wires, *r*′.

3. Magnetize the two wires to very exactly equal magnetic moments in the contrary directions. This is easily done by a few experiments tried to make them rest as nearly as possible perpendicular to the magnetic meridian.

4. Take two pieces of equal and similar straight steel wire, soft hardened, each one centimetres long, and about .04 centimetres diameter. Magnetize them equally and similarly, and mount them on a suitable frame to fulfil conditions

5 and 6. Call them R R and R′ R′. R and R′ denoting the ends containing true north polarity (ordinarily marked B), and R R′ true south (ordinarily marked N or S). The small letters, *r*, *b*, *r*′, *b*′, more on the same plan the polarities of *r* & and *r*′ &′.

7. The magnets R R, R′ R′, are to be relatively fixed in line on their frame with similar poles next one another, at a distance of about two centimetres asunder, as thus, R R′ R′, with R B′ = two centimetres.

8. This frame is to be mounted on a geometrical slide upon the case, within which the astatic pair, *r* &, *r*′ &′, is hung in such a manner that the line of R B, B R bisects *r* &, approximately at right angles, and that R B B R may be moved by a micrometer screw through about a millimetre on each side of its central position, the line of motion being the line of R B, B′ R′, and the " central position " being that in which B and B′ are equi-distant from the centre of *r* &.

9. By aid of the micrometer screw bring the luminous image to its middle position on the scale.

10. Cause R B, B′ R′ to have different temperatures. The luminous image is seen to move in such a direction as is due to *r* approaching the cooler, and receding from the warmer of the two deflectors B R, B′ R′.—*Proceedings Royal Society, Edinburgh.*

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Correspondence.

THE THERMO-ELECTROPHORE.

To the Editor of THE TELEGRAPHIC JOURNAL.

STRATHLEVEN.

SIR,—On the 19th of March last I made a communication to the French Academy of Sciences on the result of experiments I had made as to the transformation of plastic electricity. (Comptes-Rendus de l'Academie des Sciences, 19th April, 1880). Full details of these results were lately given in *Nature*, the *Engineering*, *Hardware* and *Industries* Journals.

I have received since that date from various places a number of letters addressed to my thermo-electrophore of the same nature as my thermoscope.

I have the honour therefore to briefly latent the following in your next issue:—

The thermo-electrophore, in contact with the thermoscope. This apparatus is based upon a new principle discovered by me. Nine causes of the formation of atmospheric electricity the origin of the electricity in the thunder cloud and in others is explained upon this principle. But, what is most important, I have established a definite basis of this principle on which a thermo-electrophore is transformed immediately into a source of electricity and with very little loss of energy. The formation of electricity in my thermo-electrophore takes place at the time of the passing of the vapour of certain liquids to the solid state, at the moment when the solidified movement of the vapour becomes transformed accordingly to my researches, sufficiently completely into electro-molecular movement, or current.

By means of certain arrangements I am even confident of utilizing the heat of the air.

If I am able to render my apparatus practicable, applying to my calculations, it will be possible to obtain electricity (steam engines and Gramme machines utilizing only a tenth part of the heat obtained from the coal consumed) to the extent of two-thirds of the heat expended.

I believe even that by combining the thermo-electrophore with the Gramme machine (which arrangement call the dynamophore) it will be possible to obtain a motor relatively very light (approximately four times lighter and cost) consuming a proportionately less amount of coal in comparison with the steam engine of equal power.

Accept, Sir, the assurances, &c.,

GREGOIRE BABITSCHEFF.

Vitebsk, *Dec.*, 1880.

contact arm is constrained to remain in the "on" "off" positions by a spring, which is so arranged at the moment of breaking contact a strong coupl exerted, tending to carry the arm rapidly away safe and non-sparking distance. No are can pos form, and the spring is strong and of a peculiar f The wires are easily coupled up, all connections b made on the face, a recess being left at the back o

determined by an ins
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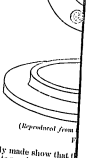

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Archive of Columbia College, by Aug 16, 1887.

N.Y. Times, Aug 16, 1887.

Press, Palatine, Ill. Aug 16, 1887.

EDISON'S LATEST IDEA.

The Direct Conversion of Heat into Electricity and Power.

FROM THE NEW YORK BUREAU OF THE PRESS.

NEW YORK, Aug. 16.

Among the most interesting of the eighty-five papers read before the American Association for the Advancement of Science to-day was one by Thomas A. Edison read by Professor George F. Barker upon the conversion of heat into power directly by means of magnetism and by the same principle the conversion of heat into electricity. Of the discovery Mr. Edison says:

"When whenever a magnetic field varies in intensity within a vicinity of a conductor current is set up in it, or vice versa whenever a conductor is moved in a magnetic field a current is set up in it. If the conductor is moved in a magnetic circle and varying the magnetizability of that core by varying the temperature, it would be possible to generate a current. This idea constituted the essential feature of the new generator, which therefore depends upon varying the magnetizability of the core.

"The principle was first applied to the construction of a simple form of magnetic engine, a model of which was exhibited to-day. The armature of the experimental engine, having the form of a small fan, is made of thin iron plates bent in the form of a ring and capable of rotation about an axis perpendicular to the plane of the magnet. By suitable gearing the armature is caused to rotate about 1,500 times a minute. A coil of wire is wound around this bundle of rings and through the entire length of the armature. When this screw is so adjusted that the coils are symmetrically disposed with reference to the poles of the magnet, there is no current, since the two coils are thereby portions of the same circuit. But when the armature is moved by the screw, so that the coils are moved nearer to the poles, there will be formed about the coils a magnetic field, since the coils are thereby brought into the region of greatest magnetic intensity. The construction of a machine of sufficient size to demonstrate the feasibility of producing electricity or power on a large scale by this principle has not been completed. The new machine will be run by a 50-horse-power engine, the equivalent of the device already exercised produced readily about a common centre. The amount of power developed by the engine is estimated, but it is stated that the pressure of combustion are 1,000 pounds to the square inch. The amount of electrical energy developed by the machine depends upon the number of turns of wire, upon the coils, the temperature range, and, in fact, upon the rate of temperature variation. Further, the rate of temperature variation depends upon the rapidity with which heat can be put into the coils, the temperature range, and the specific heats of the materials employed. Mr. Edison thinks that his device will be found to be more economical than the steam engine and dynamo. It is based on the fact that the magnetism of some of the metals, as iron, cobalt and nickel, is greatly affected by heat, and the other well-known fact that whenever a magnetic field varies in strength in the vicinity of a conductor, a current of electricity is generated in that conductor. Putting the two things together, Edison says it occurred to him that by placing an iron core in a coil of wire and varying the strength of the magnetism of that core by varying the temperature, a current would be generated. We believe some arrangement for producing electricity directly from heat is among the probabilities of the future. Many of the best inventors of the age are giving their attention to electrical matters and it is one of the most promising fields for research and investment. Where three years ago thousands were invested in this line, to-day there are millions, and still the stream continues to pour in. What the end will be there is no safety in prophesying, save that it will not be disaster.

N.Y. Tribune, Aug. 16, 1887.

Adventurer, Canton, N.Y. Aug. 25, 1887.

"I DON'T KNOW,"

was Thomas A. Edison's response to the inquiry, what is electricity? Whether he knows or not, the great inventor toys with the mysterious force with more success than all other men on this terrific ball. Inventions are numerous, and he continues his investigations as zealously as ever. The Menlo Park wizard's latest production is the pyromagnetic governor, a device by which he can turn the heat of a domestic furnace into light and get power out of heat. When electricity is fully understood the world will be supplied with many conveniences and comforts that are not even now dreamed of.

Guardian, Saltcoats, N.B. Aug 17, 1887.

"Edison's latest idea" is the direct conversion of heat into electricity and power. This was the title of a paper read by Professor George F. Barker before the American Association for the Advancement of Science to-day. The paper was read before the Academy of Sciences in this city, and by the courtesy of the president of the association, Professor Barker, I was enabled to obtain a copy of the paper in advance of its delivery. The paper, which is of considerable length, is devoted to a description of the experiments which Mr. Edison has been making for the purpose of ascertaining the practicability of the idea, and the paper, like every original production of Mr. Edison, is replete with interesting matter. The principle involved in the new invention is that of magnetism. Mr. Edison says: "Whenever a magnetic field varies in intensity within the vicinity of a conductor current is set up in it, or vice versa whenever a conductor is moved in a magnetic circle and varying the magnetizability of that core by varying the temperature, it would be possible to generate a current. This idea constituted the essential feature of the new generator, which therefore depends upon varying the magnetizability of the core." The principle was first applied to the construction of a simple form of magnetic engine, a model of which was exhibited to-day. The armature of the experimental engine, having the form of a small fan, is made of thin iron plates bent in the form of a ring and capable of rotation about an axis perpendicular to the plane of the magnet. By suitable gearing the armature is caused to rotate about 1,500 times a minute. A coil of wire is wound around this bundle of rings and through the entire length of the armature. When this screw is so adjusted that the coils are symmetrically disposed with reference to the poles of the magnet, there is no current, since the two coils are thereby portions of the same circuit. But when the armature is moved by the screw, so that the coils are moved nearer to the poles, there will be formed about the coils a magnetic field, since the coils are thereby brought into the region of greatest magnetic intensity. The construction of a machine of sufficient size to demonstrate the feasibility of producing electricity or power on a large scale by this principle has not been completed. The new machine will be run by a 50-horse-power engine, the equivalent of the device already exercised produced readily about a common centre. The amount of power developed by the engine is estimated, but it is stated that the pressure of combustion are 1,000 pounds to the square inch. The amount of electrical energy developed by the machine depends upon the number of turns of wire, upon the coils, the temperature range, and, in fact, upon the rate of temperature variation. Further, the rate of temperature variation depends upon the rapidity with which heat can be put into the coils, the temperature range, and the specific heats of the materials employed. Mr. Edison thinks that his device will be found to be more economical than the steam engine and dynamo. It is based on the fact that the magnetism of some of the metals, as iron, cobalt and nickel, is greatly affected by heat, and the other well-known fact that whenever a magnetic field varies in strength in the vicinity of a conductor, a current of electricity is generated in that conductor. Putting the two things together, Edison says it occurred to him that by placing an iron core in a coil of wire and varying the strength of the magnetism of that core by varying the temperature, a current would be generated. We believe some arrangement for producing electricity directly from heat is among the probabilities of the future. Many of the best inventors of the age are giving their attention to electrical matters and it is one of the most promising fields for research and investment. Where three years ago thousands were invested in this line, to-day there are millions, and still the stream continues to pour in. What the end will be there is no safety in prophesying, save that it will not be disaster.

N.Y. Tribune, Aug. 16, 1887.

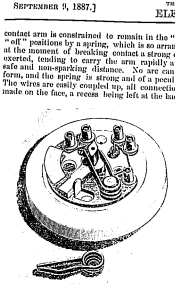
Gazette, Courier, Greenfield, Mass. Aug. 22, 1887.

At one of the sessions of the meeting of the American Association for the Advancement of Science, which has been held the past week, Thomas A. Edison read a paper upon electricity, in which he gave an account of an apparatus he is developing for obtaining electric light and power directly from coal without the intervention of the steam engine and dynamo. It is based on the fact that the magnetism of some of the metals, as iron, cobalt and nickel, is greatly affected by heat, and the other well-known fact that whenever a magnetic field varies in strength in the vicinity of a conductor, a current of electricity is generated in that conductor. Putting the two things together, Edison says it occurred to him that by placing an iron core in a coil of wire and varying the strength of the magnetism of that core by varying the temperature, a current would be generated. We believe some arrangement for producing electricity directly from heat is among the probabilities of the future. Many of the best inventors of the age are giving their attention to electrical matters and it is one of the most promising fields for research and investment. Where three years ago thousands were invested in this line, to-day there are millions, and still the stream continues to pour in. What the end will be there is no safety in prophesying, save that it will not be disaster.

N.Y. Tribune, Aug. 16, 1887.

More than one subject of general interest was taken up yesterday by the American Association for the Advancement of Science, but the topic that will attract the greatest attention was the forenoon's work, but a good second to this was furnished in the two papers of Mr. Edison. Everything said about the Niagara Canal to the four contributions on that subject was highly favorable. Engineer Peary's paper, giving the result of Engineer Menocal's observations and estimates, is easily the most important of the four. The cost of the canal is set down as about $64,000,000; six years will be required to locate and construct it, and when finished a steamship can pass from end to end in thirty hours. These are estimates only; and estimates must always be taken with allowance. One of Mr. Edison's papers was on the pyromagnetic dynamo, a machine for producing electricity directly from coal, on which the famous inventor is still at work; the other treated of a "bridge or balance for measuring magnetic conductivity." This sounds rather technical, but is perhaps eminently practical.

contact arm is constrained to remain in the "on" and "off" positions by a spring, which is so arranged that at the moment of breaking contact a strong couple is exerted, tending to carry the arm rapidly away to a safe and non-sparking distance. No arc can possibly form, and the spring is strong and of a peculiar form. The wires are easily coupled up, all connections being made on the face, a recess being left at the back of the



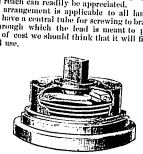
switch for leading in the wires. Provision is made in every switch for a safety fuse which can be easily replaced. The use of steel for the spring of these switches would in certain cases be found to be objectionable, especially in ship work, and we would suggest the substitution of German silver, which has been found in practice to be far preferable.

A NOVELTY IN SWITCHES.

THE want has long been felt of a handy switch to form part of, or to be easily attached to the lamp holder, both for hanging lamps and for use with brackets, in order to save the expense of running leads down to wall

switches. The Walsall Company has brought before boxes. The contact is made by a spring which is forced our notice a switch well calculated to serve those pur- by the finger between the edges of two brass tubes and when fairly engaged is held in position by the notch: it is readily released by the finger pressing the other end of the spindle carrying the spring, while a spiral spring gives a rapid "fly off." The brass tubes are connected to one lead and the lamp respectively. As attached to a suspended holder it is at once seen that it requires only one hand to put the light on and off, and the advantages of this for lamps hanging only just within reach can readily be appreciated.

The arrangement is applicable to all lamp holders which have a central tube for screwing to brackets, &c., and through which the lead is meant to pass. As a saving of cost we should think that it will find a large general use.



A neat little switch with double spring contacts is also before us, the chief merits of which are its simplicity and neatness, while ensuring as good a contact as can be desired.

ON THE PYROMAGNETIC DYNAMO, A MACHINE FOR PRODUCING ELECTRICITY DIRECTLY FROM FUEL.*

By THOMAS A. EDISON.

THE production of electricity directly from coal is a problem which has occupied the closest attention of the ablest inventors for many years. Could the enormous energy latent in coal be made to appear as electric energy by means of a simple transforming apparatus it would be inconceivable its result with reasonable economy, but it will be conceded, probably, that the mechanical methods of the entire world would be revolutionised thereby, and that another of those grand steps of progress would be taken, of which the nineteenth century so justly boasts.

The simple production of a potential difference by means of heat is as old as Seebeck and Melloni. The science of thermo-electricity thus originated has been developed by Becquerel, by Peltier, by Thomson and by Tait, and the thermo-batteries of Clamond and of Noe have found many important practical uses. The results already attained in these generators have stimulated research marvellously, and many investigators have believed that in this direction lay the philosopher's stone. Our fellow-member, Moses G. Farmer, worked long and assiduously in this field, producing, it is believed, the most satisfactory results, as regards economy, which have ever been obtained. His never succeeded in converting 1 *per cent.* of the energy of the coal into electric energy. Quite recently Lord Rayleigh has discussed with his well-known ability the law of efficiency of the thermo-battery from the standpoint of the second law of thermo-dynamics. And he concludes that for a copper-iron couple, working between the extreme limits of temperature possible for these metals, a conversion of not more than one three-hundredth part of the coal energy can be hoped for. While, therefore, as a heat engine the thermo-cell appears to follow precisely the law of Carnot, and hence may have a theoretical maximum efficiency equal to that of the reversible engine of this

* Read before the American Association for the Advancement of Science, New York, August, 1887.

N.Y. Times, Aug. 16, 1887. 63

Prof. William A. Rogers, who says he comes from Paris, was unable to attend the meeting of the Academy this week, owing to the illness of his wife. Mrs. Rogers, who is a daughter of Prof. Joseph Henry, the first secretary of the Smithsonian Institution, is reported to be somewhat better to-day.

Press, Philadelphia, Aug. 16, 1887.

EDISON'S LATEST IDEA.

The Direct Conversion of Heat Into Electricity and Power.

FROM THE NEW YORK BUREAU OF THE PRESS.

NEW YORK, Aug. 15.

Among the most interesting of the eighty-four papers read before the American Association for the Advancement of Science to-day was one by Thomas A. Edison read by Professor George F. Barker upon the conversion of heat into electricity directly by means of magnetism, and by the same principle the conversion of heat into electricity. Of the former Mr. Edison says:

"Since whenever a magnetic field varies in strength a current of electricity of a certain direction is induced in a coil of wire surrounding such field.

Mr. Edison thinks that his device for the direct conversion of heat into electricity by means of the heat from an ordinary furnace is the result of a series of experiments in that direction. He calls the machine the pyromagnetic generator.

Gazette, Cornwall, Greenfield, Mass. Aug. 22, 1887.

At one of the sessions of the meeting of the American Association for the Advancement of Science, which has just closed, the last week, Thomas A. Edison read a paper upon electricity, in which he gave some account of an apparatus he is developing for obtaining electric light and power directly from coal without the intervention of the steam engine and dynamo. It is based on the fact that the magnetism of some of the metals, as iron, cobalt and nickel, is greatly affected by heat, and the other well-known fact that whenever a magnetic field varies in strength in the vicinity of a conductor, a current of electricity is generated in that conductor. Putting the two things together, Edison says it occurred to him that by placing an iron core in a coil of wire and varying the strength of the magnetism of that core by varying its temperature, a current would be generated. We believe some arrangement for producing electricity directly from heat is among the probabilities of the future. Many of the best inventors of the age are giving their attention to electrical matters and it is one of the most promising fields for research and investment. Where three years ago thousands were invested in this line, to-day there are millions, and still the cream continues to pour in. What the end will be there is no safety in prophesying, save that it will not be disaster.

N.Y. Times, Aug. 16, 1887.

More than one subject of general interest was taken up yesterday by the American Association for the Advancement of Science, but the topic that will attract the greatest attention was the Nicaragua Canal, but a good second to this was furnished in the two papers of Mr. Edison. Everything said about the Nicaragua Canal in the four contributions on that subject was highly favorable. Engineer Peary's paper, giving the result of Engineer Menocal's observations and estimates, is easily the most important of the lot. The cost of the canal is set down as about $94,000,000; six years will be required to locate and construct it, and when finished a steamship can pass from end to end in thirty hours. These are estimates only, and estimates must always be taken with allowances. One of Mr. Edison's papers was on the pyromagnetic dynamo, a machine for producing electricity directly from fuel, on which the famous inventor is still at work; the other treated of a "bridge or balance for measuring magnetic conductivity." This sounds rather technical, but is perhaps eminently practical.

Aventure, Canton, N.Y. Aug. 25, 1887.

"I don't know," was Thomas A. Edison's response to the inquiry, what is electricity? Whether he knows or not, the great inventor toys with the mysterious force with more success than any other man on this electric ball. His secrets are numerous, and he continues his investigations as zealously as ever. The Menlo Park wizard's latest production is the pyromagnetic generator, a device by which he can turn the heat of a domestic furnace into lights and get power out of heat. When electricity is fully understood the world will be supplied with many conveniences and comforts that are not even now dreamed of.

Guardian, Pittsburgh, Pa. Aug. 17, 1887.

From a paper read by Thomas A. Edison before the American Association for the Advancement of Science it appears that he has made considerable progress in the subversion of heat into power directly by means of magnetism, and upon the same principle, the conversion of heat into electricity. He is constructing a machine of three horse-power, in which the output of electrical energy will be greater, he thinks, than in any device now known and the cost of operation less. If the consummate process of generating electricity by means of a steam engine is ever superseded by a more economical method a sensational revolution will be the consequence.

eminent philosopher, yet in practice its efficiency falls very far below this theoretical maximum.

It therefore follows that if the result hoped for is to be attained at all it must obviously be looked for in some other direction than in that of the thermo-coil. In considering the matter, another line of investigation suggested itself to me, the results of which I have the honour now to submit to my fellow members of the physical section. It has long been known that the magnetism of the magnetic metals, and especially of iron, cobalt and nickel, is markedly affected by heat. According to Becquerel, nickel loses its power of being magnetised at 400°, iron at a cherry-red heat and cobalt at a white heat. Since, whenever, a magnetic field varies in strength in the vicinity of a conductor a current is generated in that conductor, it occurred to me that by placing an iron core in a magnetic circuit, and by varying the magnetisability of that core by varying its temperature, it would be possible to generate a current in a coil of wire surrounding this core. This idea constitutes the essential feature of the new generator, which, therefore, I have called a pyromagnetic generator of electricity.

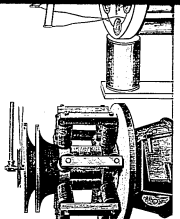
The principle of utilising the variation of magnetisability by heat as the basis of electric machines, though clearly applicable to generators, was first applied to the construction of a simple form of heat engine which I have called a pyromagnetic motor. A description of this motor will help us to understand the generator subsequently constructed.

Suppose a permanent magnet having a bundle of small tubes made of thin iron placed between its poles and capable of rotation about an axis perpendicular to the plane of the magnet after the fashion of an armature. Suppose further, that by suitable means, such as a blast or a draught, air can be made to pass through these tubes so as to raise them to redness. Suppose that by a flat screen symmetrically placed across the face of this bundle of tubes, and covering one-half of them, access of the heated air to the tubes beneath it is prevented. Then it follows that if this screen be so adjusted that its ends are equidistant from the two legs of the magnet, the bundle of tubes will not rotate about the axis, since the cooler and magnetic portions of the tube-bundle (*i.e.*, those beneath the screen) will be equidistant from the poles and will be equally attracted on the two sides. But if the screen be turned nearer one of the poles and the other nearer the other, then rotation of the bundle will ensue, since the portion under the screen, which is cooler, and therefore more magnetisable, is continually more strongly attracted than the other and heated portion. This device note, therefore, as pyromagnetic motor, the heat now passing through the tubes in such a way as to produce a disymmetry in the lines of force in the iron field, the rotation being due to the effort to make these symmetrical. The guard plate in this case has an action analogous to that of the commutator in an ordinary armature. The first experimental motor constructed on this principle was heated by means of two small Bunsen burners, arranged with an air blast, and it developed about 100 foot-pounds per minute. A second and larger motor is now about finished, which will weigh nearly 1,500 pounds, and is expected to develop about 3 horse-power. In both these machines electromagnets are used in place of permanent magnets, the current to energise them being derived from an external source. In the latter machine the air for the combustion is first forced through the tubes to aid in cooling them, and then goes in to the furnace at a high temperature.

The earliest experiments in the direction of the pyromagnetic production of electricity were made with a very simple apparatus, consisting of a charged electro-magnet, having a tube of thin iron passing through its cores near their outer ends, a coil of wire being wound around this tube, and including an ordinary sounder deliberately adjusted in its circuit. The tube beneath the coil was covered with asbestos paper. After heating the tube to redness by a gas blast directed into it at one end, a jet of cold air was suddenly substituted for the flame, the sounder at once closed, showing that the change in the magnetisability of the iron had varied the distribution of the lines of force within the coil, and thus had produced a current of electricity in this closed circuit.

The construction of a machine of sufficient size to demonstrate the feasibility of producing continuous currents on the large scale in this way was at once begun and has only just been completed. The new machine consists of eight distinct elements, each the equivalent of the device already mentioned, consisting of the two legs of an electro-magnet somewhat far apart (12 inches actually), having at one end the ordinary yoke, and at the other a roll of corrugated sheet iron ·005 inch thick called an interstitial armature: this armature having a coil of wire wound upon it and separated from direct contact by means of asbestos paper. The eight elements are arranged radially about a common centre, and are equidistant, the eight interstitial armatures passing in fact through the iron discs, which constitute the common pole piece of all the electro-magnets. The coils wound upon the interstitial armatures are connected directly in series, the whole forming a closed circuit. Through the centre of these discs a hollow vertical shaft passes, carrying at its lower end a semi-circular plate of fire clay called a guard plate, which, when the shaft is turned, revolves close to the lower ends of the sheet iron armatures and screens off half of them from the access of heat from below. The shaft carries a cylinder of insulating material having metallic contact pieces let into it on opposite sides, the line joining them being parallel to the straight edge, of the guard plate. Upon this cylinder eight springs press, each of these springs being connected to the wire of the closed circuit above-mentioned midway between the coils. The length of the metallic segment is so proportioned that the following spring touches it just as the preceding one leaves it. The springs themselves are so adjusted that each of them comes into contact with its metallic segment just as the preceding coil of the pair to which it is connected is uncovered by the rotation of the guard plate. Upon the same shaft, and above the cylinder just mentioned, a pair of metallic rings are placed, insulated from the shaft, to each of which one of the metallic segments is connected. Brushes pressing upon these rings take off the current produced by the generator.

The entire machine now described is placed upon the top of any suitable furnace, fed by a blast, so that the products of combustion are forced up through those interstitial armatures which are not covered by the guard plate, and raise them to a high temperature. The field magnets, when charged, magnetise of course only those interstitial armatures which are cold, *i.e.*, those beneath the guard plate. On rotating this plate, the interstitial armatures are successively uncovered on the one side and covered on the other; so that continually during the motion four of the eight armatures are losing heat and the other four are gaining heat. But those which are losing heat are gaining magnetism, and *vice versâ*. Hence, while currents are generated in all the armature coils, since in all the magnetism is varying, the current in the coils beneath the guard plate will be in one direction, while that in the coil exposed to the fire will be in the other. Moreover, whenever a armature passes out from under the guard plate, its condition at once changes: from losing heat and gaining magnetism it begins to gain heat and lose magnetism. Hence, at this instant, the current in its coil is reversed, and, consequently, the line connecting this coil with the one opposite to it constitutes the neutral line, or line of commutation, precisely as in the ordinary dynamo. Indeed, the action of the interstitial armature coils of the pyromagnetic dynamo resemble strongly that of the ordinary armature coils of the Gramme ring, not only in the manner of connecting them together, but also in their functions, the change of direction in the current as the magnetism of the field changes sign in the latter case, corresponding closely to the change of current in the former case, due to the direction of the temperature change. But



It will be observed that while in the Gramme ring the loops between the armature coils are connected to commutator bars, in the pyromagnetic dynamo the armature coils are connected to an equal number of brushes (in

It will be observed that while in the Gramme ring the loops between the armature coils are connected to commutator segments equal in number to that of the coils, upon which commutator two brushes press, in the pyromagnetic dynamo the loops between the armature coils are connected to an equal number of brushes (in this case eight), while the commutator segments are only two in number; so that the functions of the commutator and the brushes in this generator are in a certain sense reversed as compared with the ordinary dynamo.

The potential difference developed by this dynamo will obviously depend (1) upon the number of turns of wire on the armature coils; (2) upon the temperature difference in working; (3) upon the rate of temperature variation, and (4) upon the proximity of the maximum point of effect. No advantage will be gained, of course, by raising the temperature of the interstitial armatures above the point at which its magnetisability is practically zero; nor will it be advantageous on the other hand to cool it below the point where its magnetism is practically a maximum. The points of temperature, therefore, between which for any given magnetic metal it is most desirable to work, can be easily

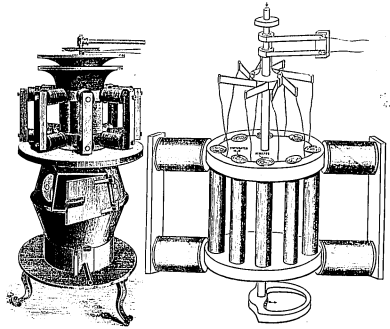


Fig. 1. (Reproduced from the "Electrical World.") Fig. 2.

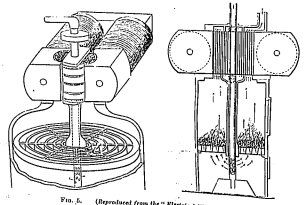
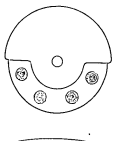


Fig. 5. (Reproduced from the "Electrical World.") Fig. 6.

determined by an inspection of the curve showing the relations between heat and magnetism for this particular metal. Thus the points of temperature at which the magnetisability is practically zero, as above stated, are a white heat for cobalt, a bright red for iron and 400° for nickel. On the other hand, while at ordinary temperatures iron has a maximum intensity of magnetisation represented by 1,390, its intensity at 220° is 1,360; and hence no commercial advantage is gained by cooling the iron below this temperature. Nickel, however, whose maximum intensity of magnetisation at ordinary temperature is 800, has an intensity of only 330 at 220°. Hence, while this metal requires a lower maximum temperature it also requires a lower minimum one; but it may be worked with much less heat. The rate of the temperature variation is determined by the rapidity with which the guard plate revolves. And this in its turn is dependent upon the rapidity with which the interstitial armature can be cooled and heated. That it may take up and lose heat readily the sheet-iron of which it is made is very thin (only 005 inch thick, even when its durability is increased by enamelling or nickelling); it is corrugated and rolled up so as to expose a large surface (about 60 square feet for the eight armatures), and hot and cold air are alternately forced through the armature. Experiments

FIG. 3.



(Reproduced from the "Electrical World.")

FIG. 4.

already made show that the guard plate can probably be made to revolve 120 times a minute. Since the potential difference is proportional to the number of lines of force cut per second, it is evident that by doubling the speed of rotation, twice as many lines of force would flow across the generating coils per second and the output of energy would be quadrupled. Exactly what thickness of metal is the most suitable for the purpose, what the relative volume occupied by metal and by air space in the interstitial armature should be, what is the best diameter for this armature, or even the best metal, what the best limits of temperature and what the best speed of rotation to produce the maximum potential difference—all these are questions which must be decided by experiments made upon the generator itself.

The results thus far obtained lead to the conclusion that the economy of production of electric energy from fuel by the pyromagnetic dynamo will be at least equal to and probably greater than that of any of the methods in present use. But the actual output of the dynamo will be less than that of an ordinary dynamo of the same weight. To furnish 30 sixteen-candle lights in a dwelling-house would probably require a pyromagnetic generator weighing two or three tons. Since, however, the new dynamo will not interfere with using the excess of energy of the coal for warming the house itself, and since there is no attendance required to keep it running, there would seem to be already a large field of usefulness for it. Moreover, by using the regenerative principle in connection with it, great improvement may be made in its capacity, and its practical utility may very probably equal the interesting scientific principles which it embodies.

[We reproduce on preceding pages the drawings exhibited at the meeting in explanation of the paper. Fig. 1 represents the pyromagnetic generator in perspective. Fig. 2 shows diagrammatically the manner in which the coils are connected with the commutator at the top and the manner in which they are built up. The cores of thin corrugated iron are held at the top and bottom by iron plates, which are magnetised by the surrounding electro-magnets. The corrugated cores, which allow the passage of the heated gases through them, are covered with asbestos and then wrapped with wire, the ends being joined in series, as shown, and the joints connected to the brushes instead of to the commutator. The air blast passes through the shaft from above and passes out from the apertures in the revolving plate of fire-clay below the tubes. Fig. 3 shows this plate, looking from below, from which it will be seen that four tubes are cooling, being screened from the heat, and also by means of the cold air blast, and four are being heated by the passage of the heated gases. Fig. 4 shows the plate resting upon the top of the stove. The pyromagnetic motor is shown in diagrammatic perspective in fig. 5 and in section in fig. 6. The armature, it will be seen, is built of small iron tubes, part of which placed obliquely to the lines joining the poles, are continually cooled and attracted by the poles, while the remainder are demagnetised by the heat.]

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

(From the Special Correspondent of the "Electrical Review.")

THE fifty-seventh annual meeting of what was once called "the Peripatetic Parliament of Science," in other words, the British Association for the Advancement of Science, has now come to an end. It has been a noteworthy meeting in many respects. From the purely scientific side it has been an eminent success, for although nothing startlingly new has been communicated, there have been recorded decided and important advances in more than one branch of scientific knowledge. To the physicist and the chemist, perhaps, the most important of all the papers were those put before Sections A and B, sitting jointly under the presidency of Sir William Thomson, on Saturday. These dealt with that interesting but hitherto rather vaguely known subject, electrolysis. Prof. Oliver Lodge has laboured strenuously to make this field a more open and better cultivated one, and he has gathered under his standard a number of truly scientific workers whose eminence indicate the importance to be attached to the new researches of which they were on Saturday the communicators and exponents.

A second reason for marking the Manchester meeting of 1887 as one a little out of the ordinary run was the presence of a large number—closely approaching one hundred—of foreign scientists, whose fame had preceded them. Profs. Wiedemann, Quincke and Weber from Germany, and Prof. Lippmann of Paris, each had something to communicate on physical questions, and all the English members were enthusiastic in the reception which they accorded their visitors. No less cordial was the greeting which was extended to the American men of science, of whom Prof. H. A. Rowland and Prof. C. A. Young took the most prominent part in the transactions of Section A.

What was not quite so satisfactory as the nature of the subjects discussed and the great gathering of re-

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N.Y. Post, Aug. 15, 1887.

ADVANCEMENT OF SCIENCE.

Production of Electricity from Fuel.

Papers by Thomas A. Edison—Other Matters Before the American Association To-day.

The Council of the American Association for the Advancement of Science met at the rooms this morning. The reports of the various committees were read, and after transacting routine business the committees adjourned. The sections met as usual at ten o'clock in their rooms, and the attendance was very large. The number of scientists registered this morning was 650, and there were a great many ladies among them.

At a session of the Biological Club in the room of Section F., the Rev. Thomas Morong advocated the establishment of a national botanical exchange for domestic and foreign plants. Dr. Vasey of Washington, J. Scroop Watson of Cambridge, Dr. R. L. Britton of Columbia College, Rev. Thomas Morong of Ashland, Mass., and Prof. Byron D. Halsted of the Agricultural Colleges, Ames, Ia., were appointed a committee with power and instructions to solicit, if possible, the Department of Agriculture in a scheme for the establishment of a botanical exchange, and to ask the Smithsonian Institution for distributing facilities. They will report through the botanical journals.

In section B, Physics, Prof. George F. Barker read two papers by Thomas A. Edison—on the Tycomagnetic Dynamo; a machine for Producing Electricity Directly from Fuel, and on a Magnetic Ratchet or Motion for Converting Magnetic Conductivity. The following is what was practically said by Mr. Edison on the new dynamo:

The production of electricity directly from coal has a portion which has been supplied for almost sixteen of the ablest inventors for many years. Could the enormous energy latent in coal be made to appear as electric energy by means of a simple transforming apparatus which accomplishes its result with reasonable economy, it will be conceded probably that the mechanical method of the entire world would be revolutionized thereby, and that another of those grand steps of progress would be taken of which the nineteenth century has been so full.

The simple production of a potential difference, by means of the contact of dissimilar substances, is the science of thermo-electricity thus established, has been developed by Seebeck, Peltier, Becquerel, Thomson, and by Tait, and the Siemens batteries of Clamond and Mile have found a commercial application.

The science of thermo-electricity thus established, way as to produce a dissymmetry in the lines of and the other and heated portion. The electric arc, therefore, on a pyro-magnetic motor, Association for the Advancement of Science in New York yesterday, was read by Thomas A. Edison, read by Professor George F. Barker, the eighty-one years trial before the Academy of Sciences at Philadelphia, and by the latter before the Division of Heat into Electricity of the American Association.

"Since whatever a magnetic field varies in strength in the vicinity of a conductor a current is generated in that conductor, it occurred to me that if a conductor, such as a coil of wire, were made and varying the magnetism by a heated core by varying its temperature, it would be possible to generate a current in a coil of wire surrounding the core."

Mr. Edison thinks that his device can furnish light for a whole house by means of the heat from a single burner, and he will soon test his experiments in that direction. He calls the machine the pyromagnetic generator.

Inquirer, Phila. Pat
Aug. 17, 1887.

ELECTRICITY FROM COAL.

A Whisper of a Discovery Which Thomas A. Edison Is Said to Be Developing.

Scientific Men Discussing the Possibility of Generating Electricity Directly from Coal.

Edison's Pyromagnetic Dynamo.

The best generation of electricity from coal is subject is at least of exceeding interest. If electricity can be generated in available strength by other means than by friction produced by the dynamo machine we are on the brink of wonderful changes in our methods of manufactured and in comfortable made for general comfort. Mr. Edison believes that he has discovered a means whereby heat acting upon an iron core covered by coiled wire and in magnetic circuit will produce electricity. If this can be done ingenuity ought not to be at fault to find a means of making the surplus heat from furnaces and fires in manufactories or dwellings available for producing sufficient electrical strength to light our houses.

Everybody knows that under the usual circumstances of combustions large amount of heat is carried off by the draught in the chimney which is necessary to make the fire burn. The extra heat is absolutely wasted and there has been no method of preventing it. If Edison's plan of placing his apparatus in a chimney will generate enough electricity to illuminate our houses by incandescence or are lights a great advance will be made toward the comfort of the people and the household economy. It is not necessary to confine the thought to the one subject of lighting. The electricity produced from waste heat can be used for other purposes than illumination. It can be applied to the working of machinery and then be easily managed by low motive power, and might prove in the household the one great boon which would make the sewing machine a perpetual pleasure.

N.Y. Journal
Aug. 16, 1887.

THE WIZARD'S POWER.

Edison's New Invention Described Before the Scientists.

His Latest Apparatus First Made Public Through The Journal, and How It Is Made.

In Section B of the meeting of the American Society for the Advancement of Science yesterday was read the paper on his new pyromagnetic dynamo invented by Thomas A. Edison.

The great point in this invention is that it is destined to revolutionize the present power and light manufacturing methods of the world, was announced exclusively by THE MORNING JOURNAL yesterday, and the first descriptive article of the machine shows that it is even more wonderful than THE JOURNAL'S first article stated it to be.

Mr. Edison had tried to have a pyromagnetic dynamo made in time to exhibit to the scientific scientists, but he found it impossible to do so. His description of the machine and its theory, however, was very complete. The paper was read for Mr. Edison, who was not present, by Professor George F. Barker.

The new invention of electricity directly from the combustion of coal, the paper says, is confessedly into electricity, and the mechanical energy of the latter is utilized from 75 per cent of the fuel-energy of fuel. The simple production of potential difference by means of the contact of dissimilar substances, the science of thermo-electricity thus established, has been developed by Seebeck, Peltier, Becquerel, Thomson, and by Tait, and the Siemens batteries of Clamond and Mile have found a commercial application.

The science of thermo-electricity thus established, has been developed by Seebeck, Peltier, Becquerel, Thomson, and by Tait, and the Siemens batteries of Clamond and Mile have found a commercial application.

The electrical energy latent in coal be made to appear as electric energy by means of a simple transforming apparatus which accomplishes its result with reasonable economy, it will be conceded probably that the mechanical method of the entire world would be revolutionized thereby, and that another of those grand steps of progress would be taken of which the nineteenth century has been so full.

The simple production of a potential difference, by means of the contact of dissimilar substances, is the science of thermo-electricity thus established, has been developed by Seebeck, Peltier, Becquerel, Thomson, and by Tait, and the Siemens batteries of Clamond and Mile have found a commercial application.

The electrical energy already of thermo-electricity attacked in these generators have stimulated research unremittingly, and many investigators who believed that in this direction lay the philosopher's stone. Our friend, Moses G. Farmer, worked long and assiduously in this field, producing, it is believed, the most satisfactory results hitherto recorded, and his name will be remembered. He never succeeded in converting in piece of permanent magnets, the current is one per cent. of the energy of the coal into electric energy.

While recently Lord Rayleigh has discovered with his well-known ability the law of efficiency of the thermo-electric battery from the standpoint of the record, investigations, and he spectroles that for a specified couple, working between the extreme limits of temperature possible for those twilight's conventions can never rise more than one-fourth per cent of the coal energy can be tapped for. As a last engine, therefore, the thermo-electric seem to follow precisely the law of Carnot, and a large coals in this way was at once begun.

The machine is placed, upon the top of any suitable furnace, fed by a blast, so that the products of combustion are forced up through the tubes which are not covered by the guard plate, and raise them to a high temperature.

The potential difference developed by this dynamo will obviously depend, it upon the number of turns of wire upon the armature coils; (2) upon the temperature difference at working; (3) upon the rate of temperature variation; (4) upon the proximity of the maximum point of effect. Experiments have shown that the guard plate can possibly be made to receive 170 times a minute. Since the potential difference is proportional to the number of lines of force cut per second, it is evident that by doubling the speed or rotation, twice as many lines of force would thus across the generating coils per second and the output of energy would be quadrupled. Exactly what thickness of metal would be most suitable for the purpose what the relative volumes occupied by metal and by air spaces in the interstitial armature alcohol; what is the best diameter for this armature, or even the best speed; what the best limits of temperature, and what the best speed of rotation to produce the maximum potential difference—all these are questions which must be decided by experiments more upon the generator itself.

The results thus far obtained lead to the conclusion that the economy of production of electric energy from fuel by the pyromagnetic dynamo will be at least equal to and probably greater than that of any of the methods in present use. But the actual output of the dynamo will be less than that of the dynamos of the same weight. To furnish thirty sixteen-candle lights will require a pyromagnetic dynamo weighing a pyromagnetic generator weighing about one ton. It will however be possible to run this machine for with setting the screws of energy of its coal for warming the house itself, and since there is no attendance required to keep it running there would seem to be already a large field of application for it. Moreover, by varying the expenses, principle in connection with it, great improvements may be made in its capacity, and in practical utility may very probably equal the latest existing scientific principles which it embodies.

Newark, Newark, N.J.
Aug 16, 1887.

HOBSON'S LATEST IDEA.

The Direct Conversion of Heat Into Electricity and Power.

Among the most interesting of the eighty-one papers read before the Associate Association for the Advancement of Science in New York yesterday, was one by Thomas A. Edison, read by Professor George F. Barker, before the Division of Heat into Electricity of the American Association.

"Since whatever a magnetic field varies in strength in the vicinity of a conductor a current is generated in that conductor, it occurred to me that if a conductor, such as a coil of wire were made and varying the magnetism by a heated core by varying its temperature, it would be possible to generate a current in a coil of wire surrounding the core."

Mr. Edison thinks that his device can furnish light for a whole house by means of the heat from a single burner, and he will soon test his experiments in that direction. He calls the machine the pyromagnetic generator.

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N.Y. Herald, Aug. 16, 1887.

EDISON'S LATEST DEVICE.

PYROMAGNETIC GENERATOR.

HE TELLS THE SCIENTISTS ABOUT HIS TYCOMAGNETIC DYNAMO.

The Wizard's Method for Turning the Heat of a Domestic Furnace into Electric Energies and Lighting Houses by It.

Among the most interesting of the eighty-one papers read before the Associate Association for the Advancement of Science in New York yesterday, was one by Thomas A. Edison, read by Professor George F. Barker, before the Division of Heat into Electricity of the American Association.

"Since whatever a magnetic field varies in strength in the vicinity of a conductor a current is generated in that conductor, it occurred to me that if a conductor, such as a coil of wire were made and varying the magnetism by a heated core by varying its temperature, it would be possible to generate a current in a coil of wire surrounding the core.

Acting upon this idea, Mr. Edison placed a metal electro-magnets in a circle, all their poles in contact with one iron disk, and their magnetic poles in contact with another. Passing through the disks and isolated from them is a metal rod, around which is coiled a insulated iron core and opposite to the electro-magnetic poles permeability of the electro-magnets. The rod is connected at one end with the armature of the electro-magnets, and at the other with a ratchet wheel. A pawl is pivoted to a fixed support and rests upon the ratchet. Then the metal is magnetized, and the armature is drawn to the electro-magnets, and held, before but, when non-magnetic, is withdrawn by a spring. The rod is then heated, and the magnetic conductivity was generated in the coils of wire surrounding the rod.

The apparatus for producing currents was so modified as to furnish electric lights for a whole house by means of the heat from an ordinary furnace, and he will, perhaps be enabled to test his experiments in that direction very soon.

The proposed pyromagnetic motor is thus described by Mr. Edison: "Let us suppose a ring of iron wire wound in the form of a permanent coil. The wheel is made of tubes of thin iron or steel, and the ends of the tubes are connected with a hub, which conveys the heat or air at the center of the wheel. The

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Mt. Jerkins Aug 16th 1887
Ast. Lo. Cottage

EDISON'S PYROMAGNETIC DYNAMO.

Professor Thomas A. Edison would not seem to be resting on his paper on his new invention, the pyromagnetic dynamo, but is continuing experiments with it, as appears by another paper presented to the Franklin Institute by Professor Thomas P. Barker. This paper is entitled "Experiments with Edison's Pyromagnetic Dynamo," and merely all the necessary conditions of the experiments were on hand at Menlo. Mr. Edison's paper began by stating that he had found that the magnetic qualities of iron, in the field of the pyromagnetic generator of electricity, is not confined to nickel, as believed.

It is well known that the thermo-cell appears to fail. Are heat rays, or vibrations, necessary to the flow of the current? Is the current produced by heat, or by the heat-rays? Efficiency rises the reversible action of this cell. Is the cell reversible? Is it a true cell? Is it a true thermo-cell? Is it a true thermo-cell? Is it a true thermo-

Journal, Lowell, Mass. Dec. 23, 1887.

EDISON'S NEW IDEA.

"Tone" Edison's chief d'œuvre is to be a contrivance to extract electricity from coal without the interposition of fire, water and steam to make the wheels go round for the purpose of converting the latent forces of carbon into lighting. He expects to succeed and when he does, his great life work will have been set to filling chimes.

At present only 9 per cent of the electric force known to be concealed in coal, is saved by the time it has passed through the various subterranean mazes, ending in current through a cable. If Mr. Edison saves the other 91 per cent and reduces twenty times the cost of running lights and machinery by electricity, he will have all the water hands left on Pactolus at his command. However, we suppose the agriculture will make us pay such a tremendous royalty on his machines for the first, fifteen years after their construction, that we shall have to wait half a generation before the public begins to realize on the salvage of force.

It is a pity that our system rules the government out from securing for the people at large the benefit of the great inventions and discoveries. If it were so arranged that when a citizen had perfected an invention, the government could step in and put it on record a price as it would sell for and then the market, and make it free to all, the inventor and the public would not have to share the benefit with corporations so as to enable outsiders who have done nothing to pile up millions out of the brains of the Edisons, the Fultons and the Morses.

The French government is wiser. It is not afraid of employing science. It has at its command the services of experts in all scientific departments, who are competent to put a valuation on any invention or discovery that will be of great public utility, and upon the judgment of those scientific commissions the government buys the patent, having reserved for itself the first right of purchase, and this policy has not only prevented advantage to the nation. The government of the United States pays appliances to her as to any other customer, and war rats eat of the pontiis.

In this country the government habitually trusts all the work of her inventors and scientists as a friend until, some private capitalist with more sense steps in and pilfers the spoil.

Just exhibit how much 'this' nation would have saved if twenty years ago the government had been as smart as the Western Union Telegraph company, and had employed Mr. Edison to work for it on the same or similar terms under which the great corporation contracted for his services. But the government never had in its employ any man of great genius, except as a soldier or a sailor. Why does it waste its opportunities?

News, Newark, N. J. Sept. 28, 1887.

EDISON HARD AT WORK

PLANS OF THE GREAT INVENTOR

How He Employs His Time—Waiting for Machinery Started in England to Perfect His Tyrannosaurus Motor—His New Laboratory.

A few weeks ago, in a paper read before the annual meeting of the American Association for the Advancement of Science in New York, Thomas A. Edison showed that it was possible to produce electricity directly from heat, without the aid of steam or machinery. Public interest was excited by the announcement, but the matter sank under which electricity interest was in great part forgotten, and here was a fire which demonstrated that some day the electric light and power, with all their accessories, might be as cheap as gas. In conformity with his usual custom of not talking about his inventions until he could go no further with his theory more until he had finished certain pieces of machinery. Thus, pieces could only be obtained in England, and nothing remained but to stalk the lions and await their arrival. This was done, and since then the machinery has been practically at a standstill.

Mr. Edison informed a NEWS reporter when asked what progress he had made with his new discovery that there was nothing to say except that he was waiting for machinery which was ordered and has been delayed, but which he would again take it up. Mr. Edison calls his new machine a "tyrannosaurus motor." His paper gave a technical description of it and its method of working. Instead of coal consists of placing an iron core in a magnetic field and then heating it. The expansion caused by the heating is to be transformed into motion. This motion will, however, be very small, and will require an ordinary dynamo of the same weight. He calculated that to furnish thirty-two candle power in a house would require a tyrannosaurus motor weighing between 200 and 300 pounds. Should the arrangement of the motor was that it could be placed on top of a furnace and be run by the release of the energy of the coal from warming the house itself, and would require no attendance beyond stoking the furnace. Mr. Edison's workings upon the invention.

Mr. Edison has a new laboratory established in his magnificent residence in Lakeside Park and is delighted with Orange as a home. In spite of his success in life and his accumulation of the New York banker than he. Every working day he is down at his office in New York by 9 o'clock, has a drive to the Orange depot, the Delaware, Lacka-wanna and Western Railroad, from whence he takes a train for Hoboken, where his laboratory now is. There he works generally until 6 or 7 o'clock at night. Mrs. Edison usually has an early dinner with the carriage and drives to the depot to meet him. The weather is clear, and the ride after the day in the laboratory labor is very pleasant. Mr. Edison's building on Valley road, at the corner of Main street, and upon a quarter of an hour inspecting its progress. Mr. Edison does not like to talk about his inventions until they are very near completion. He declares that he can think better when all is quiet, and is at night.

THE NEW LABORATORY.

The laboratory that Mr. Edison is building consists of one large building and four smaller ones, all of brick. The large one is well up. It has dimensions of 250 feet. The other buildings are 100 feet square and 50 feet high. The new laboratory is to be on the north side of the large one. All the buildings will be well provided with Valley road. They are each fitted out, and will cost

Courier, Gloucester, Mass. Dec. 24, 1887.

EDISON'S NEW IDEA.

Thomas A. Edison has a new idea. He has had it for some time, but has kept it to himself. He has now given it to the world. It is the production of electricity from coal by the direct application of steam power. Instead of the present method of first converting the steam into mechanical motion and then converting the mechanical motion into electricity, Mr. Edison proposes to apply the steam directly to the coal, and thus produce the electricity. He has already made a machine which will do this, but it is not yet complete. He has not yet applied for a patent, and will not do so until he has perfected his machine. He has, however, given the idea to the world, and it is probable that others will work out the problem before Mr. Edison has completed his machine. The idea is a very simple one, and the principle involved is not new. It is the application of the principle to the production of electricity that is new. Mr. Edison has not given the details of his machine, but he has explained the principle upon which it will work. The principle is that of the expansion of iron when heated. Mr. Edison has a piece of iron which he has magnetized. He has placed this piece of iron between the poles of a magnet. When the iron is heated it expands, and in expanding it moves between the poles of the magnet. This movement of the iron between the poles of the magnet produces electricity. The iron will expand and contract as long as it is heated and cooled, and as long as it does so it will produce electricity. The principle is a very simple one, and it is surprising that it has not been applied before. Mr. Edison has applied it to the production of electricity, and has made a machine which will do the work. It is probable that other inventors will work out the problem before Mr. Edison has completed his machine. The idea

gines to the world. A number of others agree with Mr. " Ilion that the field of invention most likely to afford great results is electricity. General Greely thinks that the next great invention is to be the storage, without appreciable loss, of electricity produced by natural forces, such as waterfalls, tides, etc., but he regards a motor-cycle as the economic invention most needed. Professor William Ripley of Colby University thinks the invention most needed is a means of generating electricity which shall be easily regulated and cheap enough to allow it to be used as a source of motion, light and heat, available for general supply and easily distributed to residences; farms and for manufacturing purposes. Milton Chase, a Haverhill inventor, says that the world not only wants, but must have, a cheaper motor than the steam engine—one that will work with economy of the consumption of the last of the principles he looks to electricity for this means. And Dr. Ernest C. Dana of Portland wants an electrical miracle destroyer to prevent epidemics.

But do we look to electricity for future wonders simply because our latest and most startling inventions have been in that field? The telegraph, after all, was not an accumulation on the steam engine; and perhaps the next great revolutionizing invention will be in some entirely unexpected field, and outside of electricity. Mr. Edward Atkinson thinks that the great invention" need to come, and the one most needed, is the conversion of the nitrogen of the atmosphere into food for plants without the detour by animal methods. This would certainly be a revolutionary, for it would make men independent of the soil, which has yet been limited in its way of invention. Mr. Atkinson thinks. Professor C. G. Hinchliffe of Sweden thinks also with the imagination to run his mind, is the one missing needful. "The earth will never be completely under control," he says, "until we can navigate the air with swiftness and safety. The air is the universal highway. The road is always open; it costs nothing to keep it in repair; it goes over all savage man's deep. Mountains and rivers and seas will be no barriers to the device that will overcome the initial difficulty—that of flying at all. Think of the wants [illegible] class of inventors who are simply looking for something to invent may well apply themselves to it. Mr. Stanley also wants a means of separating aluminum from clay—and Mr. Robinson of Rose-dale College joins him in this—and a means of utilizing and bringing to New England the vast quantities of sunshine now generated every day in the Desert of Sahara. This sunshine, after a means of capturing a great mass of natural energy wasted every day suggests to us the question, Why do not some of these inventors, in their specialties, aspire toward a means of utilizing the surplus energy of the ocean tides? Every day in the year the ocean are engaged in titanic, mountain labors, twice in every twenty-four hours the seas bend themselves to a lift that would turn all the wheels that there are in the world, and all that the utmost industry could set up in the future; and all this power is of course to no purpose whatsoever. It is like Atlas straining his muscles forever to hold up nothing at all.

There are some other answers to the Lewiston paper's question that people in general will no doubt regard as whimsical. Rev. Henry Blanchard, D. D., of Portland, avows himself a student of, though not yet a convert to, Henry George's doctrines, and thinks that, if George and Stuart Mill are right, the "single tax on land" is the thing that the world needs and calls for. Wiggin, the weather prophet, has a very startling idea. The world needs, in his view, a means of producing fine constantly only those atmospheric elements necessary for the nourishing of the system, "when of course the digestive organs below the true stomach will gradually be absorbed and disappear. When man's viscera disappears, the mental energy will be reserved for thought and the prime source of disease will disappear." This is in echoes which will recommend itself highly to dyspeptic and listless persons. The eliminating of the liver, for instance, from the human system has long been regarded by a considerable section of the human race as a consummation devoutly to be wished. But Mr. Wiggins's proposed means of elimination is likely to be very slow. The race might have developed into quite human form of life before the bowels had been rendered rudimentary. But for all that, the notion is not absolutely unscientific. George Francis Train's scheme seems the last with a rubicelle ad absurdum. He wants "the electric fluid—that is, the soul," kept in storage in the human body; "its generation and use of man is an electric conservative. The human system is a vast storage battery. It gets its force to keep from escaping man would live forever." But after all, good philosopher of Madison square, are you sure that that would be a thing to be desired?

Leader, Cleveland, O.
Dec. 25, 1888.

ELECTRICITY FROM COAL.

Thomas A. Edison Tells What His Youthful Inventions Will Bring.

AKRON, Dec. 24.—[Special.]—Thomas A. Edison, the electrician, is spending the holidays with his father-in-law, Lewis Miller, in this city. In an interview to-day he said he was now at work on an invention that would produce electricity direct from coal discharging entirely with the use of batteries, etc., now required. Besides, he said, it would do away with the entire heat-ing of coal before it could be converted into electricity as is done by the present system of burning. "It will be [illegible] of Mr. Edison.

Journal, Indianapolis, Ind
Dec. 25, 1888.

Mr. Edison is said to be experimenting on a process of producing electricity direct from coal without the intervention of boilers or steam engines as an intermediary. Such a thing seems at first blush impossible, but with modern science, and especially with Edison, there seems to be no such word as impossible. The evolution of electricity from coal by means of combustion and steam involves a great loss in the transformation of power and consequent waste of energy. It is could be extracted directly from the coal it would add incalculably to its efficiency, force and practical value. Only experts can say whether such a thing is possible, but the fact that Edison is experimenting in that direction shows he thinks it is, and there is no telling what he will do.

N. Y. Tribune
Dec. 25, 1888.

MR. EDISON'S NEW SCHEME.

Akron, Ohio, Dec. 24 (special).—Thomas A. Edison is spending Christmas with his father-in-law, Lewis Miller, in this city. He says he is now experimenting on an invention whereby electricity shall be produced direct from coal, dispensing entirely with the use of batteries, etc., now required. Besides, he says, it would do away entirely with the necessity of heating coal before it could be converted into electricity as is done by the present system of burning.

Richmond Pittsburgh, Pa
Dec. 25, 1888.

WHAT EDISON IS DOING.

He is Working on an Invention That Her Revolutionize Motive Power.

Akron, O., December 24.—Thomas A. Edison, the great electrician, is spending the holidays with his father-in-law, Lewis Miller, of this city. In an interview to-day he said he was now at work on an invention whereby electricity would be produced direct from coal discharging entirely with the use of batteries, etc., now required. Besides, he said, it would do away with the entire heating of coal before it could be converted into electricity, as is done by the present system of burning. "It will be

Mercury, San Jose, Cal.
Dec. 25, 1888.

EDISON'S INVENTIONS.

He Can Now Produce Electricity Direct From Coals.

Akron (O.), December 27.—Thomas A. Edison spent Christmas with his father-in-law, Lewis Miller, of this city. In an interview he said he was now working on an invention whereby electricity would be produced direct from coal, dispensing entirely with the boiler and engine, etc., now required. Besides, he said it would use the entire heat units of the coal, instead of only about 5 per cent, as is done by the present system of burning.

Press, Troy, N. Y.
Dec. 25, 1888.

Edison is trying to devise a means to produce electricity direct from coal without the intermediate process of steam production. There is more waste of coal than of any other necessary material. Only a small percentage of it, less than it produces is useful. An invention that would make all the heat available would be as great a boon to mankind as any that the human brain has made.

Evening Herald, Syracuse, N.Y.
Dec. 25, 1888.

EDISON'S NEW IDEA.

He Contemplates Producing Electricity Direct From Coal.

AKRON, O., Dec. 24.—Thomas A. Edison, the electrician, is spending the holidays with his father-in-law, Lewis Miller, of this city. In an interview to-day he said he was now at work on an invention that would produce electricity direct from coal discharging entirely with the use of batteries, etc., now required. Besides, he said, it would do away with the entire heating of coal before it could be converted into electricity as is done by the present system of burning. "It will be

Evening Telegram, N.Y.
Dec. 24, 1888.

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Evening Telegram, N.Y.
Nov. 17, 1888.

EDISON'S NEW IDEAS

HE BELIEVES ELECTRICITY IS THE COMING POWER.

We Must First Discover How to Produce Electricity from Coal Without Wasting Its Energy in Heat—Look at Edison's Laboratory—He Has Little Faith in Aerial Navigation.

If you meet Edison this morning he has just discovered something, and if you meet him to-morrow he has added a new find in the realm of scientific invention. It is hard to keep up with him. Probably no investigator in the field of science has ever been surrounded by such perfect conditions for prosecuting his researches. This has not always been so, of course, for Thomas Edison has discovered, among other things, the way of making money.

His laboratory is about a mile from the station at Orange, on the Delaware, Lackawanna and Western Railroad. His charming home is set far removed in the beautiful rolling foothills of Llewelyn Park. Within the inclosure where his working plant is situated stands a large three-story brick building. This is the laboratory, a perfect bastion of energetic experimenting. To the north of the building are three smaller ones, all about the same size.

AN UNPLEASANT ATMOSPHERE WHERE RUBBER GLOVES ARE NECESSARY.

One of these is for ore milling, for Edison contends that the best ore for fertilizers comes from the baser metals. The building next to this is the machine shop for assembling, where the heavier stuff is kept.

Next to this is the galvanometer room, or building, for measuring experiments with electricity. Edison's office is in the main building, and connects with the electrical establishment, and the machines rest on masonry piers that run from the bottom into the ground. The bolts and every metallic part of the instrument is of brass to avoid deflection at the needle.

Within one enters the laboratory he is confronted by a placard which informs the intruding visitor that Mr. Edison is so occupied with his work that he cannot be seen. Below are greetings to callers, and the like, unpleasantly. Happily, an acquaintance so near the door of the sanctum himself, the placard of its business-like inhospitalities. He was engaged at his usual occupation, that of experimenting with electricity, and hugged close to the corner of an office desk.

This time of writing admitted of a cursory glance at the building. There is a fine library room, with numerous shelves, and a large table covered with books and papers. There is a stenographer in attendance, and a clerk. Then there is a science room, and the large annex brilliantly lit by electric lights. There are hundreds of these being constantly tested in the building, and there is a constantly increasing number of new ones being experimented on. He has 107 men in constant employment in this place at Orange. Mr. Edison is conducting experiments

Boston Journal, Boston, Mass.
Dec. 25, 1888.

EDISON'S NEW IDEA.

What Edison is Hacking His Brains Over.

Edison's friends, Akron, O., where the wizard and Edison is spending the holidays at his father-in-law's, says, that he is working on an invention whereby electricity may be produced direct from coal, without at the same time wasting power in converting water into steam to boilers, and that into power, and that the great electrician believes that he may be able to use almost all the heat units of the coal instead of from 5 to 10 per cent, as at present. This is something which Edison has been working at for two years. With hints from this scientists whom he has consulted he has made practical headway in the solution of the great problem. From the conclusion I may in which he now assists he has apparently made some progress since he last spoke for publication on the subject, and has hopes that he may reach the heart and core of the mystery. If he succeeds he will be the greatest benefactor the human race has known since the mystical days when Prometheus stole the fire from heaven and gave it to man. All the cunning and valuable inventions with which his name has been associated, the quadruplex, the phonograph, and the incandescent light—will shrink into insignificance and will be regarded as the mere idle thoughts of a leisure moment. If he is able to discover how electric energy the most that lies in the carbon and hydrogen of coal he will have given to man the greatest gift that man can use of Nature, unless it be the secret of the winds and rains. He will have multiplied by ten the present capacity for work of every ton of coal in the world, and will thereby have decuded our mechanical powers. He will have revolutionized the world of machinery. What the Cuvies began to do in the primitive water wheel of the Egyptians of the days of Pharaoh that will Edison's device so to the newest steam engine. Steam engines and gas engines will all go to the junk shops, and new plants—when one cannot yet tell—will be taken their place. Should Edison make such a discovery, all we ask of him is that he will be moderate, and that he will not charge so high a royalty as to heap up for himself a fortune of more than a thousand million dollars during the life of his patent. It will be in his power to control the accumulated wealth of all the Rothschilds and Vanderbilts, and as concentrate on himself—the hatred and scorn that would be now lavished on Gould. Investors look out no patent on six discovery and draw up his papers in unending fans, but to suggest the gods and bad to suffer for it. It is necessary that the public may be put on to imitate him to the point of angering Zeus.

Budget, Boston, Mass.
Dec. 25, 1888.

Thomas A. Edison says he is now experimenting on an invention whereby electricity would be produced direct from coal, dispensing with boilers, engines, dynamos, etc. He thinks, he said, this would use nearly the entire heat of coal, instead of only about five per cent., as done by the present system of burning.

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be "about sixty different though some of them entirely outside the field of electricity, though, think they can very well so-exist in the one of course, to where are closely in this inventor-man. ment. As soon as I find that something I am at work trouble, where so much is still unknown. wantingness does not lead to practical results, Am engine of forty horse power runs all the long I do not consider it as an idea machinery of shops, though there is a genuine scientific man would do nothing. I do not care larger motive power seeking."

On the third floor there is at the western extremity a good sized lecture room, where lectures on interesting points in physics and chemistry are delivered by the professors of the workpeople. Experiments are performed here before all, although he has the valuable gift of explaining his inventions in non-scientific parlance which they involve, with much clear-ness and precision. He is a man who has clear thought as well as subtlety, can grasp the idea at once.

In this room is a grand piano, one made for Josef Hofmann, and sent to Mr. Edison for his opinion. Some young phenomenon has completed his vocal education on the new talking phonograph. Dozens filled wax cylinders were before long stored on the floor. Verse-rafters are the favourite records of some pleasure-seeni, and when one is fitted on the rear cylinder of the phonograph and the glass-tipped speaking tube adjusted to the ear, as in the pictures, the sufferer hears the sound of a still harsh, clearly disarticulating the different instruments, or some vocal solo with piano accompaniment; or one conventional remarks, or an address by the inventor. The best records of the kind made in Europe was played into the ear, with every intonation, emphasis, or lassitude recorded or not. It is a wonderfully accurate talking instrument. It is an inexpressive machine. Mr. Edison's own voice is the best record of all. Its nerves regulate everything that has to be done.

The rolling of the adjoining room was blasted with electric lights, which studded its entire floor with a galaxy of little stars.

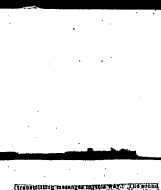
"The quarter of an hour's grace in the twenties, or more than up after a walk through the laboratory, and, after getting on the library on the ground floor, Mr. Tate, the genial business manager of the establishment, went out to see Mr. Edison.

In a moment he came in, with a cigar box under his arm, dressed in a black suit and a flannel shirt with a carelessly knotted tie. After the manner of a man who in the building would never dress, he looked as he was one of the humblest employees. He was delighted to get his best look at me as the first re-mark about at him. In the ordinary tone of conversation for the full, the inventor of the telephone, Edison, the inventor of the phonograph, is deaf. He has a round face, brown hair, good-natured, ordinary air, and fond of an easy posture when he is sitting talking, with

DRIVING EDISON'S 1,000 VOLTS

"What is your best trick in the field of science, Mr. Edison?" was the first question.

"I am not a scientific man," was the rather unexpected response. "I am an inventor. There is a difference between them. Although it may prove heresy to say so, I don't believe in pure science myself with the theory. I do believe in practical. An inventor is essentially practical. I've been at work all night, and all day, and



Thomas A. Edison.

that you rarely find the two together." I do not trouble myself about the theories. I have got the facts and through experiment I discover the principles. I am a practical man. I am always experimenting to see what I can get out of things. I don't care a rap about the theory. I'm only after the dollars."

"What was it you did first?" was the question put to the inventor who was responsible for the duplication of the cylinders for the phonograph.

"How there can be success so easily as one, and absolutely so easy as the opposite, after so many years from now if the principles are known, I cannot understand. It is as absurd, as if I really can bear it as well as you could by suggesting the epidiascope as an instrument."

"Years ago, some talk of light about the air ship as a vehicle of transportation."

"Yes, I have given a little thought to it, but not to be regarded as at all practicable for any more ordinary. Do you think this is a practical thing?"

"Make the gas, or any lighter than the air. It will always be at the mercy of the wind. None of the science of the matter is understood, and the practice of it seem feasible, or give promise of success. I have given some thought to the subject, and have experimented more or less with it. But my conclusion is that, unless some apparatus could be invented by which the balloon could be kept steering, the whole cannot be subjected to practical which will counteract the influence of the currents."

"What about electricity in connection with balloons? Can it be used in any way?"

"Nothing practical. If one can make a balloon dirigible without electricity can be questioned. But without the energy being present in heat, and the means of doing this cannot be accomplished at a reasonable expenditure, then the application of electric power as a motive power is impossible. Some other motive power will be found, probably, before many years, but it has not been discovered yet. Electricity as a motive power is a gem of the first rank, but when the means of relaying or producing electricity are considered, the cost is prohibitive. Unless this enormous waste of energy is brought down about, 330 tons of coal will do the work of 1,000 horse when it is burned and steam employed as the motive power. But this can't be done with the present means of producing electricity. The great loss of energy is in the combustion. What is accomplished this result under laboratory conditions, but these will not go to make the process available from a commercial point of view.

"Still there is nearly an immense field for advancement in electricity as a motive power. Nothing has been done in the way of storing it. The term of years required in the past has been about vanished. There is only one force, and that is energy. It comes in many forms, as the molecular movement or a mass movement, and it is the province of science to deal with the problems of the universe. Hence you see now that, if the latent force in coal can be relied on as electricity without waste as soon as it is got, it would be combustion, it will take the great place in the world. It is a question of time and conditions. It is not a matter of science as to-day, this are about on a par with buying to-get a horse and carriage for a million dollars. I was, on the 5th of February, 1851, and sold for hundreds of dollars to William Jones, of Newark, N.J., and he has it with a cosy smile. It is full of a day banner with a gold fringe and other useless frequently, no matter what may be the theme.

"Do you suppose the interstate nature of electricity will ever be discovered?" was asked him in reply.

"Yes. I think it can and will be some day. There are thousands working at these things, and from all the different men that is collected on the subject of electricity somebody will find out the secret. It will be a matter of accident or of the greatest of intellect, etc. Indeed, they are not invented—they discovered, the telephone is still not invent it. He was making experiments on telegraphy by sound, and happened upon what is the transmission of the sound waves.

"What do you think of the Keely motor?"

"I don't think much of it. The biggest work it has done so far has been to enable Keely to wear diamond studs and drive good horses. Then that invent a thing or discover a thing which will do what he says it will do, and which don't pay any facts in it, and doubt if anything ever comes of it."

"Has anything been done in this line of telegraphing from a moving train?"

"Yes. The system is perfect now. The Lehigh Valley road has twenty trains equipped for transmitting messages by means of the induction system. The idea is to have a wire along the track and through it operate it. The current is induced into the moving train. A diagram of the system has been given out by the company. I do not know whether the wires are on or off the ground, or whether they are in a pipe conduit."

Speaking of the Gilmore, which that Keely system wears on his coat, the Lehigh Valley road has its name and not the name of the inventor, Edison, with a grin. "That wear rubber gloves, and somebody told me that he saw the lineman put them on to climb the pole. I don't believe it, look."

We had one dog that received a current of electricity every morning and the old fellow survived it. We concluded to let him live after that, and he is alive to-day. He is still with me, ever after his shock. We call him Edison, because he played with the thunder-bolts."

"What else have you been doing of late?" in-quired the interviewer of Mr. Edison, as he rose to go.

"Too many things to tell you. I've been experimenting a good deal with microbes, trying to understand the beast and see how they work. I've been trying to get them in line, and see what they can be made to do. I've got a microbe in order if probably at the bottom of that, and if we could know how to catch them and take their tongs out they would be less harmful. One pencil have to harness an ox, or my colleague has been waiting half an hour, and it is time for me to be off. Good-by. I am dressed if I do not get home till as late."

So, with a cheery good night, the great inventor got into his team and drove off through the wet, leaving the impression that here was an instance of where the scientific theory is practical.

Argus, Portland, Me.
Oct. 9 1888

According to Thomas A. Edison, the next great economic invention will be the production of electricity direct from coal. That there is more or less electricity in every substance has been long claimed by scientific men.

Argus, Albany, N.Y.
Dec. 25, 1888.

Edison is reaching his brains to perfect a invention whereby electricity may be produced direct from coal, without all the intermediate processes of converting water into steam and that into power. What he is about is why does he not work to get the electric fluid direct from the sun, instead of using the power it has stored up through all the countless ages in the black diamonds? One should be an easy for him as the other.

Times, Emmanuel Cal
Dec. 26, 1888

Thomas A. Edison spent Christmas with his father-in-law, Lewis Miller, in Akron, Ohio. He is now experimenting on the invention whereby electricity would be produced direct from coal, dispensing entirely with boilers, engines, dynamos, etc. Besides, he said, he would use nearly the entire heat units of the coal, instead of only about five per cent. as is done by the present system of burning.

Commercial Herald Ohio
Dec 28 1888

Mr. Edison is experimenting on a process for getting electricity directly from coal, thus doing away with boilers and steam engines, and greatly reducing the expense. Should he succeed, it will create a great revolution.

Commercial Bulletin
San Francisco

Electricity direct from coal is again being experimented upon. A despatch from Akron, O., states that Thomas A. Edison, the electrician, who has been visiting in that city during the holidays is now devoting nearly all his time to experimenting with a contrivance that will produce electricity direct from coal, thus dispensing with all costly machinery now required, besides utilizing nearly the full strength of the material, instead of about five per cent., as is the case at present. "It will be done," said Edison in conclusion.

Sun, Santa Cruz, Cal.
Dec. 28, 1888.

EDISON ON ELECTRICITY.

He Will Produce it from Coal, Without Boilers, Engine or Dynamos.

Akron, Ohio, Dec. 27.—Thomas A. Edison spent Christmas with his father-in-law, Lewis Miller of this city. In an interview he said he was now working on an invention whereby electricity would be produced direct from coal, dispensing entirely with the boilers, engines, dynamos, etc., now required. Besides, he said, he would use nearly the entire heat units of the coal, instead of only about 5 per cent, as is done by the present system of burning.

Chronicle, San Francisco, Cal.
Dec. 27, 1888.

EDISON'S AMBITION.

The Wonderful Sharpening of the Scientific Genius Hopes For.

Akron, Ohio, Dec. 27.—Thomas A. Edison spent Christmas with his father-in-law, Lewis Miller, of this city. In an interview to-day he said he was now working on an invention whereby electricity would be produced direct from coal, dispensing entirely with the boilers, engines, dynamos, etc., now required. Besides, he said, he would use nearly the entire heat units of the coal, instead of only about 5 per cent, as is done by the present system of burning.

Times, San Jose, Cal.
Dec. 31, 1888.

Akron, Ohio, Feb. 27.—Thomas A. Edison spent Christmas with his father-in-law, Lewis Miller of this city. In an interview he said he was now working on an invention whereby electricity would be produced direct from coal, dispensing entirely with the boilers, engines, dynamos, etc., now required. Besides, he said, he would use nearly the entire heat units of the coal, instead of only about 5 per cent, as is done by the present system of burning.

Evening Bulletin
San Francisco Cal.
Jan 2, 1889

ELECTRICITY.

Its Combination from Coal, Without Boilers, Engine or Dynamos.

Akron, Ohio, Dec. 27.—Thomas A. Edison spent Christmas with his father-in-law, Lewis Miller of this city. In an interview he said he was now working on an invention whereby electricity would be produced direct from coal, dispensing entirely with the boilers, engines, dynamos, etc., now required. Besides, he said, he would use nearly the entire heat units of the coal, instead of only about 5 per cent, as is done by the present system of burning.

Evening Chronicle
San Francisco Cal.
Jan 3, 1889

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Electricity From Coal.

A dispatch from Akron, O., where the wizard Edison is spending the holidays at his father-in-law's, says that he is working on an invention whereby electricity may be produced direct from coal, without all the intermediate processes of converting water into steam in boilers and that into power, and that the great electrician believes that he may be able to see about all the heat units of the coal instead of from 5 to 10 per cent, as at present. This is something which Edison has been working at for ten years, according to the Chicago *Tribune*. With hints from the scientists whom he has consulted he has made gradual headway in the solution of the great problem. From the confident way in which he now speaks he has apparently made some progress since he last spoke for publication on the subject, and has hopes that he may reach the heart and core of the mystery. If he succeeds he will be the greatest benefactor the human race has known since the mythical days when Prometheus stole the fire from heaven and gave it to man. All the cunning and valuable inventions with which his name has been associated — the quadruplex, the phonograph, and the incandescent light — will shrink into insignificance and will be regarded as the mere idle thoughts of a leisure moment. If he is able to convert into electric energy the power that lies in the carbon and hydrogen of coal he will have given to man the greatest gift that man can ask of nature, unless it be the control of the winds and rains. He will have multiplied by ten the present capacity for work of every ton of coal in the world, and will thereby have decupled our mechanical powers. He will have revolutionized the world of machinery. What the Corliss engine is to the primitive water wheel of the Egyptian of the days of Pharaoh that will Edison's device be to the present steam engine. Steam engines and gas engines will all go to the junk shops, and new plants — what we cannot yet tell—will take their place. Should Edison make such a discovery, all we ask of him is that he will be moderate, and that he will not charge so high a royalty as to heap up for himself a fortune of more than a thousand million dollars during the life of the patent. It will be in his power to outvie the accumulated wealth of all the Rothschilds and Vanderbilts, and to concentrate on himself the hatred and abuse that are now lavished on Gould. Promotheus took out no patent on his discovery and took his pay in unendurance. Edison, we fear, would be more modern, and he angered the gods and had to suffer for for it. It is possible that Edison may prefer not to imitate him to the point of angering Damos.

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Times, St. Charles, Minn.
January 31, 1889

THOMAS A. EDISON, the great electrician, passes the holidays with his father-in-law, Lewis Miller, of Akron, O. In an interview with a reporter he said he was now working on an invention whereby electricity would be produced direct from coal, dispensing entirely with the boilers, engines, dynamos, etc., now required. Besides, he said, he would use nearly the entire heat units of the coal instead of only about five per cent., as is done by the present system of burning.

Tribune, Evansville, Canada
January 3, 1889.

Edison's Latest Discovery.

Mr. Edison is now working on an invention whereby electricity may be produced direct from coal. If he succeeds he will have multiplied ten fold the present capacity for work of every ton of coal in the world and will have given to man the greatest gift that man can ask, unless it be one of quiet, the shirtmaker's, three fifty natural wool night robes.

Republican, Monmouth, Ill.
January 3, 1889

Mr. Edison says: "Undoubtedly the next great discovery will be some method of getting electricity from coal direct without the intervention of boilers to make steam, driven engines to run dynamos, which in their turn, with the intervention of magnetism, do work, whether in operating motors or in making light."

Journal, Kansas City, Mo.
January 14, 1889.

Mr. Edison says: "Undoubtedly the next great discovery will be some method of getting electricity from coal direct without the intervention of boilers to make steam, steam-driven engines to run dynamos, which, in their turns, with the intervention of magnetism, do work, whether in operating motors or in making light."

World, Detroit, Mich.
January 27, 1889

MR. EDISON'S LATEST EXPERIMENTS.

Mr. Edison, the Anglo-American expects, is now engaging on an invention whereby he expects that electricity may be produced direct from coal, dispensing with boilers, engines, dynamos, etc. Besides," he says, "this would use nearly the entire heat units of the coal instead of only about five per cent., as done by the present system of burning."

Herald, Chicago, Ill.
January 27, 1889.

Mr. Edison says: "Undoubtedly the next great discovery will be some method of getting electricity from coal direct without the intervention of boilers to make steam, steam-driven engines to run dynamos, which, in their turn, with the intervention of magnetism, do work, whether in operating motors or in making light."

Beacon, Albion, Ohio January 3, 1889

A TALK WITH EDISON.

APPLYING FORCE FROM COAL DIRECT THE NEXT DISCOVERY.

WHAT IS BEING DONE WITH THE PHONOGRAPH—SOME ELECTRIC LIGHT EXPERIMENTS IN AKRON.

From Monday's Daily Beacon.

Thomas A. Edison and Mrs. Edison, and their children, Miss Marion Thomas, William and Madeline, arrived in the city on the 12:17 Npsom train this afternoon, and will spend Christmas and the balance of the week at Oak Place, the home of Mrs. Edison's parents, Mr. and Mrs. Lewis Miller. Mr. Edison had scarcely finished his dinner when he donned hat and overcoat and set out in company with Mr. Lewis Miller to visit the station of the Akron Electric Light Co. Mr. Edison recently sent one of his dynamos to Akron and it was put up at the Standing-Ely Co.'s station, for supplying electricity for 40 incandescent lamps. After seeing that the machine worked perfectly, Messrs. Edison and Miller went across to the power house on the Akron Street Railway Co. Here they were joined by Mr. Gaud, of New York City, one of Mr. Edison's assistants, who has been in Akron experimenting at the Falls Rubber Shops on apparatus for furnishing interchangeably a current for arc and incandescent lights. The results so far attained have been quite satisfactory.

On his return to Oak Place Mr. Edison received a Beacon reporter in the living room on the third floor, where a mammoth Christmas tree has been equipped with 40 incandescent lamps which burst into a blaze on the turning of a switch. In answer to the first question about the phonograph, which is, of course, the absorbing topic in connection with the great electrician's name just now, he said:

"We employ now about 350 men and boys at our phonograph factory in Orange, N. J., and expect to increase the number to 500. I have issued an order that will require 85 machines a day for six months."

"What class of people do you assist?"

"Oh, it will be used chiefly in offices for correspondence. And then actors and singers use it."

"In what way is it useful to a prima donna, for example?"

"Well, there's one thing about that that I don't exactly understand, but it seems that singers can't judge with the ear of the imperfect tones made in their own voices. You know when you hear your singers in your ears and talk, your voice sounds very strange. There are sounds of all the tissue and bone and muscle of the head. An imperfect tooth for instance would make a defect in the vibrations. Now into phonograph you can record every voice but your own, and in the reproduction of your own tones there is something that takes out these peculiarities and imperfections of the vibrating substances of the body."

"What recent experiments have you made with the instrument?"

"I am constantly in receipt of phonograms from England. . . . got one the other day that reproduced the 4,000 voices of the Haydn and Handel Society of London. The Gaiety Theatre Co. from London is over here, you know. Some time ago one of the young ladies came over to Orange and sang into the phonograph. The phonogram was sent back to London and at the Gaiety Theatre there they reproduced the voice of one of their own singers. Sir William Thomson sent me a phonogram the other day, in which he says that the phonograph is a perfect elucidation of the mathematical conception of sound."

To the question, what the next great achievement in the line of electrical discovery would be, Mr. Edison said:

"The next thing will be some simple contrivance by which we can turn coal into electricity direct, without the intervention of boilers and engines and dynamos. We now utilize as power only 4 or 5 per cent. of the force in coal. That is, we put one horse power out of five buckets full of coal. We might as well put five or six horse power out of one bucket full. A good many men are working upon this. I have been at it for some time. It's going to be done. All that expensive machinery for getting work out of coal will be done away with."

Democrat, Watertown, Dak.
July 1, 1889

Mr. Edison says: "Undoubtedly the next great discovery will be some method of getting electricity from coal direct without the intervention of boilers to make steam, steam driven engines to run dynamos, which in their turn, with the intervention of magnetism, do work, whether in operating motors or in making light."

Record, St. Cloud, Fla.
July 2, 1889

"The great developments in electricity will result, I am firmly convinced," said Mr. Edison to an interviewer in Paris, "in discovering a more economical method of producing it. At present we only get from coal consumed about four or five per cent. of its latent electricity. The rest is wasted in heating water, expanding steam, pushing pistons, turning wheels, and finally moving a dynamo machine to operate. A process will ultimately be found for extracting ninety or ninety-five per cent. of the electricity directly from the coal. Then steam engines will be abolished, and that day is not very far off now. Already we can get electricity directly from coal to the amount of ninety per cent., but only for experimental purposes. When I was on shipboard coming over I used to sit on deck for hours and watch the waves. It made me positively savage to think of all that power going to waste. But we'll claim it up one of these days along with Niagara Falls and the wind. That will be the electric millennium."

Tribune, Minneapolis, Minn.
July 21, 1889

Advocate, Newark, Ohio
January 3, 1889

ELECTRICITY AS FUEL.

Charles H. Carpenter's Invention for Utilizing Electric Heat.

Charles E. Carpenter, the young man who has obtained considerable notoriety lately for his unsafe fire electrical research, and his dog killing apparatus, has just completed an invention which bids fair to make for him both fame and fortune among the profession of electrical engineers. There is no application of electricity in which students of that science have not been very successful, and this is the production of heat. The difficulty does not lie in the simple production of heat, but in its concentration as one piece, so that electricity can be used as economically as common fuel. The problem with all electrical engineers, who have turned their studies in this direction, was to discover some means of heat insulation, and in this Mr. Carpenter has succeeded. He considers this is the last link in the problem to a practical way, and his opinion is said to allow been thoroughly indorsed by some very able electrical engineers of this city and Chicago, who have been shown his plans.

This secret will not be disclosed until after the patents are issued, which will be applied for in a few days. The principle of the invention is such that a person could sit with a griddle in his lap and fry cakes without feeling the heat. The heat is confined to a smooth steel surface in the middle of the griddle, and on either side and the bottom the range of insulation is perfect. The heat is applied in the same manner as it is applied to the smooth surface of a laundry roller, instead of steam, which is frequently used at present. It will also be applied under coffee urns and other utensils in the kitchen, and in the same manner as in the griddle. It will be as easy to arrange that the greatest economy in the use of the electricity is obtained as that it will cost no more than gas or other cooking fuels. A switchboard is furnished, by which the current can be turned on and off at will, and the convenience of the invention.

F. W. Stevens and John W. Estey are interested with Mr. Carpenter in securing the patents, and Mr. Stevens will apply to-day for letters patent. Two years with a capital of from $50,000 to $100,000 is asked for in the various circuits. Mr. Carpenter, the inventor, has been in the city several years, and during that time has conducted an eight cent at Taylor's restaurant. All of the time he could spare from his special business he was pursuing his studies in electricity, and the result of his application and experiments is the invention acquired by yesterday alone, inasmuch as he locked the means to complete his course at Cornell University, where he began his studies. His invention will help to prove of great practical value, and he believes it will revolutionize the whole system of using the materials necessary to produce the required degrees of heat in that which is used in an ordinary kitchen household range. A. Taylor has made a contract with the inventor to introduce it in his establishment, and is having a range put in to be operated by it manufactured after Mr. Carpenter's plans for use in his restaurant, where the first practical operation will be seen within a few weeks.

Bizzard, Gridley, Pa.
January 12, 1889

Mr. Edison says: "Undoubtedly the next great discovery will be some method of getting electricity from coal direct without the intervention of boilers to make steam, steam-driven engines to run dynamos, which, in their turn, with the intervention of magnetism, do work, whether in operating motors or in making light."

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Advocate, Newark, Ohio
January 3, 1889

Graphic, N. Y.
January 5, 1889.

THE NEXT DISCOVERY.

Being asked what he thought would be the next field in which electrical invention would employ itself, Mr. Edison said: "Undoubtedly the next great discovery will be some method of getting electricity from coal direct without the intervention of boilers to make steam, steam-driven engines to run dynamos, which in their turn, with the intervention of magnetism, do work, whether in operating motors in making light. Such a combination would mean one bucket of coal furnishing one horse-power for ten hours a day. That is, we get five or six per cent. of the force of coal for one horse-power, whereas we ought to get five or six horse power out of one bucket. That is, we get five or six per cent. of the force of coal direct, whereas by obtaining electricity direct we should get nearly five per cent. This economy of coal is the great desideratum. I am not working in the direction of this discovery, although it would be a good thing in itself. The thing a good many men are working on—and I have been doing a good deal at it—is to get a simple and inexpensive apparatus for applying the force that is in coal to the production of heat. I think that would revolutionize the world of machines, for it would do away largely with boilers and engines. So, it is nothing like what Keely is after, because he is trying to get something out of nothing. The thing I speak of is bound to be done."

Journal, Susquehanna Bridge, N. Y.
January 12, 1889.

THOMAS A. EDISON says he is now experimenting on an inventing whereby electricity would be produced direct from coal, dispensing with boiler, engines, dynamos, etc. This he says would use nearly the entire heat of coal instead of only about five per cent. as done by the present system of burning.

Herald, Hornick, N. Y.
January 19, 1889.

Hurry It Up.

Thomas A. Edison is develing nearly all his time to experimenting with a contrivance that will produce electricity direct from coal, thus dispensing with all the costly machinery now required, besides utilizing nearly the full strength of the mineral, instead of about five per cent., as is the case at present. "It will be done," says Edison.

Times, Mohawkville, Ohio
January 1, 1889.

THOMAS A. EDISON, the great electrician, passed the holidays with his father-in-law, Lewis Miller, of Akron, O. In an interview with a reporter he said he was now working on an invention whereby electricity would be produced direct from coal, dispensing entirely with the boilers, engines, dynamos, etc., now required. Besides, he said, he would use nearly the entire heat units of the coal instead of only about five per cent., as is done by the present system of burning.

The Omaha Bee

Editor is Making the Drama.

Chicago Tribune: A dispatch from Akron, O., where the wizard Edison is spending the holidays at his father-in-law's, says that he is working on an invention whereby electricity may be produced direct from coal, without all intermediate processes of converting water into steam to drive and that into power, and that the great electrician believes that he may be able to use about all the heat units of the coal instead of from 6 to 10 per cent, as at present. This is something which Edison has been working at for ten years. With hints from the scientists whom he has consulted he has made gradual headway in the solution of the great problem. From the confident way in which he now speaks, he has apparently made some progress since he last spoke for publication on the subject, and has hopes that he may quench the heart and core of the mystery. If he succeeds he will be the greatest benefactor the human race has ever known since the mythical days when Prometheus stole the fire from heaven and gave it to man. All the cunning and valuable inventions with which his name has been associated—the quadruplex, the phonograph, and the incandescent light—will shrink into insignificance and will be regarded in the more idle thoughts of a leisure moment. If he is able to convert into electric energy the power that lies in the carbon in a lump of coal he will have given to the greatest gift that man can ask, and will have placed the control of the winds and waves in the hands multiplied by ten thousand. The work of every ton of coal in the world and will thereby have to decuplied our mechanical powers. He will have revolutionized the world of machinery. What the Curtis engine is to the primitive water wheel of the Egyptian of the days of Pharaoh that will Edison's device be to the present steam engine. Steam engines and gas engines will all go to the junk shops, and new plants—what we cannot yet tell—will take their place. Should Edison make such a discovery, all we ask of him is that he will be moderate, and that he will not charge so high a royalty as to lump up for himself a fortune of more than a thousand million dollars during the life of the patent. It will be in his power to outrival the accumulated wealth of all the Rothschilds and Vanderbilts, and he can retire on himself the hatred and odium that are now lavished on Jay Gould. Prometheus took out no patent on his discovery and drew his pay in unending fame, but the angered Olympian lord had to suffer for it. It is possible that Edison may prefer not to imitate him to the point of angering Domos.

ELECTRICAL SCIENCE.

Electricity directly from Heat.

ATTEMPTS to generate electric currents, by utilizing the fact that magnetic metals lose their magnetic properties when sufficiently heated, have been made for some years. It is only recently, however, that such experiments have been made on a practical scale, and with any promise of ultimate success. When we consider that in the most economical source of electricity, the dynamo-electric machine, we transform the energy of our fuel to the energy of steam under pressure, then through the steam-engine to mechanical work, and finally by the dynamo to the energy of electrical currents, losing energy in each transformation, our ultimate return being perhaps ten per cent of the energy expended; when we add to this the complication and expense of a steam-plant, — it would seem that, even if our means of direct conversion is not so economical as the dynamo, yet if it have any reasonable efficiency, and is simple of construction, it would supplant the older method.

In August of 1887 Mr. Edison read before the American Association for the Advancement of Science a paper on pyromagnetic generators. Briefly the principle on which his machine was built is this. If a piece of iron wrapped with wire be put between the poles of a magnet, a number of lines of force will pass through it, and therefore through the coils of the wire, depending directly on the strength of the magnet and on the magnetic permeability of the iron. Now, it is well known that the permeability of iron becomes very nearly zero when it is raised to a bright red heat: so, if we heat the iron, the lines of force through it will decrease, and this decrease will cause an electro-motive force in the coil of wire. When the iron cools, there will be an increase of lines of force, causing an electro-motive force in the opposite direction. Mr. Edison's machine, built on this principle, consists of eight horseshoe magnets arranged in a circle, the poles facing inward; and between the poles of each is a roll of this laminated iron covered with asbestos and wrapped with wire: we will call these the armatures. This is placed over a furnace, and beneath it revolves a half-circle of fire-clay, which shields half of the armatures from the heat. If this shield be turned continuously, half of the armatures are being heated while the other half are being cooled; and the electro-motive forces in the two halves, which would be in opposite directions, are added by a commutating arrangement on the shaft of the shield. A blast of cold air assists the cooling of the armatures.

In his paper, Mr. Edison gave no data as to the performance of the machine, except the statement that a generator to feed thirty incandescent lamps would weigh two or three tons.

Nothing has been heard lately of this generator: it will naturally take time to perfect it and make it practical.

Within the last month, however, attention has been called to a machine using the same general principle as that of Mr. Edison, but differing greatly in detail, — an invention of M. Menges of the Hague.

One form consists of a Gramme ring within which is a stationary electro-magnet. The two are horizontal, and are separated by a considerable air space: this space is filled by a zigzag ribbon of iron extending around the inner circumference of the ring, with which it revolves. Now, if this ribbon of iron be cold, most of the lines of force will pass through it from one pole to the other of the magnet: few will go through the armature. If, however, the ribbon be heated at points at right angles to the poles, the magnetic resistance will be increased, and most of the lines of force will pass through the armature: there will be no motion, since every thing is perfectly symmetrical. If, now, the heat be applied to the ends of the same diameter at points forty-five degrees from the pole, the symmetry disappears, and there will be a rotation. Now, the Gramme ring rotating in a field of force will generate currents as in an ordinary dynamo-electric machine. In reality, then, we have a motor-dynamo arrangement, the former transforming the energy of heat into motion, the latter transforming the energy of motion into electrical energy.

Both the 'pyromagnetic generators' of Mr. Edison and M. Menges are an advance on previous machines of this type. It is difficult to see, however, how, in their present form, either can produce any very considerable quantity of electrical energy, with any reasonable size of apparatus. The publication of reliable figures on the performance of these machines would be of great interest.

Menlo Park Scrapbook, Cat. 1039

No. 25. "Telegraph Apparatus"

This scrapbook covers the years 1873-1882 and contains clippings about telegraphy. Many of the clippings for the mid-1870s are advertisements for telegraph apparatus. There are 132 numbered pages.

Blank pages not filmed: 70-132.

1039

Telegraph Apparatus
other than Duplex Quad or Multiplex

Part 25.

NEWARK BOOK BINDERY & BLANK BOOK MANUFACTORY,
JOB & MERCANTILE PRINTERS.
WILLIAMS & PLUM,
777 Broad St., Newark, N. J.
STATIONERS and BOOKSELLERS,
MERCANTILE PRINTERS,
BOOK BINDERS,
FIRST CLASS BLANK BOOK MANUFACTURERS,
LITHOGRAPH CHECKS, BONDS, NOTES, &c.

Tel Journ Sept 1. 77

AN IMPROVED DOUBLE CURRENT KEY.

By P. TRIMMER, *of the Firvian Gulf Telegraph.*

FIG. 1 gives an elevation, and fig. 2 a plan of the connections of this key.

FIG. 1.

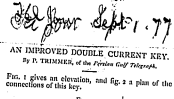
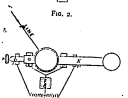


FIG. 2.



In Fig. 1, K is an ordinary Morse key. L is a brass beam, the two halves of which are insulated from each other at A. The beam works on an axis (shown by the dotted lines) beneath K, from which it is insulated, and plays between the back and front stops *b b'* and *f f'*; it is maintained in whatever position it may be last thrown by the action of K, by the rollers *r* and *r'*. These two rollers work on springs which are so adjusted that when the beam L *b* is in the position of rest, as shown in Fig. 1, *r* tends to press it downwards, and *r'* upwards. This order of things is reversed when K is depressed, as *r'* then presses L downwards and *r* presses it upwards. *s* and *s'* are two weak spiral springs by means of which the negative and positive poles of two batteries are maintained in connection with the back and front halves of L respectively. They exercise no influence over the movements of L.

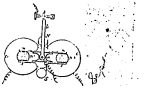
The back and front stops *b* and *f* are permanently in connection, and are to earth through the adjustable resistance marked "Shunt."

The action of the key K is as follows:—Fig. 1 shows the key at rest. The switch (not shown in the diagram) being turned to "send," the negative current passes on to the beam L at A, and at the stop *b* it divides between the shunt and line; if now K be depressed, L does not follow its movements immediately, being held in position by the spring *s*, but finally it is struck against by *f'*, at which moment the full positive current passes to line, and then L being pressed down until the stop *f* is reached, the shunt comes into play carrying off a portion of the current. The negative half of L has at the same time been raised from contact with the back stop *b*, and now occupies the same position with respect to *b* and *b'* as the positive half had previously occupied with regard to *f* and *f'*—viz., touching neither. If now K is allowed to fall back similar movements takes place first, the full negative current is sent to line at the moment L is struck, which continues until the position of rest is regained, and then the reduced current flows. This arrangement has been worked satisfactorily through 700 miles of cable from Kurrachee to Jask, but from the incomplete nature of the apparatus no reliable comparisons as regards speed with the ordinary "permanent" current keys have been obtained.

Tel Journ Oct 1. 77

THEILER'S PATENT RELAY.

THE peculiarity of this Relay consists in the novel construction of its magnetic armature and its combination with an electro-magnet, whereby the power is thoroughly utilised.



The figure gives in plan an outline-drawing of the relay. It consists of an ordinary electro-magnet *c c*, of which *p*, p_1, are the poles. Two light tongues or bars *a a*, and *z z*, of soft iron are mounted on a pivotted axis at *d*, their flat sides facing each other, and kept a certain distance apart by a short piece of brass, shown in the figure by the dark shading. The armature in fact somewhat resembles a double toning fork.

This armature is magnetised by a horseshoe permanent steel magnet, whose poles *x* and *x* are shown in the figure. These poles are in close proximity to the portions of the tongues *a a*, and *z z*, which, at the middle of their length, are made to project.

The magnet poles impart similar polarity to the ends of the tongues, to which they are respectively in close proximity to; consequently, when the electro-magnet becomes magnetised by a current, the whole armature tends to turn on the axis at *d*.

Fixed to the armature is a brass tongue *f*, which is furnished at its extremity with the usual platinum contact point playing between an insulated and a contact screw.

This Relay is found to give very good results, especially for fast speed working.

Tel Journ March 16 1878
Nat. Mus. 12. 1878

3950. "Receiving instruments and relays."—W. H. PAGET HIGGS. Dated August 19, 1872. 6d. This designs to utilise the loosening of friction by the reversing relays. One method consists in providing a continuously revolving disc of paper, or other suitable absorbent substance, moistened with water or a saline solution. On the moistened disc is placed a metal disc which is kept from revolving by a tension or friction force. The two discs are connected in circuit with the line. When the current passes, the usual friction between them is reduced, and the metallic disc consequently turns in a direction opposite to the rotation of the paper disc. An arm or tongue attached to the metallic disc is thus moved to and fro in obedience to the signal currents, and makes or breaks contact, or produces visible signals.

3130. "Receiving instruments of electric telegraphs."—J. and A. STEARNS. Dated August 17, 1872. 6d. This consists of a recorder, in which a rectangular coil of wire is made to rock to and fro between the poles of a magnet when the signal currents from the line are made to traverse it. The coil is suspended by two spiral springs coiled in opposite directions, and rigidly attached at their inner ends to the top and bottom of the coil, the whole being sustained by a single fibre at the top. A style dipping in ink, is used as the marker. The ink is stimulated to flow by the discharges from a Ruhmkorff coil.

MILITARY TELEGRAPHY.

SYSTEM OF M. TROUVÉ.

THE system of military telegraphy, invented by M. Trouvé, deserves to attract attention for two reasons; in the first place it furnishes an apparatus complete and sufficient in itself, and all that is required in the majority of cases; and, on the other hand, it has already been adopted by more than one European army, that is to say, it is not a new thing recommended only by the inventor, but a contrivance which has, up to the present, been appreciated by competent judges. The apparatus consists of a two-wire cable for connecting the two stations, a battery and a speaking instrument. Fig. 1 represents the line and the two stations, or, to speak in less technical language, the two correspondents. The officer to the right has selected his point of observation. He carries on his belt a battery, which you see at his side, and a telegraph instrument which he can put in his pocket, or hang on his epaulet between the intervals of corresponding.

The soldier who is at some distance to the left, carries on his back a bracket, similar to those used by the commissionaires in Paris; on this bracket, on the upper part, there is a large bobbin, on which is wound the cable, and on the lower part, the battery; and in addition to this he has a telegraph instrument, which is at the moment under consideration, suspended high up on the left side of the bracket.

In proportion as the soldier advances the cable unwinds itself and falls on the ground, the bobbin turning on its axis; the time for corresponding

FIG. 1.—MODE OF LAYING DOWN THE MILITARY TELEGRAPH OF M. TROUVÉ.

any hindrance to the communication. We should here remark that owing to the small electric resistance of the line, a slight leakage would be but of slight importance. The two conductors are joined to the battery of the stationary officer before the separation of the two telegraphists; the special terminals are lettered, so as to give rise to no mistake. Before starting they test their apparatus, by sending a short sentence in each direction.

After having again taken his position, the moveable telegraphist advises his correspondent by sending the word of command, and the exchange of messages can commence. The soldier carrying the bobbin seeks out paths inaccessible by carriages; if he has a certain route to traverse he would give preference to a locality where the trees would allow him to carry the wire sufficiently high to allow carriages and cannons to pass beneath it, for it will be understood that if the wire was laid the little telegraph by his hand begins to work communications. maintained without nor is it necessary ncealed; there is a ible, so that after se will be obliged to equally well at a for example, as the through the entire ground or on the

ulated conductors, gutta-percha, and der a covering of ption it can be laid , and can even be e a brook without

along the road it would run the risk of being crushed and cut by wheels passing over it. Practically, for this and analogous reasons, it is necessary to furnish the telegraphist with an assistant, for lifting the cable on the branches of trees and for various other emergencies. Further, when it is time to cease the communication, the telegraphist receives the order to return to the starting point, and there again a companion is necessary to wind up the cable on the bobbin, by means of a handle which is attached to the end of the axis to the right of the bobbin (fig. 2); he turns this and winds up the wire while the carrier walks slowly to facilitate the operation.

We have here shown two telegraphists, one stationary, the other moveable, separated by a maximum distance of a thousand metres. But the second may be accompanied by a third carrier, with a bobbin, &c., exactly the same; and when one of

continued to make room for carrying out the manufacture of his patent india-rubber, over which his arrangement with Messrs. R. S. Newall & Co., which, unfortunately, was cancelled by litigation between the parties. A few years later a partnership was entered into with Mr. (now Sir George) Elliott, and it was said that this arrangement on the part of Sir George Elliott was to induce the Gutta-Percha Company to combine with the firm of Glass and Elliott to form the present Telegraph Construction and Maintenance Company.

This was followed by a second arbitration, so that the first seven years of Mr. Hooper's patent flew past without the slightest pecuniary benefit. It is perhaps within the mark if we say that at least £25,000 was spent during these seven years to free his patent rights, and to allow of the working of his patents.

Not only did Mr. Hooper rely on his own individual resources for perfecting his patents and becoming a trial of the merits of his core, but he succeeded in removing a very strong feeling of opposition which at one time seemed too influential to admit of being overcome by a private individual. In the year 1864 several lengths of india-rubber insulated wires by different manufacturers were sent to India to test their durability and suitability for that climate. The only one which remained good was that made by Mr. Hooper. This led to the receiving several orders from the Indian Government, and established the reputation of his manufactures. We believe that about 15,000 miles of cable have been made with this core, the last of which, made and laid for the Cuba Submarine Telegraph Company in 1873, is a practical proof of its merits. Without exception it is, when well made, electrically, the most perfect cable in existence.

In the year 1870 Mr. Hooper's business as a contractor had increased so extensively that he formed a limited liability company, which was known as Hooper's Telegraph Works, Limited.

Little is known of what led to the collapse of this company, but at the time negotiations had been going on for making and laying a cable to the Cape, which, line" Hooper's Company had the contract, &c., from the Government. We have heard that the manufacture of an Atlantic cable for the French company was also being negotiated for.

Mr. Hooper was a liberal supporter of science, and we have been informed that no invention relating to submarine telegraphy which was submitted to him was dismissed without the most attentive study.

One very important matter which Mr. Hooper had worked upon was the protection of iron &c., used in the covering of cables. In his earlier patents he proposed covering of vulcanised rubber for this purpose. Attention is being again directed to the matter from the fact that two Atlantic cables are now defunct from the corrosion of the iron wires not allowing their being fished up.

It is a general opinion that Mr. Hooper largely profited by his company; this we believe is an error. If we consider that Mr. Hooper, in the first place, held over one-fourth of the total shares of the company, and that the latter was indebted to him for nearly £150,000. We can easily conceive that he would have been a great deal better off without the questionable extension of business

which it is considered necessary on the conversion of a flourishing undertaking into a limited liability concern. Few mortalities perhaps worked harder for an object whose fruit after disappointing results have followed. But not often that it is our pleasure to therefore have regretted to allow the moment to pass without adding our tribute of respect to the memory of the late William Hooper.

We fully believe that one very important benefit to submarine telegraphy, arose from his labours and those of other india-rubber manufacturers threatening the monopoly of gutta-percha as an insulator, which led to great improvements in gutta-percha cables.

VANDER PLOEG'S TYPE PRINTING TELEGRAPH APPARATUS.

THERE have perhaps been invented more varieties of type printing than of any other kind of telegraph instruments. Many of these differ from one another in but very unimportant details, and it is not often that any very distinct points of novelty are introduced. Mr. Ploeg's apparatus, however, decidedly possesses features which, as far as we know, are not found in any existing forms of printing instruments, and therefore it well deserves being brought to notice.

The apparatus consists essentially of a transmitter, a "speaker" and "reinforcer," and a receiving and printing apparatus.

The transmitter, fig. 1, is constructed with a handle 1, which in several revolutions imparts by means of a pinion 2, and wheels 3, 4, one revolution to an axis on which the needle 10 is fixed.

The handle has four optional points of rest, 6, 7, 8, 9, placed in horizontal and vertical lines, and in turning it forwards or backwards the needle 10 is turned in the same direction; the points 6, 7, 8, 9, correspond to the spaces on the dial around which the needle 10 turns.

The axis of the needle is attached and gives motion to a wheel 11, which makes or interrupts the contact in the line circuit at the points 12 and 13, and it carries by friction a bar 14, which is pushed against a stop 15 when the axis is turned from right to left, and which is pushed against a stop 16 when the axis is turned in the reverse direction. Whilst moving between 15 and 16, the bar causes an oscillation of a reverser or commutator 17, the two arms 18, 19, of which, separated from each other, sometimes put the point 20 in contact with 21, and 22 with 23, and sometimes 20 with 23, and 21 with 22. Thus the current of the battery, which enters the apparatus at 20, issues thence it by the points of contact 17, 23, and leaves it at 21 to pass along the line and return by the earth at 23, will be reversed according to the direction in which the handle 1 is turned; it will be positive in the line on turning the handle from right to left, and negative on turning it from left to right, or *vice versâ*, but always inversed in a contrary direction.

To clear the line at the point of departure of a possible overcharge of current, there is a small spring 24 which brings the line into contact with the earth between the reversals of the current.

Tel Journ Dec 1. 1876

The Latest Improvements in the Hughes Apparatus, and a New Method of Translation with the Apparatus. By M. pp Hepner-Altenecg.

Hitherto special accessories have had to be furnished to Hughes' apparatus, meant for automatic re-transmission from one line to another. There would be no use, but even inconvenience, in placing the apparatus then furnished at stations which do no translation. Hence the employment of two systems of apparatus, the one for translation, requiring operators specially initiated, and the other simple apparatus only used at extreme stations. The method here described reduces the disadvantages of this, with the aid of two improvements in the Hughes' apparatus. One devised by Hughes himself, consists in transferring the working and insulated contacts of the turning chariot to a lever fixed to the stand of the apparatus, and which reproduces the up and down movements of the chariot. This is a simpler arrangement, and gives more certain contacts. The other improvement is the purely mechanical engearing of the printer axis in the transmitting apparatus, excluding all electro-magnetic action of the sending current.

Tel Journ Aug 15 '73

The Telegraphic. Vol. ix. No. 96.

On the Resistance of Relays.—By C. H. Haskins.—I have explained (see *Telegraphic Journal*, p. 209) the law governing the resistances of relays upon a given line. Granting the law I stated, how can this exact proportion be maintained, especially on millened lines, where new offices are frequently being opened? As it is impracticable to keep an exact balance of resistance between the relays on a line and the line wire, we must adopt some practical compromises. Have three or four standards of resistance, and apply any given circuit with the relays whose resistances approaches most closely that shown by the application of the law. For instance, you may have five standards for relays :—70 —100—150—250—400, and, suppose line is very long, with only five or three offices upon it, some one of these relays will carry near the desired resistance. And another fact should be remembered—that a relay with a light armature and short lever will work freely with less current than one with a heavy armature and lever; because, when the armature is held by the spring or rest, the power required to overcome its inertia and set in the relay " is in direct proportion to the weight to be moved. Therefore, a light armature and lever will close freely with a comparatively feeble current.

A New and Improved Switch Board.—The general features of the switch are so familiar that only a brief description will be necessary, in order to point out the improvements which have been adopted to simplify the operation of changing the loops from one main line to another. Some of the studs are split longitudinally, which is the case of the ordinary pattern. These split studs are split to their parts insulated with hard rubber. The right-hand side is connected with the left-hand side of the next succeeding stud, and also through to those used for connecting the instrument to the line. By inserting the plug on the plate, and inserting right and left of the stud, the circuit through the relay on a sterling-point, passes through the vertical stop out around the loop back to the stud, splitting the stud on the further side, then by a permanent connection on the back of the board to the second loop, through which it can be made to pass by a similar manipulation of the studs to either of the lines corresponding to the board. On the right-hand side a number of studs are placed, and are so arranged that by use of a plug the loop section of the board may be used for such line or lines desired. The advantages claimed for this switch are as follows :—The loops being arranged in the above manner, the operators will more readily notice their position, and can, with greater facility, connect such as are wanted than by the plans heretofore in use. The loop studs being directly in line with each other, the placing of a branch office in connection with the lines can be effected more speedily, and without so much examination of the board, as when they are placed in any other position. This switch was designed by Mr. James B. Yoakly, agent of the Gold and Stock Telegraph Co., 7 Baltimore office.

Tel Journ June 1. 73

Telegraphic Litigation.

The Western Union Telegraph Co. vs. the St. Joseph and Denver City Railroad, American Union Telegraph Co., and others.

In the United States Circuit Court, at Topeka, Kansas, July 31st, Judge McCrary rendered his opinion in this case, which effects the telegraph line on that road from St. Joseph, Mo., to Hastings, Neb., which was one of the Western Union telegraph lines forcibly seized by the railroad during the night of February 26th, inst.

Judge McCrary holds that it is not in the province of either party to declare the contract void. On the question of the effect of the foreclosure proceedings, Judge McCrary holds that the notification of the contract, and use of the line under it, bind the successors the same as the original railroad company. On the question of the exclusive privilege given the telegraph company of constructing and operating a line of telegraph along the railroad, he says he has little doubt that the clause referred to is valid, and if any [illegible] company so desires to construct a

Tel Journ Aug 15. 73

138,859. T. A. Edison, Newark, New Jersey. *Printing telegraph.* Dated October 22, 1872. A step on the type wheel-shaft is so arranged with an adjustable detent as to allow half-a-dozen or more of revolutions without the action of the escapement lever, but is released each time the said lever is moved. The paper feeding pawl is connected with a slotted link, so as to be lifted before the retounding arm is moved back; and a cam like slot in a slide, operated by the printing lever, is so arranged as to move the type wheel one letter forward or backward upon its shaft.

138,859. H. Henning, Ottawa, Ill. *Telegraph circuit and switch.* Dated February 4, 1873. Two plates insulated from each other, having line and instrument connections, are cut through near their centres so as to break circuit. Insulated buttons, with two metallic strips on face, pivoted at back, so that by turning it a completes circuit to or cuts out the instrument. Ground connected to either plate by switch peg. A switch and cut out formed of two parallel plates, with line, local and ground wire connections, adjustable bridles and metallic pegs.

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mitter armature be moved or vibrated by sound, like sounds will be produced by the motion or vibration of the armature of the other telephone upon the circuit.

"Fifth. In a system of electric telegraph or telephony, consisting of transmitting and receiving instruments, such as are described in the fourth and fifth plans, united upon an electric circuit, I claim the combination in the armature of each receiving instrument of any given motion by subjecting said armature to an attraction varying in intensity, however such variation may be produced in the magnet; and hence I claim the production of any given sound or sounds from the armature of the receiving instruments, such as are above mentioned by subjecting said armature to an attraction varying in intensity in such manner as to throw the armature into the form of vibration which characterizes the given sound or sounds.

"Sixth. The combination, or the manner described in the fourth and fifth plans, of an electro-magnet with a plate of iron or steel, or other material capable of inductive action, which can be thrown into vibration by the movement of armature, or any of the armatures of a magnet.

"Seventh. In electric telephony the combination with the plate of a magnet having poles upon the end or ends of the magnet nearest the plate, substantially as described in the fourth and fifth plans.

"Eighth. In an electric telephone, the combination with a permanent magnet and plate armature of a soft iron pole piece forming the core for the coil, substantially as described in the fourth and fifth plans.

HIGGINS' IMPROVED PRINTING TELEGRAPH INSTRUMENT.

No class of telegraph instrument is, perhaps, more useful for the distribution of information to a large number of stations simultaneously than the kind which prints in Roman type the message transmitted; and in no class has more ingenuity been displayed in effecting improvements which have for their object the production of a compact and simple instrument which can run at a comparatively high speed, and be free from a liability to skip letters, and which, also, so that the error may not repeat itself beyond improved instrument seems to promise to be free from these particulars in a high degree, and is, therefore, well worthy of notice.

The object aimed at by Mr. Higgins is mainly the construction of a printing telegraph instrument which can be worked on a single wire without the aid of clockwork for driving the type wheel.

The instrument consists of the following parts :—

Either one or two type wheels fixed to a common axis and driven by a propellent, which is so constructed as to prevent the momentum of the type wheels carrying them beyond the desired point. For this purpose two pallets, carried by a rocking lever, act alternately on the top and bottom of a ratchet wheel on the axle of the type wheel, with pin stops for the pallets to come against at the end of their forward movement. An arrangement is also provided for bringing the type wheel to the zero point.

The armature which carries the pallets is composed of iron and brass, and is magnetised from a large fixed permanent magnet through the armor of which it forms a part.

The transmitter sends alternate currents; the currents pass through (or cause other currents to pass through) coils or electro-magnets which are placed on either side of the magnetised armature.

The printing is effected by the current being diverted by a magnetic switch which is made rather sluggish of movement, and only acts when the current is caused to flow for a slightly longer time than when the type wheels are being rotated.

The circuit of the type magnets is closed at such times, and in the whole force of the battery passes through the printing magnet, or a separate battery may be used for operating the printing.

The printing from one wheel or the other, when two are used, is controlled by an arrangement which traverses a shield to and fro to cover or uncover the paper below the wheel to be printed from, and at the same time brings a support below the printing paper and so locks it and unlocks the printing pad under the one not being printed from.

Where figures are not much required one type wheel and a narrower band of paper and lighter printing mechanism may be employed. The arrangement will continue the same, but a greater number of contacts per revolution of the type wheel will be required.

Sixty or more characters may be used, but for the distribution of general intelligence thirty-six will be sufficient with a corresponding saving in cost.

For long distances an escapement and train of clockwork are employed, the other arrangements remaining the same; but the shunting magnet puts in operation a local battery instead of diverting the main current.

The type wheel axis is connected to and obtains motion from the train by a light intermediate coiled spring; the pulsations are thus therefore sensibly felt by the train.

Any form of transmitter which sends alternate currents and can be stopped on either, and when no current is passing, may be employed, provided the motion be regular.

To detach the armature which controls the type wheel promptly from the electro-magnet to which it was last attracted two springs may be employed, which are of such tension that very little force is needed to repel it. The coils must be such that the armature may also be cut off, so as to concentrate the whole force of the current on the other. The inking roller is made of cloth covered with Utrecht velvet.

Fig. 1 shows a vertical section of the instrument; fig. 2 is a plan of the same; fig. 3 is an under side view ; and fig. 4 shows separately some of the parts in considerable connection with the type wheels.

A is the electro-magnet for actuating the propellent; it consists of four coils; they are arranged in pairs and are so wound that when excited by the passage of a current the poles facing each other are of opposite signs. Between each pair of poles there is a soft iron tongue a; the two tongues are both mounted upon an axis c, which is built up of iron and brass, the centre portions between the tongues being of brass to prevent magnetic connection between the two tongues. The outer ends of the axis, which are of iron, pass through the extremities of the permanent horse-shoe

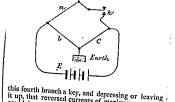
Tel Jour Mar 15 1875

A SINGLE CONTACT DOUBLE CURRENT KEY.

In every form of double current key hitherto in use, from two to four contacts have been employed in addition to the switch contacts which cut off the battery and the line wire through the receiving instrument to earth. Where four contacts are employed, as in the ordinary double current key the play of the lever is necessarily considerable, otherwise false signals are liable to be made. Again, in the latter form of key, the several currents must be of equal strength; and in the submarine keys, where not less than two contacts are employed, it is usual to have two batteries, one for sending a current in one direction and the other for giving a reversal. In the following arrangement, only one contact and one battery is employed for sending reversed currents; and, moreover, the relative strengths of these currents can be adjusted to a great nicety. The figure shows the method by which the result is arrived at. *a*, *b*, and *c* are three resistances forming the arms of a Wheatstone bridge, *e* is a battery, and *f* the line wire. The fourth arm of the bridge is formed by a single contact key, *k*. As is well known, if the fourth arm were of such a resistance *x*, that

$$x = \frac{a\,c}{b}$$

then no current would pass out to line; but if *x* were larger than this value, then a current would pass to line in one direction, and if *x* were smaller than $\frac{a\,c}{b}$ then a current would pass in the opposite direction. It is clear if *x* were made either *a* or *b* by making



this fourth branch a key, and depressing or leaving it up, that reversed currents of maximum strength could be sent out to line, and by adjusting the resistance *a*, *b* and *c*, the relative values of these currents could be altered at pleasure.

A priority in the arrangement consists in the fact that the reversal takes place without any break, and it might therefore prove of service as a "polo changer" in the quadruplex telegraph system, and, indeed, in any telegraphic apparatus where a multiplicity of contacts might be objectionable, and where an instantaneous reversal is required.

H. R. K.

Tel Jour July 15, 1873

The Telegrapher, May 31, 1873.

New Intaxonic Type Printing Telegraph.—Theoretically may be described as a combination of the Little and the Bonelli apparatus. The machine by means of which the transmitting strip is prepared consists of twenty-five cylindrical steel punches, each one-tenth of an inch in diameter and the same distance apart, arranged to form a square of five rows each way. A key-board, analogous to that of the House printer, is so arranged in connection with the punches, that when any particular key is depressed the proper punches for forming that corresponding Roman letter are selected and forced through the paper slip, perforating the paper with apertures arranged in the form of the letter. The letters, as perforated in the transmitting slip, are half an inch in height, the strip, after having been thus prepared, is passed at a rapid rate through a transmitter similar to that of the Little automatic, but provided with five circuit closers, side by side, corresponding precisely to the five horizontal ranges of punched apertures from which the letters are formed. A corresponding receiving instrument, running at an approximate speed, is provided with five pens or styles, arranged in a row transversely across the chemically prepared strip, which is made to pass beneath them. The Roman letters, as recorded upon this strip, are much smaller, and appear far more legible than upon the transmitting strip. Five lines of wire, of course, required to work it, although it is considered possible to be able to do the work with one. With five circuits the rate of speed with which messages may be recorded in plain Roman letters is from four to six hundred words per minute for the permanent printing, with an iron solution, and twelve to fifteen hundred words per minute with the fugitive iodine solution.

Tel Jour May 1, 1874

M. Mouzaour has called the attention of the French Academy to a new telegraph of his invention, in which both the transmitter and receiver consist of two ivory plates carrying the disconnected ends of an open part of the circuit. The sender places this continuous between his lips, and sends the message by talking or by closing the circuit by his lips, according to a code of signals. The receiver, holding the receiving apparatus similarly, interprets the message by the sensation he feels. This is an old idea, but may be cleverly worked out in this case. M. Mouzaour claims to become a competitor for the Volta prize with it.

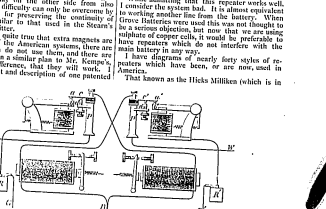
Electrical News Aug 15 1873

Improvements in electric apparatus. Frank Wirth, of the firm of Wirth and Co., patent agency, Frankfort-on-the-Main, Germany. (A communication from Josef Leiser, manufacturer, Vienna, Austria.) January 26, 1873.—No. 296. All batteries hitherto constructed, especially those which have to be transported, have the disadvantage that when they were charged they could not be hermetically closed, and that when the elements had to be lifted out a complicate mechanism was necessary. If such batteries were to be transported for some distance the several parts of them and the acid had to be packed in separate vessels. Elements that remain filled during the time when they are not employed consume metals and acids uselessly, and are readily spoiled. All these disadvantages are avoided with my apparatus. . . . . .

of Working by Translation on a Closed Circuit," he gives a diagram of a translator (or repeater as they are called here), which he says "is clearly applicable to the instruments in common use, and does not require any extra magnets, such as are used in the American systems."

Instruments arranged as in the diagram would not translate or repeat a single word on a closed circuit. It looks very well in theory, but in practice would be a complete failure. If Mr. Kempe had made an experiment before publishing the diagram he would have found that, during the instant while the relay armature is moving from the front to the back contact, there is nothing to prevent the relay on the other side from also so arrangement for preserving the continuity of the circuit, similar to that used in the Steam's Duplex Transmitter.

Although it is quite true that extra magnets are used in most of the American systems, there are repeaters which do not use them, and there are also repeaters on a similar plan to Mr. Kempe's, but with this difference, that they will work. I enclose you a cut and description of one patented



nearly ten years ago by Mr. B. B. Toye, Superintendent of the Montreal Telegraph Company in this city, and which has been in daily use ever since on a large number of lines. You will see that it would cost but a few shillings to make ordinary instruments available.

In the diagram M M' are the relay magnets of the eastern and western circuits respectively, S S' are the sounder magnets, which are connected with the relays and local batteries in the ordinary manner. These connections are omitted in the drawing to avoid confusion of lines. The flat springs, *a c* and *a' c'*, are supported by the standards F F', but are insulated from them by a piece of vulcanite rubber, as shown in the diagram.

E and E' are the eastern and western line wires, and B is the point of connection with the main battery and ground.

At E and E' is a "resistance," which should be adjusted so as to equal that of the main line as nearly as practicable.

In the diagram the operator on the eastern circuit is supposed to be working, and at this moment has his key open. The western main circuit is broken by the lever of the eastern sounder at the points *c' d'*, but the western relay, M, is kept closed by a branch circuit from the battery at B, established through the relay points, *a' b'*, the sounder, lever, and standard, the resistance, R', and ground at C', and from thence back to the battery.

Now, if the eastern circuit be closed, the lever of the eastern sounder, S, will close the western circuit at *c' d'*, at the same instant breaking the branch circuit at *a' b'*. If the western circuit is broken, the same action takes place on the opposite side of the apparatus.

If both circuits are closed, each is complete through its own relay and respective points, *c d* and *c' d'*."

While admitting that this repeater works well, I consider the system bad. It is almost equivalent to working another line from the battery. When Grove Batteries were used this was not thought to be a serious objection, but now that we are using sulphate of copper cells, it would be preferable to have repeaters which do not interfere with the main battery in any way.

I have diagrams of nearly forty styles of repeaters which have been, or are now, used in America.

That known as the Hicks Milliken (which is in use on the Western Union Lines) seems to be nearly perfect.

Yours truly,
HUGH NELSON.

DISTINCTIVE STAMPS FOR TELEGRAPH MESSAGES.—Such notice has been issued from the General Post Office to the effect that on and after Monday, the 1st of May, no postage stamps other than those embossed on the telegraph message forms still on hand, will be received in payment of telegrams.

THE Eastern Extension Australasia and China Telegraph Company (Limited) announce that their cable between Java and Australia is interrupted. Messages for Australia will be sent by post from Singapore on 1st May, from Java on 3rd May, or from Galle on 9th May.

To Correspondents.

*** Duly authenticated contributions, theoretical and practical, on every subject connected with the interests of which "THE TELEGRAPHIC JOURNAL" is the organ, will always command attention. Anonymous correspondence will be strictly disregarded. Literary communications and books for review should be addressed to the Editor. Business communications to the PUBLISHERS, 10, PATERNOSTER ROW, E.C.

Electrical News
Sept 18 1875

PATENTS.

ABSTRACTS OF SPECIFICATIONS.

Improvements in electric telegraphs. George Allan, civil engineer, and James Wallace Brown, electrician, 18, Leadenhall Street, London. February 12, 1875. No. 553.—The main objectare (1), to record dots and dashes sent through submarine cables at a superior speed; (2), to translate or re-translate signals from one circuit to another at a superior speed; and (3), to relay or re-translate from land to submarine or land line without sending land line circuit through cable line or vice versa. The improvements consist:—First. In constructing what we call a conical, preferably of a metal bar provided with adjustable insulated platina steps or stops. The conical is mounted in bearings, and has to revolve by an armature. In bearings, and has to revolve in bearings, preferably on the armature above mentioned. Part of said disc serves as insulator and part as conductor; the conducting portion is provided with a local wire. The said disc bears against a metal surface also provided with a local wire. Various arrangements equivalent to the said disc may be used. Third. In the use of compensating springs in combination with our movable contact, sliding once against the other, and so adjusted as to maintain the armature of a relay or its equivalent in any required position. The springs and magnet act on the armature so as to compensate each other's action; one spring only may be used. Fourth. In connecting two circuits outside the relay or pecker, and connecting the armature of the relay or pecker to the line. The forward stop of the relay or pecker is connected through the right hand electro-magnet and to the battery, the back stop through the left hand electro-magnet, so that opposite poles of the battery, the centre of the said battery being carried to earth. Fifth. In connecting the receiving relay or pecker through its armature or equivalent to a receiving battery. The centre of such battery is connected to earth, and the extreme positive pole to the right hand stop of relay or pecker, and the extreme negative pole to the left hand stop, or vice versa. Sixth. In winding the relays differentially. Seventh. In using two arms pivoted one on each side of an armature or its equivalent, of a relay or pecker or the equivalent of a relay or pecker, the said arms being placed angularly in relation to the armature but in the same plane. The free ends of the said arms are connected together by a bar which passes freely through a hole or slot in the armature. The ends of the said bar serve as contact points, and a similar bar passes through the armature and has the ends working in the arms above described. Stops are provided and compensating springs are attached to the armature.

Electrical News
Aug 12 1875

Improvements in electric signalling apparatus. Benjamin Pryse Stockman, civil engineer, 3, Nunn's Corner, Westminster. January 22, 1875.—No. 255. This Specification describes a construction of "transmitting key" for sending two or more currents through the line each time the key is depressed, and also a receiving instrument in which a loop or single line of gold, platinum, or other non-magnetic metal is used.

Electrical News
Sept 25 1875

2378. *Printing Telegraph.* JOHN E. SMITH, New York, N.Y. Filed May 21, 1875.—Type wheel revolved both on make and break of circuit. One coil of printing magnet in a local circuit closed by escapement lever on prolonged closure of main circuit, other in a local ditto on momentary closure. Device applied to stop transmitter automatically at end of message. Printing telegraph the arrangement of one-half or portion of the type wheel of the printing magnets in one local circuit or branch of a local circuit, and the other half or portion of the type wheel of said magnets in another local circuit or branch of a local circuit, in combination with a circuit breaker that shall, by the rotation of the type wheel, to open and close the said circuit or circuits alternately through the two parts of the printing magnets, substantially as set forth. 2. In a printing telegraph, a printing magnet in a local circuit or circuits, a type wheel magnet in a main circuit, and an escapement wheel that allows the type wheel to advance a whole character at a single movement of the escapement pallet, in combination with a lever that serves the double purpose of liberating the type wheel and closing the local printing circuit, to effect an impression by either a prolonged opening or closing of the main circuit. 3. In a printing telegraph, the ratchet wheel *l* and the pawl *m*, in combination with the lever *f*, substantially as described. 4. The springs *e* and *e'*, in combination with an electromagnet C, pallet B, and wheels for being into an electric circuit a resistance of measurable or infinite. 5. The magnet C, pallet B, springs *e* and *e*, resistance *k*, lever *f*, ratchet wheel *l*, and pawl *m*, in combination with a train of wheels, substantially as set forth. 6. In the transmitter of a printing telegraph, the combination with a train of wheels of the arm F, and the loosely-fitted lever E, substantially as and for the purposes set forth. 7. The lever E, in combination with the lever H, substantially as set forth. 8. In printing telegraph apparatus, a self-locking transmitter, in combination with a self-locking reister.

Electrical News
Oct 16 1875

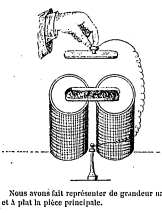
Improvements in Telegraphy. Robert Coddington, of 88, Piccadilly, Middlesex. (A communication from Marcus Gally, of Rochester, state of New York, United States of North America.) March 27, 1875.—No. 1128. The object of this invention is, first, to produce simple apparatus, easily adjusted, and not necessitating the use of resistance coils, double batteries, or divided currents; secondly, to allow intermediate offices to be transmitting different messages without interrupting a through message passing in an opposite direction; thirdly, to allow messages to lap by or overreach each other without conflict; fourthly, to allow either or both of the messages passing in opposite directions to be dropped at any number of, or at all, the intermediate stations; fifthly, to so construct the manipulator as to make it available either as transmitter, receiver, or repeater; and sixthly, to furnish improved devices for transmitting or receiving instruments without reference to the particular system of circuits, &c.

Aug 20, 78

LE RELAIS À COMPRESSION DE CHARBON

DE M. EDISON

Comme nous l'avons promis dans notre dernier numéro, nous allons donner une description sommaire du relais à compression de charbon de M. Edison, dont l'Exposition universelle vient de s'enrichir.



Nous avons fait représenter de grandeur naturelle et à plat la pièce principale.

Elle se compose d'une petite auge en chonite dont les deux fonds, supérieur et inférieur, sont en fer doux : elle est placée au-dessus d'un électro-aimant et remplie de poussière de charbon.

Nous avons représenté un opérateur au moment où il ferme cette auge, après avoir placé dans l'intérieur la matière pulvérulente.

Le principe d'action est analogue à celui dont M. Edison a tiré à tant de reprises un parti si brillant.

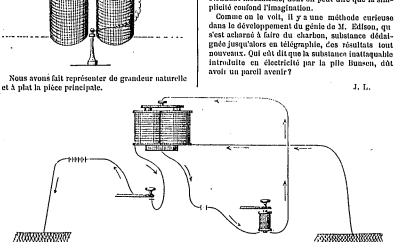
Quand on fait passer un courant dans l'électro-aimant, le fond supérieur, qui est mobile, se trouve attiré, magnétiquement, par le fond inférieur qui est fixe et la poussière de charbon est comprimée. Il en résulte que sa conductibilité est augmentée et qu'un courant local, qui passera du fond supérieur au fond inférieur, par l'intermédiaire du charbon, sera renforcé.

C'est cette différence de pression qui fait parler un marteau local.

Il suffit du dessin que nous donnons pour que chacun puisse se rendre compte de la marche de cet étonnant mécanisme, dont on peut dire que la simplicité confond l'imagination.

Comme on le voit, il y a une méthode curieuse dans le développement du génie de M. Edison, qu'est acharné à faire du charbon, substance délaissée jusqu'alors en téléphonie, ces résultats tout nouveaux. Qui eût dit que la substance inattaquable introduite en électricité par la pile Bunsen, dût avoir un pareil avenir?

J. L.



UNITED STATES.

136,630. H. D. Rogers, Cincinnati, Ohio. *Printing and Dial Telegraph and Circuit.* Dated May 24, 1873 Places Morse sounder and a printing or dial telegraph in same circuit and on same line. Printing circuit thrown on automatically when in use, cut out when instrument is not in use. Morse sounder key and lever transmitter in one circuit breaker. The method of rotating the type wheel, by the circuit forming the alternators upon a flexible strip, which is then affixed to the type wheel frame.

140,143.—Adolphus A. Knudson, Brooklyn, N. Y. *Printing Telegraph.*—Application filed May 15, 1873. The operation of printing thereon in an extra pair of magnets, the spring of wheel armature furnishes in drawing up the armature, the motive power to revolve the type wheel.

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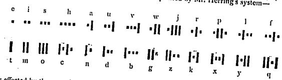
is carried to 700 turns a minute, and the number of reversals is, therefore, 5,600 a minute. The large machines, divided into four circuits, furnish the currents for four circuits of four or five candles each, making, in all, 16 or 20 candles, according to the requirements of the locality. Each of these candles yields a light equal to 100 Carcel jets or about 800 standard sperm candles. The motive power necessary for producing these 20 lights is about 20 horse-power.

HERRING'S PRINTING TELEGRAPH.

This instrument, which has caused so much discussion of late, is constructed to print the dot and dash of the Morse alphabet in such a manner that one can never be mistaken for the other. The following is a key to the Postal Telegraph Alphabet, as printed by Mr. Herring's system—



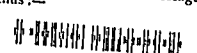
This is effected by the use of two distinct levers—an arrangement which permits the dot and dash to be printed vertical instead of longitudinal, and to be produced instantaneously instead of by continued pressure, thus saving the time of the operator and very considerably diminishing the length of the message slip. The coil of paper on which the message is received is made to travel by clockwork in the ordinary way. It passes directly over a thin metallic disc placed transversely to the course of the slip, revolving on an axis and dipping into an ink well. Over the paper is the lever terminating in a broad style, placed vertically above the disc so that the descent of the lever compresses the slip of paper between the disc and the style. The central portion of the lever carrying the central portion of the style can be acted upon either independently of the lateral portions or together with them. In the one case only the narrow central portion of the style descends, and the slip of paper is pressed upon the inking disc at only a single point of contact, which produces a vertical dot, and in the other case the style descends as a whole, and having a concave edge it presses the paper into contact with the disc, thus producing a vertical dash. The pressure of the style stops for the moment the revolution of the inking disc upon the immediate recommencement of which the ink supply depends.

Mr. Herring has therefore placed upon the axle of the disc a box containing a spiral spring, so arranged that when the disc itself is checked, the power of the clockwork coils the spring. The moment the disc is released the coiled spring gives the necessary impulse to produce immediate revolution. Each lever also serves to clamp the paper at every impression, thus insuring perfect clearness and regularity in the signs.

The operator is furnished with two keys, one of which commands the central or dot portion of the lever and the lever as a whole. One therefore produces the dot and the other the dash, and no mistake can occur between the two except by the use of the wrong key. The printing is remarkably clear, distinct, and compact, and gives a legibility to the messages which no other modification of the Morse system has ever attained.

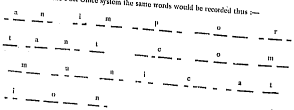
The utility of Mr. Herring's system in transmitting and recording messages may be partly perceived from the following comparison between it and the system of the Post Office.

On Mr. Herring's system a message would be recorded thus:—



an important communication.

On the Post Office system the same words would be recorded thus:—



140,489. Thomas A. Edison, N. J. *Circuit for Printing Telegraph.* Application filed February 18, 1873. Two relays in main line circuit, central printing and type wheel circuits, form one local battery, the relays having polarised armatures and being so wound that one armature is attracted while the other is repelled. One or the other brought into action by reversal of current. Two polarised electro-magnets in a main circuit, in combination with two local circuit connections to the magnets of a printing instrument, and a mechanism for opening and closing the main circuit and reversing the polarity of the current.

2. The combination of the permutator wheel *o*, sheet 2, fig. 3, current wheels S S, standards T T, and lever Y, actuated by the worm c' working in the sector *b'* substantially in the manner and for the purpose specified.

153,498—Electric Signaling Apparatus.—Wm. H. Sawyer, New York, N. Y. Filed April 16, 1874.

For signaling a variety of wants in "district telegraphy," the want being designated by the repetition of an arbitrary signal a certain number of times. The crank K winds the spring and releases the circuit wheel. The crank cannot be moved till the appropriate button, F P R M, is pushed in, which releases the crank lever, at the same time placing a detent, *f, p, r* or *m*, in the way of the crank lever to limit its movement, and also breaking the "cut-out" *o*, throwing the current through the sounder *s*. Shaft projects through face of box and carries a pointer for additional safeguard in showing that proper want was signaled.

1. In a telegraphic apparatus for automatic signaling the combination of the circuit breaker E (arranged to transmit a specific arbitrary signal), and a train of wheel work driven by a weight or spring for actuating the same, with the stops *f i p r m* ar-

40. B. Hunt, of Middlesex. *Improvements in Printing Telegraph Instruments.* Dated January 3, 1873. The improvements consist mainly in a series of mechanical devices arranged and operating in combination with an electro-magnet and a polarized magnet under certain electrical conditions that each of the magnets shall release an escapement, the polarized magnet releasing the type wheel escapement and the electro-magnet that of the press mechanism; and further in the manner of actuating these escapements separately by two trains of wheels impelled by one main spring.

THE MANUFACTURE OF ELECTRICAL INSTRUMENTS.

To the Editor of the Telegraphic Journal.

Sir,—Whilst allowing full credit for the exactness of the adjustment and excellent workmanship expended by instrument makers upon electrical measuring apparatus, which telegraph engineers have to use, it nevertheless is necessary to point out that much better constructions might be introduced. If designers and manufacturers of testing apparatus had opportunities of applying the apparatus themselves, they would improve many details.

Some months ago tests had to be made of a cable miles from any large town, on a beach of loose sand exposed night and day to the full force of the trade winds. Inside the hut, which was in a perpetual state of vibration, tests with mirror galvanometer or the suspended needle were impossible, and an expedition had therefore to be made to the other end of the cable to find a still hut where reliable observation could be made. Had the testing apparatus been so constructed as to be entirely independent of the cable hut, this second journey would have been saved. But darkness was necessary for the mirror readings, and darkness was only to be had in the hut, the floor of which vibrated. Now such an accident suggested that the resistance apparatus might have been put neatly into a box. The galvanometer with its lamp and scale, if such was at all necessary, might they not have been shut up in a box, with a peep-hole and telescope to observe by, and set up in a portable tripod, stuck in the sand in some corner, so as to be independent of cable hut and trade winds? This is an isolated case, but it seems to me, generally, that testing instruments are constructed only for the physical laboratory, where every condition is favourable and successive.

Great improvement might be effected in the general arrangement of the details of apparatus, and the only plan is either to carry the manufacturing body away in cable ship to distant station, or for a diligent committee of engineers to examine the working electricians who have had to use the different testing apparatus at present in use.—I am, yours, &c.,

Nov. 1873 ENGINEER.

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M.W. Aug. 1875

[23160.]—**Electric Bells.**—To "Sigma."—A short circuit system involves a division of the current between two circuits in proportion to the resistance. Hence it is best adapted to bells made with fine wire and having considerable resistance. When stouter wire is used in the magnet only imperfect demagnetising occurs when the short circuit is closed. This is, in fact, always the case, for even with fine wire the greater number of turns compensates for the lesser current. This is the reason of the diminished blow, as the residuary magnetism retards the recoil of the spring, which consequently requires to be made stronger. The only advantages I can see in the short circuit plan are, that the spark is prevented from burning away the platinum, and the circuit can never be entirely broken by dirt, &c.; but on the other hand, these can diminish the effectiveness of the short circuit, and in that way the working power of the bell. I should certainly use the direct break principle myself.—Sigma.

[23150.]—**Short Circuit Bell.**—If "J. W. J." would explain exactly how he applies the short circuit method to his electric bell it may be possible to point out his mistake. It is evidently a mechanical error that he has to rectify. It is true, however, that there must be a *very little* sacrifice of force in each blow of the hammer on this new method. At present there is a difference of opinion on the relative merits of the two methods, but I believe a careful comparison, based on practical experience, will tell greatly in favour of the new method.—Moses Walker.

Telegraph Alphabets.

To the Editor of the Scientific American:

In your issue for March 13, you published a communication from John Millis, of Addison, Mich., in regard to telegraph alphabets, which is calculated to mislead your many readers, inasmuch as it gives an utterly erroneous and empirical view of the subject. Mr. Millis states that the Morse "alphabet is defective, as the sound of a dash is very much like the sound of a dot with a succeeding space." Judging from this, I should say that Mr. Millis is as yet but a beginner in the art, for when most persons begin to learn to telegraph they fancy they perceive the same thing. The fact is, to any one at all practised in reading by sound, the defect is by no means as stated in the communication under review. No operator could possibly mistake a dash sounded for a dot with a succeeding space; and I do not know an instance, even among very ordinary sound operators, in which a mistake has occurred for the reason given by Mr. Millis.

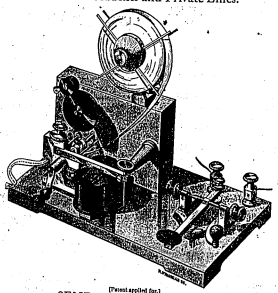
The defect is in the spaced dot letters, C, O, R, Y, and Z. This was long ago recognized. Bain avoided it; but his alphabet was longer than the Morse. In the European code, also, the defect is avoided; and were it not for the difficulties involved in a change, the Western Union Telegraph Company would have adopted it some time ago. It was seriously proposed at one time, as I clearly remember. This being the acknowledged and long felt defect in the Morse alphabet, to which innumerable errors can be traced and by reason of which they are occurring every day, how does Mr. Millis' proposition meet the case? In the Morse system, there are five such letters. Mr. Millis proposes to increase them to seventeen. In other words, his alphabet, besides being cumbrous and inadequate to speed, increases the chances of errors more than three times.

It may not be inappropriate to suggest that the composition of telegraph alphabets be left in the hands of the great body of experienced telegraphers, not only in this country but in Europe, who may well be presumed to know the difficulties and wants of existing systems.

Washington, D. C. May. 75 WM. E. SAWYER.

EDISON'S INK RECORDER,

For Amateur Students and Private Lines.



[Patent applied for.]

SEND FOR CIRCULAR.

EDISON & MURRAY,

10 and 12 WARD STREET,

NEWARK, N. J.

A New Relay.

This invention was patented by P. B. Delany, of New York, June 22, 1874. The inventor says in his specification that there is great difficulty on leaky lines in adjusting the retractile springs of relays at each station. If at a terminal station an operator adjusts his relay to get the writing from the other terminal the tension of his spring will be so great that when he transmits his own armature will not respond promptly but "drag." Way stations experience the same difficulty; different adjustments being necessary according to the distance and tension from each end.

If there is a battery at each end, as there usually is, the battery at the end receiving is constantly in connection with line wire, and whilst the line is interrupted at the other end there is a constant escaping from the battery through leaks, etc.; so strong even on some lines as to keep the inscriptions at way stations closed, especially those near the end receiving.

The object of this invention is to lessen if not entirely to obviate these difficulties. To accomplish this I dispense with the back yoke and place a pivoted armature at each end. These armatures have retractile springs of different tensions, so that a strong current will affect both and a weak current affect the armature, having a spring of slight tension.

The second part of my invention consists in placing the armature of a relay so constructed directly on main line circuit. The front and back stops of such armature are both connected to the main line, the path of the current being through the electro-magnet, the armature and one of its stops. It follows, then, that when the armature is moving from one stop to the other the main line is completely broken, thus giving notice to all stations, especially those whose magnets would be held closed by the current from leaks, etc., that the line is in use.

Fig. 2 shows this device. A is a relay magnet; the main line passes through the relay, back armature lever D and points either F or G, out to battery. B is a magnet in local circuit which attracts lever D and holds it on point F when line is open. C is the regular sounder. The momentum of lever D carries it from one point to the other and prevents vibration.

The inventor claims a relay having two armatures and two armature levers, capable of different adjustments substantially as and for the purpose set forth.

We have already alluded to Morse's successful completion of a telegraph line between Washington and Baltimore in 1844. In 1846, Royal E. House, of Vermont, patented an admirable long line printing apparatus, by which messages were sent in Roman capitals in lieu of dots and dashes. The next important improvement was that of Hughes, who patented a telegraph in which the feat of printing a letter with every impulse or wave of the electric current was accomplished. Two years later (U. S. Pledge, of Troy, N. Y., combined the most valuable portions of the inventions of Hughes in a combination instrument, which is considered the most perfect printing telegraph for long lines yet produced. To Mr. Cyrus W. Field is due the credit of suggesting the transatlantic cable; and through his persistent labors and energy that great undertaking was successfully accomplished.

Stearns' modification of the Gintl duplex telegraph system was the first practical solution of the problem of sending two messages at the same time on the same wire. Moses Farmer has also devised a way of sending two messages at the same time in opposite directions, by using two auxiliary batteries in combination with two principal batteries. The important researches of Thomas A. Edison have aided greatly in rendering the practical shape the system of quadruplex telegraphy; and the phonetic system of Gray and Bell aims to increase indefinitely the number of messages which can be sent simultaneously over a single wire, by using tuning forks moved by electromagnets, for sending and receiving the signals. Only one fork at the receiving station is in unison with a particular fork at the sending station, and responds to it. The first system of fire alarm telegraph was invented in 1852, by Channing and Farmer, and shortly after was adopted in Boston.

THE AMATEUR'S TELEGRAPH APPARATUS,

Comprising

SOUNDER, KEY, CUP OF BATTERY, CHEMICALS, WIRE AND MANUAL.

Several Thousands of these Instruments already sold. They give good satisfaction.

PRICES.

Amateur Outfit, complete, No. 1,	$7 00
" " " 2,	9 00
" Sounder and Key, No. 1,	6 00
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Battery, per Cell,	60

DISCOUNT.

Twenty per cent. discount will be allowed when remitted for in advance.

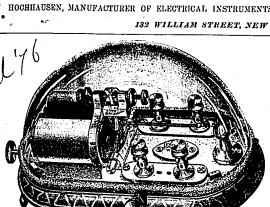
GEO. H. BLISS & CO.,

220 Kinzie St., Chicago, Ill.

W. HOCHHAUSEN, MANUFACTURER OF ELECTRICAL INSTRUMENTS,

192 WILLIAM STREET, NEW YORK.

April 76



STANDARD MAIN LINE RELAY.—No. 1.

This is the most highly finished and beautiful Relay now in the market. The working parts are covered with a glass shade, and thus absolutely protected from rust or dirt. All the adjustments are arranged to work from the outside without removing the shade. Although recently introduced, this beautiful instrument has already become a great favorite.

Standard resistance 150 ohms. Any other resistance furnished to order at short notice. PRICE, $16 00.

Self-Starting Registers, of new design, protected by a Glass Shade, complete, with Paper Reel and Weights..... $40 00

Sounders, from..... $4 50 to $6 50

Electric Bells, single stroke or continuous ringing, from..... 5 00 to 8 00

Relays, from..... 9 50 to 16 00

Improved Switch Keys, from..... 2 00 to 2 50

☞ SEND FOR ILLUSTRATED CIRCULARS.

A new key is being put into the telegraph offices of the Pennsylvania railroad. Under the existing system a key and sounder are required for every wire that comes into the office. The new key can be operated by the same instrument, and requires only one sounder. The wires in turn, of local relays, attached to which, and projecting from the under surface, are a number of platina points, representing the number of wires which may enter the office, each one of which the key can be turned, and it can be discovered at a glance. This mode of connection, apart from its convenience, will enable the operators to obtain a difficulty familiar to those using the old system, the point of contact in the armature upon which it works, through the current is frequently weakened or interrupted by the clogging of the points.

NEW TELEGRAPH APPARATUS.—A new apparatus for telegraphic signalling has lately been brought before the Society of Arts. It is the invention of a Spanish gentleman, and its object is to provide a simple and inexpensive system by which any police-station—may be able to communicate with a central office, without interfering with one another. With any system of telegraphy now in use the number of persons can telegraph straightforward—that is, their messages are received at the central office in the order of their position, those nearest to the office being taken first. The signals transmitted are the movement of a pointer acted on a dial. The signals required are marked on the dial by lines, and is recorded at the central office. The receipt of the message is shown by the return of the hand to the zero point. The principal signals suggested are for giving an alarm of fire, summoning the police, or desiring the attendance of a doctor. Street accidents might also be arranged, from which a fireman or a police-constable might communicate with the central office.

Unparalleled Telegraphic Feat.—What the Phelps Motor Printer Did.

We have heretofore spoken of the most wonderful improvement in printing telegraph instruments yet developed—the Motor Printer, invented by Mr. G. M. PHELPS, the able and talented Superintendent of the Western Union Telegraph Company's extensive telegraphic shops in this city. This invention, and the ease, reliability and rapidity with which it works, has opened up a new and prosperous future for printing telegraphs, and will undoubtedly lead to its extensive reintroduction in practical telegraphic use in this country and Europe.

In order to give the Motor Printer a thorough trial, and demonstrate its speed and reliability on long circuits, an experiment in actual telegraph work on a Western Union line between Washington, D. C., and Boston, Mass., was made on Thursday evening, March 16th, the results of which were an unparalleled telegraphic feat, that astonished and delighted Printing and Morse operators, and all who were privileged to witness it.

It should be premised that the weather was unfavorable—a rain and sleetstorm having commenced in Washington in the morning, which gradually extended over the whole route—a test of the wires showing a considerable escape between the terminal points.

Mr. FRED. W. ROYCE was the operator at Washington, and Mr. C. S. NORTH at Boston. These gentlemen are known as among the best Printing Telegraph operators, their ability, to say the least, equalling that of any now or heretofore engaged in the service.

The matter sent was specials to Boston newspapers from their Washington correspondent—Mr. HOYCE sending and Mr. NORTH receiving. During the evening 4,324 words were sent and received, and during the whole time there were only three breaks. By actual count the lowest rate of speed in transmission was 84 words per minute, and from that up to 89 words per minute. It should be stated that the instruments were not geared up to the highest attainable speed, which is about 70 words per minute.

In fact, the only limit to the speed of transmission over these instruments is the ability of the operator to finger the keys.

By the arrangement for duplexing these printers, devised by Messrs. PHELPS and GRAHAM BELL, the capacity of a wire is actually doubled when these instruments are used, which is not the case when Morse instruments are duplexed.

All who witnessed this feat declared that it was unparalleled in telegraphic experience, and were enthusiastic in their commendation of Mr. PHELPS' beautiful and valuable improvement.

The Western Union Company have now in process of manufacture and nearly completed at their shop, a number of these Motor Printers, and they are to be put upon some of the principal circuits as soon as they are ready.

The circuit between Washington and Boston is the longest upon which they have yet been tried, but it is believed they can be successfully worked upon much longer circuits, and further experiments to determine this are soon to be made.

WESTERN ELECTRIC MANUFACTURING COMPANY,

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BURGLAR ALARMS,
MEDICAL APPARATUS,
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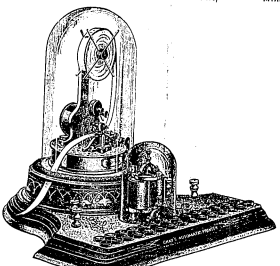
LEARNERS' OUTFITS,
BOOKS ON ELECTRICITY,
ORTON'S MESSAGE CLIPS,
ORTON'S SAFETY MESSAGE HOOKS,
MANIFOLD PAPER,
BLISS' MANUALS,
COMPOUND WIRE,



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Our facilities for the manufacture of Electrical Apparatus are unrivalled. We invite correspondence and solicit patronage.

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WESTERN ELECTRIC MANUFACTURING COMPANY,

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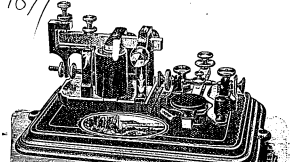
CELEBRATED PRIVATE LINE OUTFIT.

The COMPLETE OUTFIT Includes

ONE PRIVATE LINE INSTRUMENT,
ONE CELL BLISS RESERVOIR BATTERY,
THE NECESSARY CHEMICALS, WIRE FOR CONNECTIONS, AND A MANUAL.

1877



Our Private Line Instrument as now manufactured is a perfect beauty, and is fit for a parlor ornament. *It will work on a line from a city flat to his office in town.*

It combines also the touch of the key so that the resistance of the magnets may be slightly proportioned.]

The BLISS RESERVOIR BATTERY is the best and most perfect for force, constancy and economy.

Private Line Outfit, complete:

Instrument..... $10 00
Bliss Reservoir Battery, per cell..... 2 00

Twenty per cent. discount is allowed when Cash accompanies the Order.

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SPECIAL.

[ABOVE CUT HALF SIZE.]

THE SPECIALTY SOUNDER

A LIGHT, CLEAR, STRONG WORKER; agreeable to the ear and touch. Easily handled and adjusted. Highly adapted for Printing.

THE PARAGON,
(Cut One-third Size), for Short Lines and Learners.
SPECIALTY SOUNDER, $5.00
SPECIALTY KEY, $5.00
PARAGON, $5.00

Price Instruments for the first one to ten miles, $1.00.
Per mile, discount from above rate for resistance with order.
Per No. 1 Cutlery, Manual, other wire and Chemicals, for Western Union.

LANNERT & BECKER,
Mf'g Electricians,
CLEVELAND, O.

The historical collections of telegraphic instruments are of great interest. Here is the original five-needle telegraph of Cooke and Wheatstone, 1838, with its large hexagon-shaped combined dial, and heavy pointers indicating the letters by the convergence respectively of the two of the needles, and we here also find the first attempt at the insulation of underground wires, the five metallic line wires required to carry the signals being inserted in grooves cut longitudinally in triangular pieces of wood, and filled in with a hard cement, paraffin and hot beeswax. Here are also the first electric telegraphy instrument constructed by Wheatstone, and Cooke and Wheatstone's early letter dial telegraph of 1846. Passing along the collection sent by Her Majesty's Postmaster-General, the attention is arrested by two large double-needle instruments in ivory mahogany cases, bearing brass inscription plates at their base. These two instruments, constructed by Issacs, Reid Brothers, were the means of bringing to justice Jewell, the murderer, and the Times of that date, 1854, observed, that "had it not been for the efficient aid of the electric telegraph, both at the Paddington and Slough stations, the greatest difficulty, as well as delay, would have been occasioned in the apprehension of the murderer." The Bain electro-magnetic machine, or "thunder-pump," has likewise an interest as marking an early form in the series of coils and needles employed in telegraph apparatus, shows the advance made by Selmin in 1848 from the above primitive notions of the Cooke and Wheatstone long 5-inch astatic needle combination. Equally instructive is the display of Bonelli's, which must not be a forgotten that the early line wires were at first insulated with goose quills. Special attention should also be directed to a rare early forms of apparatus, which have been the medium upon which have been built two of the most valuable and important of modern telegraphic apparatus. The first is that of Gauss and Weber's telegraph (1833), constituted by the German Telegraph Department. In this original electro-magnetic apparatus, motion is given to a bar-magnet, suspended by a fine fibre, by means of the directive influence of a multiplying coil of wire surrounding it, and in the centre of which the bar oscillates freely. A mirror is attached to the axis of rotation of the magnetic bar, so that if the bar turns to the right or left, the mirror moves with it. The second early form of apparatus upon which attention is directed is that of Sykes' Yardy telegraph (1845), in which the signals are produced by the effection of electro-dynamic coils, free to vibrate over the sides of a permanent magnet. It will be observed that the motor power in Sir William Thomson's syphon recording telegraph is obtained by the motion of a delicately suspended coil of fine silvering over a soft iron core placed between the poles of a powerful magnet, the motion of the coil being operated by the delicate marker or capillary tube, which registers the signals upon the advancing paper ribbon. The early chemical printing telegraph of Alexander Bain, 1849 accomplished, with its cumbersome wooden box and governor engagement, also marks an era. In the collection of modern recording telegraphs, the high speed automatic printing instruments of Wheatstone and the syphon recorder of Sir William Thomson are the most interesting.

Mr. Culley is to be congratulated on the completeness of Post-Office display, and the exhibition of the German Telegraph Department forms a very complete historical collection of apparatus, from the beginning, in the recently-made spoke-and-wheel instrument of Messrs. Siemens and Halske, of 1875. Of the ancient telegraphic apparatus, of which the diplomatic are most ancient, such as those and Weber's or Steinheil's apparatus, copies have been forwarded so exactly made as even spots of rust are represented. The automatic form recorders and letter-printing telegraphs of Messrs Siemens deserve most careful study. The automatic Morse inker transmitter is comparatively rare in this country, and combines three important elements in its construction: it separate and transmits the messages automatically in the case of a single apparatus, the sending of the message being accomplished by the depression of fingerkeys corresponding to the letters required, and it possesses great rapidity, transmitting upwards of 80 messages an hour of the ordinary length. his most important forms of magnets current generators for reducing the electric light are well represented.

The original collection of apparatus contain objects which any will be glad to see—the apparatus with which Faraday ained the magneto-electro spark and his apparatus for ecomposing electric induction, also a portion of the battery used Sir Humphrey Davy in decomposing the alkalies, and ach of Dr. Wilde's apparatus used by him both in his researches on passage of the induced current through rarefied ases, and first experiments in galvanic gilding.

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[ESTABLISHED 1836.]

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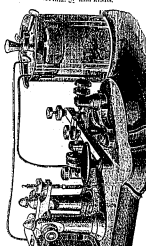
Telegraph Instruments, Batteries, Wire,

AND SUPPLIES OF ALL KINDS.



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Complete and Perfect, Individual Sounder and Key combined, with Book of Instructions, for Learners. Price, $5.00.

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Price, complete, with Battery, Wire, Book of Instructions, etc., for Lines, from a few feet to twelve miles long.....$10.00
Price, complete, with Battery, Wire, Book of Instructions, etc., for Lines, from twelve to twenty miles long.....12.00
Price, complete, with Battery, Wire, Book of Instructions, etc., for Lines, from twenty to thirty miles long.....15.00
Price, complete, with Battery, Wire, Book of Instructions, etc., for Lines, from thirty to forty miles long.....18.00
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Price, complete, with Battery, Wire, Book of Instructions, etc., for Lines, from fifty to sixty miles long.....25.00

These instruments are of the latest improved pattern, and are guaranteed to work satisfactorily from 10 to 60 miles on ordinary telegraph lines. Also, Sounders, Keys, Relays, Batteries, Wire, Insulators, Cutlery, Tools, Chemicals, and everything pertaining to the Telegraph. Send for Circular and Price List.

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Agency of SMITH'S MANUAL, one and enlarged edition, and with complete index of Stations, Postmasters, etc.

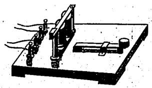
L. G. TILLOTSON & CO.,
8 Day St., New York, and 54 South 4th St., Philadelphia,
Electrical Apparatus, 31 N. Third Street, Cincinnati, O.

18

NEW MODEL "MORSE SOUNDER" TELEGRAPH APPARATUS,

For AMATEURS, STUDENTS, and PRIVATE LINES.

This Instrument, is well constructed and finished, and gives a clear, loud sound. It is capable of working on a line from 100 yards to several miles in length.



1875

Two Sets of Instruments, with Batteries, Chemicals, Connecting Wires, and Instruction Book, in box complete, 50s.

Additional Cells, where Extra Battery Power is required, 4s. 6d. each.

Bobbins of Wire—25 yards, 3s.; 50 yards, 5s.; 100 yards and upwards, 1d. per yard.

ORDERS SHOULD BE ACCOMPANIED WITH REMITTANCE.

"It is understood to be the desire of the Post Office authorities to extend the use of the 'Morse Sounder' in this country as rapidly as possible."—TIMES, October 5.

"The Postal Telegraph Department is rapidly extending the use of 'Sounders,' by converting all the inking circuits to 'Sounders'."—TELEGRAPHIC JOURNAL, November 15.

WESSMANN'S

"Pocket" Telegraph, or "Snapper" Sounder,

Price, with full Instructions, 1s., free by Post 1s. 1d.

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Importers and Exporters of Scientific Apparatus and Books,

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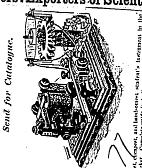


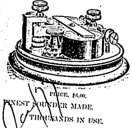
Best, cheapest, and handsomest student's instrument in the market. Complete outfit, including instruments, cell of Baltimore Battery, roll of Office Wire, package of chemicals, two message books, and Book of Instructions $5.00
Instrument alone 4.00
Will work admirably on 15 miles of line. No. 2, Student's outfit complete $6.00
Instruments and Telegraphic material of every description at lowest possible prices. Our beautiful and effective Main Line Sounder (key on base) still holds its own against the world, works on lines of any length. Largest and best line of American Plated goods in the country, including our beautiful Nickel Plated Box (on which we have just procured a patent). Our expenses being small, and our facilities large, we are enabled to give more for the money than any other house in the trade. 20 to 25 per cent. discount allowed when money is sent in advance.

77

...the British Association," being...

LITTLE MONITOR

Improved.



PRICE, $6.00.

THE FINEST SOUNDER MADE.

THOUSANDS IN USE.

THEY SELL THEMSELVES.

Magnets full-sized, with polished Rubber Covers, nicely finished and made of best material. They give a cracking good sound and are generally acknowledged the most beautiful little Sounder made.

A Splendid Little Monitor Key to match, which is a splendid instrument in every respect. PRICE, $4.00. No cast or malleable iron used in these instruments.

Sounder and Key, together, $9.00.

Orders filled promptly and sent on receipt of price, or C. O. D., if 10 per cent. accompanies the order.

M. A. Buell & Sons,

86 Bank Street, Cleveland, O.

Journal of the Telegraph.

BUNNELL'S NEW GIANT SOUNDERS PERFECTED.

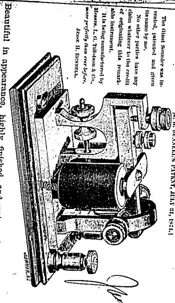
[J. H. BUNNELL'S PATENT, JULY 31, 1874.]

The Giant Sounder was invented, patented and given its name by me.

No other parties have any claim whatever to the credit of originating this remarkable instrument.

It is being manufactured by Messrs. L. G. Tillotson & Co., *more perfectly than ever before.*

JESSE H. BUNNELL.



Beautiful in appearance, highly finished, and put up in the most durable and substantial shape.

They give enormous sound with but little Local Battery power. Hundreds of them are in use in Railway and Commercial Telegraph Offices, and all operators agree that no better Sounder is desired.

PRICE, $7.50,

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DEALERS IN EVERY DESCRIPTION OF TELEGRAPH MATERIAL.

THE WESTERN ELECTRIC MANUFACTURING CO.

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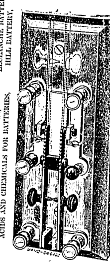
WE KEEP IN STOCK THE FOLLOWING ARTICLES:

GALVANIZED WIRE, COMPOUND WIRE, SCREW GLASS INSULATORS, (Cauvet's Patent), BRACKETS, PINS, SPIKES, BROOKS' INSULATORS, PLIERS, VISES, PULLEYS, CLIMBERS, WINDOW TUBES, BATTERY BRUSHES, SYRINGES, FUNNELS, HYDROMETERS, ACIDS AND CHEMICALS FOR BATTERIES, KERITE WIRE, BRAIDED AND WOUND OFFICE WIRE, GUTTA PERCHA OFFICE WIRE, SWITCH CORD, CALLAUD BATTERY, DANIELL BATTERY, GROVE BATTERY, BUNSEN BATTERY, LECLANCHE BATTERY, HILL BATTERY,



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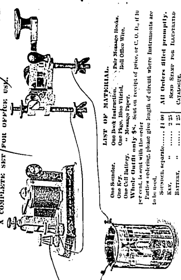
&c. Our Morse Instruments are of the Western Union, Ottawa (or Caton) style. We have ample facilities for the execution of every variety of electrical work.

THE EUREKA INSTRUMENT

A COMPLETE SET FOR OFFICE USE.



LIST OF MATERIAL.

One Sounder. One Book Instruction. 1 Pair Message Hooks. One Key. One Page, Blue Vitriol. Roll Office Wire. One Cell Battery. " Message Paper.

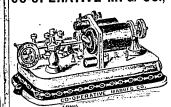
Whole Outfit only $8. Sent on receipt of price, or C. O. D., if 10 per cent. is sent with the order.

Parties ordering, please give length of circuit where instruments are to be used.

SOUNDER, separate....	$4 00	**All Orders filled promptly.**
KEY, "	2 25	SEND STAMP FOR ILLUSTRATED
BATTERY, "	1 25	CATALOGUE.

M. A. BUELL & SONS, 86 Bank St., Cleveland, O.

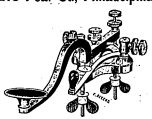
CO-OPERATIVE MFG. CO., 218 Pear St., Philadelphia.



Improved
W. U. Pattern Relay.

This Relay is acknowledged to be the best in use, is finely finished.

Price, - - - - - - $10.



No. 1 Key.

This Key is of a beautiful design, and durable in construction, and is made of the best material, combining a smooth and working Motor Key. No. 1 Key consist of Metallic Lever.

Price, - - - - - $4 25
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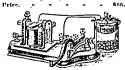


Co-operators' Learners' Instrument No. 1.

a complete outfit; enclosed in Cabinet combined sounder and Key, mounted on a walnut base, with Battery, Cherokee, Wire and Book of Instructions, sufficient for learning the telegraphing them, for practicing or communicating purposes, being all requires a regular Morse instrument, comprised of a finished Sounder, a nicely adjusted curved lever Key, made in the best manner and working beautiful in their construction which could in any way contribute to their efficiency as complete outside and Key combined.

The above instrument is nicely finished in brass, and not finished in imitation bronze that are made of cast iron.

Price of No. 1 instrument when money is sent in advance, - - - - - - $7 00
With Battery, - - - - - - 9 50
When sent C. O. D., - - - - - 8 50
With Battery, - - - - - 10 00

N. B.—Either of the above instruments can be made to work on a circuit from one to twelve miles by Winding Magnets with fine wire which will make cost of instrument one dollar extra.

Co-operators' Learners' Instrument No. 2.

THIS BEATS THEM ALL.

We have pleased a out of our No. 2 Learners' Instrument, which is pronounced by all to be the best and handsomest. We can safely say this Instrument is far ahead of other manufacturers' as to price and quality; it is finished in bronze and mounted on a walnut base.

Price of No. 2 Instrument when money is sent in advance, - - - - - - $5 00
With Battery, - - - - - - 6 50
When sent C. O. D., - - - - - 6 50
With Battery, - - - - - 7 00

Send for Price List.

W. R. BALDWIN, Manager, 218 Pear Street, Philadelphia.

(69) C. W. D. asks: In making a pony telegraph sounder or relay, the bobbins or arms of the magnets to be 1 inch long and ⅜ or ½ inch diameter, what diameter should the iron cores be, and what number wire, and how many convolutions, must I use to give sufficient force? The iron arms of the magnet are inch diameter, and the spools are 1 inch long and ⅝ inch diameter, the armature bar inch by inch by inch of soft round iron, 1 inch long and ¼ inch diameter; and the spools should be filled with six or eight layers of No. 36 copper wire, silver silk or cotton insulation, for a sounder, and of from twelve to fourteen layers of No. 36 copper wire silk insulation, for a relay.

CHAMPION LIGHTNING ARRESTER. CUT OUT AND GROUND SWITCH COMBINED. Price by mail, $1.50 Guaranteed the best and cheapest in the world.

PARTRICK & CARTER,
38 South 4th Street, Philadelphia, Pa.
Manufactory, 614, 616 and 618 Filbert Street.

WESTERN ELECTRIC MANF. CO.

220 Rinzie Street, Chicago, Ill.

POCKET RELAY,

PATENTED JULY 18th, 1871.

Our Patent Pocket Relay has an improved key, large enough to be durable and for practical work.

It has an independent circuit closer.

The sounding lever is supported by adjustable tension screws, and can be readily removed at any time, or adjusted as finely as a relay armature.

The adjustment spring is conveniently arranged, and can be repaired with ease.

The instrument gives a splendid sound.

The case is hard rubber and the same in length and width as the Celon Pocket Relay Case, and a trifle deeper.

It is pronounced the best finished and most serviceable Pocket Instrument made.

PRICE, $18.00.

Twenty per cent. discount when money is sent with order.

WESTERN ELECTRIC MANUFACTURING COMPANY.

An electro-magnetic sounder, recently described by M. Semonnis, in *L'Electricien*, has the following arrangement:—In a hollow metallic cylinder, closed at the top, open below, is suspended by a strong spiral spring, a plunger, with weight attached below. When the apparatus has been let down into the water below by a line, the weight strikes on the bottom, the plunger rises in the cylinder, and thereby closes a circuit formed by wires in the line, a battery and an alarm apparatus. At the same time a hook is caused to liberate a float, which rises to the surface, and indicates the distance travelled by the ship during the experiment. [illegible]

CENTENNIAL EXHIBITION AWARDS.

Phelps's Motor Printing Telegraph.

THE Western Union Telegraph Company exhibited at the Centennial Exhibition the Motor Printing Telegraph instrument, invented and patented by Mr. [illegible] Phelps. This instrument attracted much attention during the whole time of the Exhibition, and was kept busy printing specimens for the public, and demonstrating its practical advantages in actual operation.

It was carefully examined by Sir William Thomson, the Judges, in the electrical department, upon whose report the Company was awarded a diploma and medal for its excellence and superiority over other apparatus for similar purposes. The report of Sir William Thomson was approved by the Group Judges, Messrs. James C. Watson, H. K. Oliver, J. E. Hilgard, F. A. P. Barnard, J. Schiedmayer, Ed. Favre Perret, E. Lenssenz, Joseph Henry, and Charles E. Emery. It is as follows:

"This instrument, founded on the same principle of electromotric telegraphy as the original Hughes printing instrument and the old military teeth telegraph of the Greek General Xerxes, is a great advance on the instrument known as the "combination instrument," in which some of the peculiarities of the Hughes and Morse instruments were combined. On some points it goes back advantageously to the simple character of the original Hughes instrument, as, for instance, in dispensing with the plan of air pressure, introduced into the combination instrument, and performing the mechanical action by electro-magnetic power alone. It has the great advantage above all previous printing instruments of the electromotric class, of permitting groups of consecutive letters to be telegraphed by depressing simultaneously all the corresponding keys. Thus: if the keys A, B, are depressed simultaneously on the "combination instrument," the letters transmitted and printed are A F; if on the Phelps instrument, the fourth A B is correctly given. If all the letters of the alphabet are simultaneously depressed on the Phelps instrument, they are transmitted and printed in the order of the alphabet, and in the time of a single revolution of the type-wheel; and if any group of letters is simultaneously depressed, these letters are correctly transmitted and printed in the order in which they would be found in going through the alphabet in regular order. Thus, if the letters DAILY are simultaneously depressed, the result is daily; but to send the word "daily" correctly, all that is necessary is to first press the key D, then, as soon as it has marked, press "ally." The same manipulation would give this word correctly on the "combination instrument." But take the word "Defeat." On the combination instrument, to send this word, the key D must first be depressed; when it has made its signal, E must be pressed, and the type-wheel runs around the alphabet through Z, A and D to E, until it prints E; then F must be pressed, and the wheel runs around once more before making the fresh signal, then L and one more turn of the wheel, then ANT may be pressed simultaneously, and the word is completed, while the type-wheel runs direct from A to T. On the Phelps instrument DEFT may be pressed simultaneously, and these letters are printed while the type-wheel runs from A to I, and next ANT depressed simultaneously finishes the word as in the other instrument, while the wheel runs from A to T.

Considering the enormous gain on this one word, and the continual occurrence of words in which more or less of such gain is obtainable, I should expect to find that in practice the Phelps instrument would give an ordinary working speed quite as much as double that of the previous forms of instrument on the same electromotric principles, and I am not surprised to learn that, worked by expert operators, it can transmit from 60 to 70 words per minute.

The Phelps Electro-Motor (used also in the "Gold and Stock Transmitter," the subject of another award) is used to give the electromotric motions of the synchronous wheels of the transmitter and receiver in this instrument, and deserves special notice on account of the simplicity of the manner in which it gives the required degree of electromotric uniformity in virtue of its governor, a modification of Hebdomki's electro-magnetic governor."

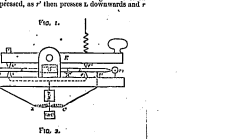
According to reports attributed to the officers of the Western Union Telegraph Company, where dynamic generators have been substituted for decomposition batteries for the generation of the current the cost of charging the wires with the dynamic current is about one-half what it was under the old system. Readers of THE TIMES will recall that some months ago, in a description of a system of telegraphy devised by one of our prominent electricians, in which the dynamic current was employed in place of that generated by decomposition, the reduction in the cost of charging was stated in figures closely corresponding to those developed by the experience of the Western Union Company. The statement was sharply taken up at the time by the partisans of the dynamic current in a series of communications, and some even went so far as to claim that the actual cost, with for volt, of electricity was about one-sixtieth of that produced by decomposition. This extraordinary assertion was based upon the fact that a pound of coal contains a certain amount of energy whose quantity is fairly accurately measured and determinable, and the amount of power in a pound of copper or zinc is also accurately determinable; and when these two factors of the problem alone are compared, and this comparison is made the basis of an estimate of cost, the relative ratio shows an advantage in favor of coal of between 45 and 60 to 1. The reasoning looked very plausible on paper, but, unfortunately, there were certain factors which the partisans of dynamic electricity did not take into account. In the use of the dynamic generator the number of thousands of energy contained in a pound of coal is one thing and the actual horse-power of that energy which appears in the circuit as electricity is quite another. In the first place, the imperfect combustion of the coal in the furnace must be regarded, and, although it may seem strange to the popular reader, in view of the great advances that science has made of late years, it is none the less a fact that not far from four-fifths of all the heat-forming energy contained in a pound of coal is wasted in the furnace through imperfect combustion; so that in operating a steam engine only about one-fifth of the actual energy of the fuel is converted into steam. This fact is so well verified that able engineers have already turned their attention to the construction of furnaces to produce perfect combustion, and the next step in the economical production of power will no doubt take the direction of better-constructed furnaces. In the second place, only about 40 per cent. of the energy transferred from the engine to the generator is actually converted into available current, and as three-fifths of the steam-power is lost before the transformation into current is completed. If, for example, the amount of energy contained in a pound of coal be placed at 100, 80 of this 100 will be lost by imperfect combustion, and 12 out of the remaining 20 will be sacrificed in the development of heat in the generator. The result is that only 8 per centum of the actual energy contained in a pound of coal is transformed into electricity in the use of the dynamic generator, while the larger proportion of the energy contained in the copper and zinc is converted, and this is the reason why the theoretical and the practical relations of the two methods are so at variance with each other, and why those who based their computations upon a mere comparison of foot-pounds of energy were so wide of the mark in their statements.

THE DOUBLE CURRENT TELEGRAPH KEY.

By P. THOMSON, of the Pontiac Gulf Telegraph.

FIG. 1 gives an elevation, and Fig. 2 a plan of the connections of this key.

In Fig. 1, E is an ordinary Morse key. t is a brass beam, the two halves of which are insulated from each other at A. This beam vibrates on an axis shown by the dotted lines between a a, from which it is insulated, and plays between the brass stops s and s'. s and s' are insulated from the key, over position it may be had thrown by the action of E, by the rollers r and r'. These two rollers work on springs which are so adjusted that when the beam t is in the position of rest, as shown in Fig. 1, r tends to press it downwards, and r' upwards. This order of things is reversed when E is depressed, as r then presses t downwards and r



presses it upwards. s and s' are two weak spiral springs by means of which the negative and positive poles of two batteries are maintained in connection with the back and front halves of t, respectively. They exercise no influence over the movements of t.

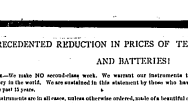
The back and front stops b and f are permanently in connection, and are to earth through the adjustable resistance marked "Shunt."

The action of the key is as follows:—Fig. 1 shows the key at rest. The switch (not shown in the diagram) being turned to "send," the negative current passes on to the beam t, at s, and at the stop b it divides between the shunt and line; if now t is depressed, t does not follow the movements immediately, being held in position by the spring s, but finally it is struck against by f, at which moment the full positive current passes to line, and then t, being pressed down until the stop f is reached, the shunt comes into play, carrying off a portion of the current. The negative half of t has in the same time been raised from contact with the back stop b, and now occupies the same position with respect to b and f as the positive half had previously occupied with regard to f and b—viz., touching neither. If E is allowed to fall back, similar movements take place; first, the full negative current is sent to line at the moment t, is struck, which continues until the position of rest is reached, when the reduced current flows. This arrangement has been worked satisfactorily through 500 miles of line, but from the incomplete details from Kerrebec to which comparison as regards nature of the apparatus no reliable comparison as regards speed with the ordinary "permanent" current keys have been obtained.—*Telegraphic Journal.*

UNPRECEDENTED REDUCTION IN PRICES OF TELEGRAPH INSTRUMENTS AND BATTERIES!

Secure.—We make NO second-class work. We warrant our Instruments to be more perfect than those of any other manufactory in the world. We are sustained in this statement by those who have had practical experience with our work during the past 12 years.

Our Instruments are in all cases, unless otherwise ordered, made of a beautiful quality of GOLD BRONZE METAL, which retains its lustre for years, and is without a doubt the best possible material of which to make Telegraph apparatus of proper durability and high finish.



Western Union Latest Standard Relay Reduced to $10.00.

Until further notice we will make a *discount of 33⅓ per cent.* from our catalogue prices on the following :

	Price.	Reduced to
No. 1 Dorsilene Spring Registers	$27 00	$18 00
No. 2 Weight Registers and Weights	37 50	25 00
No. 3 Register	47 00	31 46
	25 00	16 66

RELAYS.

No. 1 Standard Size, 10 to 100 ohms Resistance	16 00	10 66
No. 2 Light Resistance, 10 to 50 ohms	15 00	10 00
Pony Relays, 50 to 80 ohms, for Short Lines	7 50	5 00
Box Relays, No. 1 any required Resistance	15 00	10 00
Western Union Latest Standard Relay	15 00	10 66
	15 00	10 00

POCKET RELAYS.

Bunnell's "Littlefinal"	22 00	
Caton Pocket Relays	20 00, 18 00, and 16 00	14 66
		12 33, 12 00, and 11 00

SOUNDERS.

Hand Sounders, J. H. Bunnell's Patent		
Sectional Sounders	7 50	5 00
No. 1 Pony	6 00	4 00
No. 2 "	5 50	3 50
No. 3 "	6 00	4 33
Western Union Sounders with Metallic Platform Base	8 50	5 66
	10 00	6 66

KEYS.

No. 1 Western Union Pattern	6 00	4 33
No. 2 "	5 50	3 66
No. 3 "	6 50	4 33
No. 4 "	4 00	2 66
No. 5 New Tor Connecting Binding Bank Key	7 50	5 00
Paris Sounders with Electrical Adjustment	5 50	3 33
	6 00	3 66

WESTERN UNION IMPROVED PIN-SWITCHES.

33⅓ per cent. discount from Catalogue.

LIGHTNING ARRESTERS of all kinds constantly on hand.

STANDARD WESTERN UNION GRAVITY BATTERY

FOR MAIN LINE AND LOCAL USES.

No. 1	1 50	
No. 2 "	1 00	1 00
Glass, Copper, Jars and Elements for these sizes at same discount.	1 00	1 25

Quality maintained strictly first class as heretofore in all of our Telegraph Machinery and Supplies.

We are now furnishing at relatively low prices ALL MATERIALS used in the CONSTRUCTION and EQUIPMENT of TELEGRAPHIC LINES, LINE WIRE, INSULATORS, BRACKETS, PINS, TOOLS, etc., always on hand in any quantity required. Special low prices made on KERITE WIRE, OFFICE WIRE, CABLES, Etc., in any quantity.

50 PER CENT DISCOUNT.

We have a quantity of the well known HILLS PATENT LOCAL BATTERY, (size of Jars 6x8½) which we are now selling until further notice at the list prices $1.50 per cell and 50 per cent discount. We sell per cell.

L. G. TILLOTSON & CO.,

8 Day Street, New York.

1875, has produced the following results: it has brought the Danube considerably nearer to Vienna; the consolidation of the new banks prevents shifting of the current, and preserves a vast extent of fertile ground from being undone; the inundations which used to be so frequent are now entirely prevented. We shall in another article proceed to describe the execution of the work.

TELEGRAPHIC APPARATUS AT THE PARIS EXHIBITION.—No. V.

STILL keeping to the wall, the next stall past that of the "Société Anonyme Telephonos-Bell" is that of M. Jarrinet, the well-known electric bell-maker of the Rue de Morny, Paris. The bell-pulls and porcelain on view are very elegant in design. The tablet indicators are mounted on a base plate of different expansion on heating. Several also shows some very ornamental lightning rods. On this side of the hall there is less to interest the telegraph engineer than on the other; electric and pneumatic bells predominating here. After Jarrinet's come the stalls of M.M. Chauvin and Marin-Darbel, Bolvin (bells), Legay (wires and bells), De Cosse (bells), Cavedoues (pneumatic tubes and bells), Courtet (very small bells and speaking tubes), Deyrolle and Sire (bells). In the way of novelties M. Bolvin exhibits a patent electric target bell up at a distance electrically connected to a mark indicator, which can be placed beside the shooter. When a bullet strikes any particular section of the target it is forced back by the impact, and making contact completes an electric circuit, which registers the number of marks scored by the shot. M. de Cosse's battery exhibits a temperature alarm consisting of a mercury thermometer, horizontally balanced on a pivot, so that when the mercury column reaches a certain degree the balance is upset and an electric contact established which rings a bell, or otherwise gives warning. Proceeding onwards we pass in succession the smaller stalls of M.M. Müller, Tellier (bells), Pillifant, Nacke and Perin, Franche Comté (galvanised iron wires and brackets), Nastrer (who exhibits one of Reynier's electric lamps with carbon disc electrodes), Claffe (ordinary telegraphic battery), Legray (wires and bobbins), and Chenuet, the stall of M. Postel-Vinay, which comes next, we remark a well board containing a full set of the larger construction tools together with a leather knapsack of finer tools; a useful little instrument table of cut, comprising a needle instrument lightning protector, two relays and galvanoscopes; a handsome mirror speaking galvanometer cased in ebonite, with nickel plated dials and magnet. There is also on view here a Hughes and Breguet dial, a single dial on the same principle for printing twenty copies of one message locally. In the next stall are Digney and Desmarest, who, along with M. Breguet, rank as the best electrical mechanicians in France. They exhibit a variety of Morse instruments employed by the French Telegraph Administration, notably a small Morse adopted by the Administration since 1876 for service in the provinces. It is but 18 in. long by 6 in. high, and 5 in. wide, and the paper is pressed up against the working disc by the end of the armature, which is curved inward, and terminated in a triangular knife edge. This disc is made portable by being fitted into an oaken case, and provided with a belt or handle. A larger Morse, also used by the French Telegraph Administration on long circuits, and having a relay attached, is also on view. It can be fitted into a portable case with folding sides, and drawer for adjusting tools; about 18 in. long, 12 in. high, and 7 in. wide. These instruments are fully described. There is here also a solid telegraphic battery in the shape of a *manipulateur à cuvette*, as the electro-magnetic dial manipulator, formerly mentioned, is termed, with corresponding needle instrument, both having the alphabet in Roman, Turkish, and Arabic characters. It is designed for service in Algeria and other Mahomedan countries.

The firm of Dumoulin's battery, recently contrived by D'Ubigni, an Italian, is also exhibited by MM. Digney and Desmarest. The outer vessel of this cell may be described as an ample glass cylinder 4 in. wide, contrasted at its middle to contain the diaphragm, after the fashion of a sand-glass. The zinc pole, which is a flat cylinder, rests in the upper wide portion, the copper pole, which is a flat spiral ribbon, rests in the wide bottom part of the vessel, the electrode from it passing upward through a neutral bath cut in the zinc. Crystals of sulphate of copper strew the floor of the cell, and the blue solution surrounds the copper pole, but is prevented from diffusing upward to the zinc pole by the screen of porcelain. The sulphate of zinc solution surrounding the zinc pole therefore remains comparatively pure, and waste of zinc by local action is thereby saved.

The next and last stand still is that of M. E. Deschiens, who likewise exhibits a considerable variety of apparatus, including Hughes's instrument and Morse's.

At the far end of the concave there are a number of small detached stalls in two groups, comprising exhibitions by the following makers: MM. Degoz, Tisserat, Tourrade, Dumbell, Callaud, Mouchel, Doneux, Dumet, Casanelle, Legu, Paris, Barbier, Lebourseau, Gerenot and Dubois, Bigeon, Delmasse, Vassalle, Guérin and Son, Cissaco, Pelech, Delaurier, and Guerot. Of these M. Vassalle exhibits a large number of specimens of prepared carbon and graphite for various purposes, including the electric light; and M. Gerot exhibits Delaurier's bichromate battery, which in France has gradually taken the place of Callaud's for electro-plating, by reason of its great economy, and the absence of deleterious fumes. The excellent consists of a zinc and two or more carbon plates enclosed in a porous pot; the exciting liquid being a solution of bichromate of potash, sulphate of soda, sulphate of iron, and sulphuric acid in water. It is contained in the porous vase or in the carbons, and water is placed in the outer vessel around the zinc. It is known that water charged with only thirteen one-hundredths of its weight of bichromate of potash; but in presence of the other salts it dissolves many, because the sulphuric acid being in excess, the more soluble salts, bichromate of soda and persulphate of iron, are formed. In order to prevent the current falling off by a deposit of oxide of chrome on the plates, the proportions of chemicals are so calculated as to permit the oxide to be dissolved in proportions as it is produced. According to Count Du Moncel, the electromotive force of this bichromate element works for five consecutive days through 40,000 Ω, of telegraph wire averaged 2.054, taking the Daniell element as unity. On first charging, the electromotive force has been equivalent to 2.102 Daniells, and slightly hoarsather the trial in question it had recovered the value of 2.130 Daniells. The resistance of the element on first charging is equal to the resistance of 2201 Ω, and it falls on being worked to that of 1920 Ω.

Besides these small stalls there are in this part of the hall four large stalls in groups of two, namely, those of M. Walker and M. Hattier and Son, and those of MM. Coupil-Lemaout and Fellinger, and M. Walker exhibits some fine electric clocks and other apparatus; MM. Coupil and Fellinger, a complete pneumatic despatch apparatus. The neighbouring stalls of Berset and of Meslier exhibit examples of india-rubber and gutta-percha insulated wires and cables, insulators, battery jars, and other works in classic—the display of Meslier being especially fine. The specimens of cable are also dressed at the ends so to show the different layers of material. Several specimens of the Paris india-rubber gravel wire are to be seen here. It is formed of a seven-wire copper strand insulated with gutta-percha. Over the latter is wound a cotton tape steeped in a solution of copper-solution and dried, to preserve it. Over the cotton is laid a layer of tanned hemp, then a wrapping of tarred yarn, then another layer of tanned hemp, then tarred tape again, and, lastly, the whole is enclosed in a lead pipe. In another form the lead pipe is overlaid with steel wires and a protecting compound. The lead pipes are soldered

TELEGRAPHIC APPARATUS AT THE PARIS EXHIBITION.—No. VII.

Sieur's Duplex Telegraph.

The duplex system of M. Sieur, of Provins (Seine et Marne), an officer of the French Telegraph Administration, is distinct in principle from all other practical duplex systems. It is based on the use of a "distributor" or automatic current reverser, which divides up the time of sending into a series of small and equal intervals, during which a succession of alternating positive and negative currents, each current occupying an interval, are sent into the line. These currents are received separately on two polarised relays, one relay responding to the positive and the other to the negative currents. It is a system which equally admits of sending two messages in the same direction simultaneously, or two messages in contrary directions. We will first consider the case of two messages in the same direction. The distributor, or automatic reverser, is the same

Fig. 1.

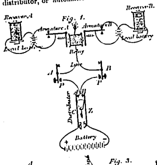


Fig. 2.

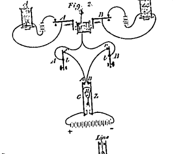


Fig. 3.

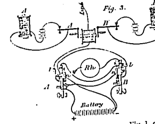
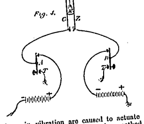


Fig. 4.



in either case, and consists of a cam, Fig. 1, connected to "earth," and turning by clockwork between two steel springs or levers C, Z, which it raises alternately as it rotates. Let us suppose that the cam revolves at a speed of twenty turns a second. It will first encounter and raise during one-fortieth of a second the spring C, and being in contact with earth, it will put the positive pole of the battery to earth during that time, whilst the negative pole, through the spring Z, is in connexion with the under stud P of the key B. Passing on from the spring C, which returns to its stud A, the cam raises in turn the spring Z, breaking contact with B. The negative pole of the battery is thus put to earth while the positive pole is connected to the stud P of the key A. During each revolution of the cam, the two poles of the battery are thus alternately drawn upon, but the intermittent currents from each are led to separate signalling keys A and B. If the key A alone is manipulated, a positive intermittent current is sent into the line, the interruptions succeeding one another at intervals of one-fortieth of a second. If the key B be worked a series of similar negative currents enter the line.

The receiver is a polarised relay with two armatures, the armature A only answering to positive currents, and the armature B to negative currents. Two polarised relays with a single armature will serve the same purpose. The armature B, which can only act under the influence of the negative current, remains passive on its upper contact, short-circuiting the local battery which actuates the recorder B, as shown; but the armature A is attracted by the positive currents into contact with its lower stop, thus breaking the short

circuit and enabling the local battery to signal on the recorder A. It is true that the armature A is only attracted for one-fortieth of a second at intervals of one-fortieth of a second, but the recorder A can be so adjusted as to bridge over the interruptions, and give entire signals, while the key A is depressed, just as if the current were a continuous one. In the same way, when the key B is manipulated, the recorder A is passive, while the negative intermittent current from B attracts the armature B, breaks the short circuit, and allows the recorder B to signal.

It will be obvious from the above that if both keys operate together in sending two different messages simultaneously, both armatures will simultaneously respond, each to its respective key, and both recorders each to its respective armature. The principle of the system consists in making two armatures vibrate at will, either singly or together, but independently of each other.

In the arrangement we have considered, the armatures in vibration are caused to actuate the recording instruments, but by another method represented in Fig. 2, they can be easily made to signal when at rest. Instead of connecting the springs of the distributor to the under studs P of the keys, they are connected in this case to the studs r on which the lever of the keys bear when at rest. A series of intermittent currents are in this way continually flowing into the line, positive from the key A, negative from the key B. These currents cause the corresponding armatures of the relay to vibrate continually. The local recording circuits are so joined up to the armatures that they are closed when the armatures are at rest on their upper stops, and open when the armatures vibrate, for the rapidly intermitting currents cause the armatures to vibrate freely midway between both their upper and lower stops. On depressing the key A, however, contact is broken at r, the positive current ceases to flow and the armature A stops. In stopping it returns to its rest stop, completes the local circuit, and causes the recorder A to signal. Similarly the key B causes the recorder B to signal; and when both keys act at once, both recorders respond together, each to its proper key.

We will now consider the problem of sending two messages in contrary directions. It is, of course, understood that, in this case, each station must be able to send a message without interfering with its own receiving instrument. Let the two stations be called respectively s and s_1. Only the station s is provided with a distributor, and it is of the form shown in Fig. 2, that is to say, the wires from the middle of the keys l unite; but before entering the line they are connected up through the receiving relay. Fig. 3 represents the arrangement of apparatus at station s_1. The relay at both stations is so joined up that the armatures A vibrate under the negative currents from s, and the armatures B under the positive currents. The levers m, n of the signalling keys are each made in two metal parts m and n, insulated from one another. In the position of rest, the distributor of the station s sends into the line a series of alternating emissions of positive and negative currents, which traverse the relay at s, and also that at s_1, where they flow to earth by the levers l and the contacts t of the keys A and B. At both stations the armatures A and B of the relays oscillate, but have no action on their recorders.

When the key A at station s, Fig. 2, is alone depressed, it follows that the armatures A at both stations stop vibrating, and the corresponding recorders signal. Similarly when B is depressed the corresponding recorders at both stations also signal. Hence the sending of station s operates both relays and recorders.

When the key A of station s, Fig. 3, is alone depressed, the part m of the bar makes contact with the lever l and raises it, while the part n raises the lever r. The negative current from the battery reaching the part n, passes by the lever r or the key A, the contact i, and the lever r of the key B, and goes to earth through the rheostat R h, whilst the positive current passing by the part m and the lever l of the key A enters the line. These positive currents from s_1 tend to intensify the negative currents from s; but the rheostat R h in circuit, is adjusted so as to reduce the intensity of the current so produced to the intensity of a negative pole singly. The negative currents from s, therefore, continue to act as if the key A of station s_1 were at rest, and the armatures B at both stations continue to oscillate. On the other hand, the positive currents from s are neutralised by the positive current sent into the line from s_1; and consequently the armatures A at both stations cease to oscillate, thus actuating their recorders. Again, if the key B of the station s_1 transmits alone, the part m of the bar raises the lever l, while the part n raises the lever r. The positive current, passing by m of the key A and its resting stud T to n of the key B and the lever r_1 goes to earth across the rheostat Rh, whilst the negative current, passing by m and the lever l of B, the contact t and lever l of A, enters the line, where it does not affect the positive currents from s, but neutralises the negative currents. At both stations, therefore, the armatures A continue to oscillate, but the armatures B are stopped. When both keys of station s_1 act together, the positive pole of the battery is connected to the line by the part m and lever l of the key A. But the negative pole, passing by the part m and lever l of the key B is insulated at the contact t of the key A; and the same pole passing by the part n and lever r of the key A is insulated also at the contact i of the key B. There is consequently a breach in the line circuit, and as no currents traverse it, the armatures of both relays act, and all the recorders signal.

When the key A of station s transmits at the same time as the key B of station s_1, the depression of the former suppresses the emission of positive currents from s, while the depression of the latter sends over the line a negative current which neutralises the negative currents still issuing from s; consequently there is practically no current on the line, all the armatures stop, and all the recorders signal. The same effect takes place, but by an inverse process, when the key B of station s is depressed at the same time as the key A of station s.

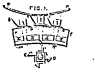
Lastly, when the key A of station s transmits at the same time as the key A of station s_1, or the key B of s at the same time as the key B of s_1, it is clear that since the positive current sent out by s, does not affect the negative one from s, the stoppage of the positive current from s affects the armatures of the relays A at both stations in the same way as if the key A at station s had not been depressed at all. Similarly the effect of depressing the key B at station s_1, while the key B at station s is depressed is the same as if the latter alone was depressed—both B relays are operated.

It will be seen that this ingenious duplex system of M. Sieur admits of a copy of the home message being recorded as it is being sent out. If the message sent from s be transmitted, for example, by the key A it will be taken down by the corresponding recorder A at s, as well as by the receiver

G. GRABNER'S QUADRUPLEX TYPE-PRINTER.

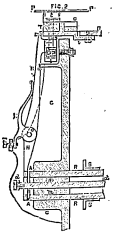
…s instrument, which is distinguished by a peculiar contriv… for printing, was patented on December 30, 1873, for …tents. Here the 60 types *t* (Figs. 2 and 3) of minimal size, …ly disposed in the compass of a type-plate T so as to shift …dily near the type-plate T is a contact-plate C, and both, …dulated by a ring *l*, are screwed on to the contact cylinder B. …a special axle above the type-plate is the paper-cylinder P, …ich is made hollow and as light as possible, and has to take up …l paper to be printed in telegraph form. Both ends of the …er are passed through a narrow slit in the convex surface of …paper-cylinder, and are stretched and firmly pressed by means …wedge. The ground surfaces of the paper-cylinder consist …o plates, and their moves endwise, as in matrices, the firmly …ected axle, a male screw, the height of whose section exceeds

FIG. 1.



…t of the types by the interval between the lines. Then, as the …linder revolves the breadth of a letter with each imprint, the …et of paper becomes printed like any ordinary printed matter. …the nave of the paper-cylinder plates is adjusted a …interposite to equalise any possible eccentric position of the …tre of gravity, and at the same time to regulate the turning …e each printing of a letter by firmly bracing the nave to the …ocket. Near the deepest part of the type-plate is an ordinary …-roller, by which the colouring matter is applied to the types. …he type-plate T, together with contact plate C and contact …inder, revolves with its axle set in motion by a weight, with …aid of several cog-wheels. But, inside the type-plate T, in …uppermost part of the plummer-block G, is an axle *a*, to which …adjusted *n* small, light wheel *b*. The four springs *e* attached

FIG. 2



…e thus wheel lie with their ends within reach of the lower ends *s* …f the types *t*; hence, while the type-plate revolves in the direc…tion of the arrow, the wheel *b* is carried along by the ends *s* so …long as no obstacle is opposed to its motion. But as soon as the …further turning of *b* is prevented, which happens at the indicated …place of wheel *b* in fig. 2, the next type *t* with its end *s* is forced …up to the spring *e*, whereupon this type is printed off on the …paper. With the upward motion of the type the spring *e* curves …upwards, and, tapering above, becomes pressed to the paper …cylinder P, which it turns round the required piece just before …the printing taken place; but, this done, as soon as it has passed …over *s*, the spring *e* again presses the type *t* down to its resting …position.

The special axle of contact plate B, of the type-plate T and contact-plate C, forms a steel magnet, to the extremity of which is screwed an iron tube R, which is thus continuously magnetised by the steel magnet. The electro-magnetic spool S is further passed over the tube R, one end of the winding connecting with the contact-plate C, the other through the line battery with the earth over the pin *d* lying within tube R, and by *n* insulated from it. The pole at *d* of the battery in question is at the same time connected with one wave of the contact-cylinder B, so that the currents may by the latter be conducted to the line when a telegram is being sent off; but, when a message arrives, the line currents come, on the contrary, from contact-lever to the contact-plate, and pass to earth through the electro-magnet. But the arriving current is so directed in the electro-magnet S that the tube R, serving as a core and magnetically induced by the steel axle, becomes unmagnetised. Hence, whereas hitherto the tube R retained the ring A (serving as anchor) attracted to the lever H revolving round axle *o*, the powerful spring K, to be correspondingly strained by means of the screw *r*, is now enabled to detach the anchor and place a wedge-shaped adjustment at the upper end of the lever H resting on a stopper before a leaf fly of the small wheel *b* and in the arresting place *u*, thus causing the just inverted types to be printed off. When this is completed, the nearest of the cams *x* (see fig. 1) immediately below the type-plate T acts on the upper end of the anchor lever H, and again places the anchor A on the tube-shaped core R.

FIG. 4.

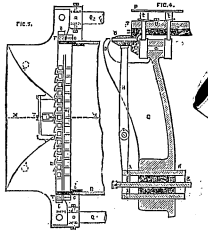


FIG. 3.

In the arrangement of the printing apparatus represented in fig. 4, and differing somewhat from the above, the anchor-lever A, which falls down through the action of the spring at the arrival of the line current, ought to press a double-cutted little wheel D into the space between the conic indented flange Z of the type-plate T, and a small conic wheel E adjusted to the shaft *a*, and thereby transfer the motion of the flange to the cam-shaft *a*, whose cams drive the types *t* towards P. Although the teeth of D and E still remain dovetailed together, the double-cutted wheel D and the cog-shaft *a* are at once stopped at the recoil of the anchor-lever, because the former with the cylindrical portion between both cones becomes pressed into the arresting place at a firmly-fixed arm *p* of the pillar block G. The types move in the same direction as the cogs. In first contrivance each type is raised with the fourth of a revolution of the small spring wheel *b*. With a 3-mm. breadth of the type-pin, with a 100-mm. diameter of the pitch-circle of the type-plate, and 1·5 revolution per second, the printing itself will require $1 : 3 (100 \times 3 \cdot 14 \times 1 \cdot 5)$, or

$$\frac{1}{300}$$

that is almost exactly $\frac{1}{300}$ second.

Now, if four such type-printers be connected with a quadruplex telegraph, each of the four contact-plates C, and each of the four contact-cylinders B, must receive 60 contact pins for 60 types. But, instead of arranging each of the four apparatus quite independently one of the other, they are joined together two-and-two in a double apparatus. Then there will not be required four

TELEGRAPHIC APPARATUS AT THE PARIS EXHIBITION.—No. X.

LEBLANC'S ELECTRIC FIRE TELL-TALE.

It is the nature of a fire to spring from the most insignificant origin, or a vast conflagration may be kindled by a spark, and its growth increases in an accumulating ratio far exceeding the compound interest law. It, therefore, becomes of the utmost importance to give quick warning of the outbreak of a fire, so that the firemen may be on the spot to commence their extinguishing operations against it as soon after its beginning as possible, for time saved then is of great value. The letter to effect this several different systems of conveying fire alarms by electricity have within the last few years been developed, and also applied, particularly in America, where fires in towns are usually of a more dangerous character than in England, by reason of the quantity of timber used in construction, and the extreme dryness of the climate in most parts. Some of these public fire-alarm systems are beginning to be adopted in this country. Glasgow, for example, has taken the question seriously in hand, and, before long, we trust that London will be supplied with street fire-alarms communicating with the fire-stations situated along the main thoroughfares, as the pillar letter-boxes are now, so that a citizen or watchman may, at a few moments' notice, send intelligence of the outbreak of a fire to the nearest fire-brigade. These systems, however, are designed for calling help after the fire has been detected; but there are, as is well known, auxiliary contrivances for automatically announcing the origin of a fire to the inmates of a building or the watchmen on duty. Thirty years ago Alexander Bain patented a means of doing this by electricity, in which a column of mercury in a thermometer completed a battery circuit and sounded an alarm, when the temperature of the locality in which it was placed rose to a certain degree. This was among the first, if not, the very first, example of this species of fire-alarm, and it is one still largely employed in warehouses, and in the holds of ships, or other stores containing inflammable goods, or other cargoes liable to fires. In France, we believe, the first fire tell-tales date from the year 1855. Many different devices have been devised to effect the same purpose, such as fusible thermostatic threads and strings passing through apertures, the explosion of bombs, and the dilatation of wires or bars of alloys by increase of temperature, the expansion of air, or some other gas, in a vessel having an elastic wall, and other more or less complex mechanisms. In 1859 the Count du Moncel invented an electro-automatic thermometer similar to Bain's, but it was only intended to maintain the temperature of rooms or workshops beneath a certain fixed degree, and not to be a fire tell-tale, although it might have been easily modified for that purpose.

All these plans, however, including that of Bain and Du Moncel, were designed only to be a fire alarm when a certain definite temperature, decided upon beforehand, had been reached. It is obvious that such tell-tales with fixed maxima are open to some objection, since in order to prevent false alarms it is necessary to know the maximum temperature which the apartment ordinarily acquires, and from the fact that a fire might have broken out and made considerable headway in some part of the place before the fixed maximum temperature was reached on the tell-tale. The fire-tale of M. Jules Leblanc, a manufacturer, of Tourcoing, France, which was exhibited amongst the telegraph apparatus at the Paris Exhibition is, therefore, an improvement upon the foregoing methods, inasmuch as it signals all sudden elevations of temperature whatever. This system has been considered so satisfactory by the Société Industrielle du Nord de la France that they have awarded a medal to M. Leblanc.

As one of the weak points in the older inventions, M. Leblanc has aimed at producing a tell-tale which will automatically follow or adjust itself to the *normal* variations of temperature, however high they may be, in the room in which it is placed, but which under the influence of a sudden and abnormally rapid rise of temperature will actuate an alarm signal. It is based upon the property which certain materials, such as felt, thick woollens, &c., possess of behaving as good conductors of heat when the heat varies by insensible degrees like that emitted by the sun or stoves, but as bad conductors when the variation in question is sudden and accidental. It is, in fact, a kind of differential thermometer, regulated automatically. The part sensitive to heat is constructed of zinc, which is one of the metals whose coefficient of expansion is the highest. Fig. 1 represents an elevation of the entire apparatus, and Fig. 2 an orthographic projection, on a larger scale, of the most important details; the indicating letters being the same in both diagrams. D is a hose of wood little liable to expand and warp under heat;

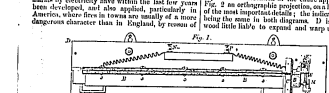


Fig. 1.

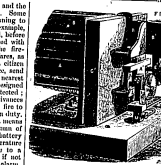


FIG. 2

C and C' two upright metal supports bolted to the base. A and B are two expansible plates of sheet zinc about 60 centimetres long and 0.05 centimetres thick, set from the same piece so as to be isometric, or having an equal expansion. They are doubled into a gutter shape, so as to be more rigid, and are rigidly fixed at one end to the support C, while being free to move at the other end through openings in the support C'. One of these plates, B, is covered with a wrapper of cloth or felt, which retards the effect of sudden changes of temperature on the metal within it; the plate A, on the contrary, is bare, and susceptible to the surrounding changes of temperature. Of exactly the same length and of similar quality these two plates give sensibly the same linear dilatation for each degree. B' is a square bar soldered to the extremity of the plate B, and F' is a small bar fixed to the box B', but isolated from it, and carrying an adjustable contact screw E. By means of this screw the range of the tell-tale is regulated. The head is milled with 120 teeth, and each tooth represents a quarter of a degree of temperature, so that an interval from a fraction of a degree to several degrees Centigrade may be at will adjusted between the contact point of the screw and the spring platinum contact F, attached to the free end of the lever zinc A, according to the degree of sensibility required in the apparatus. The zinc A carries at its extremity a metal piece A' which bears two spring contacts F F', which are intended to make contact with the screws E and M when the plate A expands far enough. M is a small insulating bar supported by the base board D and carrying the second regulating screw M. The latter screw can, if need be, be added to the apparatus as a second tell-tale of the old sort, namely, with a fixed maximum, determined beforehand. It has 50 teeth round its head, each representing a degree Centigrade. The two screws E and M are connected by wire with the terminal P to which is led one pole of a battery, and the fixed ends of the zinc plates are also connected by wire to the terminal N, to which is led the other pole of the battery. It will be seen that when the plate A expands sufficiently far to carry the spring F into contact with the screw E the battery circuit would be completed, and a local gong, bell, or other alarm in the circuit would be sounded. F' and M'' are small spring ratchets gearing in the teeth of the screws E and M and holding the latter in their adjusted positions. All the contact points are faced with platinum, to avoid the evil effects of oxidation, and the whole is enclosed in a protecting case to exclude the dust of even the finest atmosphere. After the description we have given the action of the instrument will be readily understood, and as we suppose that it is properly installed in an apartment, and that the screw E is adjusted so as to leave an interval of one degree between 18° and the contact spring F. Now, so long as the variations of temperature in the room are sluggish, the faucet or felt round the zinc plate B which carries the screw, will not interfere with the successiveness of the plots it covers, and both plates, the covered as well as the bare, will keep pace to each other in their expansion. The relative distance of the two contacts will therefore be preserved with very little alteration, since the screw is carried by one plate and the spring by the other. But, if there is a sudden rise of temperature due to any cause, such as the outbreak of a fire, the bare plate will first feel its effects, and expand so rapidly in proportion to the plate swathed in flannel, that the spring contact will be carried forward into connection with the screw contact, the electric circuit will be completed, and the alarm will be sounded.

The case of a sudden rise of temperature which we have hitherto assumed, is without doubt that to be most frequently anticipated; but nevertheless there might be fires which take their rise in a fashion so slow and gradual as to prevent the closing of the circuit in the manner described, and defeat the object of the tell-tale. M. Leblanc has also provided against this contingency, by adding to this differential sensitive arrangement the auxiliary contact which takes place at a fixed maximum temperature. Any device in the proper operation of the former arrangement is thus made up for in the end by the latter. The best site for the tell-tale is, naturally, near the ceiling of the apartment it is applied to, as in some place where heat tends to accumulate under the action of air currents determined by the disposition of the doors and windows.

M. Leblanc's tell-tale has been in use for several years past, and given very satisfactory results. It is easily readily regulated to begin with, and when once it is set up it requires no further care. They have been subjected to sudden changes of temperature, even to the extent of placing them in stoves or in iced water, and, by all accounts, appeared to have fully sustained their good character. Experiments have been made with them before various of the learned societies of France, which demonstrated that they are able to signal any sudden outbreak of fire in two or three minutes afterwards, let the gradual range of temperature be what it may within the limits of the fixed standard here for a day. At one of these trials, which took place at the Brussels International Exhibition of Hygiene in 1876, there were five tell-tales from different countries pitted against each other. They were tested in a large *salle* of 11 lineal by 23 ft. wide, and 14 ft. high, well lighted by large windows and very well ventilated, a circumstance rendering it more difficult to heat up. The heat was produced by supplying a light to a small gas cooking-ring box soaked with alcohol. All the apparatus were placed at one extremity of the hall, while the fire was stationed at the other extremity at a distance of 42 ft. After the alcohol had been lit for a quarter of an hour, M. Leblanc, of which there were three, sounded their alarm, and all the other tell-tales tried remained silent. M. Leblanc's own instrument regulated for use in warehouses, libraries, docks, and warehouses, signalled after the interval of 35 seconds; his second, regulated for places where the temperature is more variable, such as concerts, workshops, &c., after two minutes; and his third, regulated for industrial establishments, in which the temperature is extremely variable, such as in wool and linen factories, after two minutes and ten seconds. As some of the other instruments tried gave way indications at all, the burning time was placed beneath them at the distance of a few metres, and even in this advantageous position, only two fulfilled its function and died after an interval of 15 minutes. The jury, therefore, awarded to M. Leblanc the medal at their disposal.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VII.—NO. 143.

MR. HERRING'S INSTRUMENT.

The letter from a correspondent which we publish in the present number of the Journal contains remarks which have much truth in them. They are evidently the opinions of a skilled practical telegraphist, who from long experience is well qualified to know the value of any improvements that may be suggested in the existing forms of telegraph instruments. The opinion of the writer of the letter is not, of course, necessarily a strictly correct one, though the arguments seem plausible in the main. In the case of Mr. Herring's printing telegraph which we described in our issue for Dec. 15, we have had opinions as to its merits expressed by men who are well known as eminent scientific experts, and whose names are household words in the electrical world, and now we also have the opinion of a practical telegraphist, which, as we desire only to be fair, we would recommend to the notice of our readers. The general public and probably also inventors give their verdict on this question on the side of the eminent scientific authorities who have been invoked. But a mere blind following of the opinion of scientific experts and men of name is not to be upheld. The judgment of such men on particular points is practically law, and correctly so; and their opinion on subjects which, to a certain extent, lie outside their own sphere of work, in many cases is also extremely valuable, simply from the fact that their natural astuteness enables them in many cases to see clearly at first sight the exact facts of the matters connected with their profession on all one. A man may be a perfect oracle, but it does not therefore follow that he is competent to say whether a violinist handles his bow properly, or whether a new form of bow is more suitable for the purpose than those previously used. In order to determine that matter it is absolutely necessary for him to possess a knowledge of the requirement in question. So it is in telegraphy; a thorough knowledge of the systems, that are being attempted to be improved, is absolutely necessary before a correct opinion can be arrived at, and this can only be obtained by lengthened experience. We do not mean to say that it is useless therefore to attempt to introduce improvements into systems of which a thorough knowledge is not possessed, but there is perhaps, a certain tendency in inventors to feel convinced that they know much better what improvements are wanted than those who have had to deal with the object which the inventor is desirous of remodelling or superseding. On the other hand, there is equally a tendency the other way, viz.: for those in authority to reject any proffered aid from outsiders, a natural inertia to suffer change; and perhaps also a feeling of wounded professional egotism because the improvement in question did not originate with them. Now, the fact that these discordant tendencies exist on both sides, seems to us to call for a competent and independent third party which would mediate between inventors and telegraph officials. We have already advocated such a course in pointing attention to the Commission of experts appointed to recommend inventions to the authorities, in France and other Continental countries, and it still appears to us to be the link required for the harmonious interaction of outside inventors and the Government telegraph service of England.

MR. HERRING'S INSTRUMENT.

SIR,—For the sake of your non-telegraphic readers, I appeare to me very desirable that the recent article ...understood to Mr. Herring's device should not be allowed to pass without a remark or two, suggested as much by practical experience as by long consideration of the subject. At one time, indeed, I must have owned to a certain bias in favour of Mr. Herring, having myself met, under somewhat similar circumstances, with what I regarded as scant justice from the ate engineer-in-chief of the Post Office; but increased knowledge has long since convinced me that the "eternal fitness of things," and not the Postal Telegraph authorities, is the real enemy with which Mr. Herring has to contend. One is truly at a loss whether to admire most that gentleman's "dogged resolution," or deplore his apparent lack of practical familiarity with current telegraphic requirements, whereby he remains, as it were, for ever whirling round and round in the back-water of invention.

Had he been content to apply his system to needles, bright's bells, and similarly-worked instruments, the question would lie within very narrow limits; but when, n place of the universal Morse Alphabet and Varley's monopoly "Double Current," he proposes to introduce a new peculiar "tongs and sheets," worked by slight ...ent reversals, we may well enquire whether the proposal is likely to result in aught else than abortive ...ments. Mr. Herring evidently talks and legislates ...oriental dot and dash, and does not appear to be mistaken one for another; but the fact is—as ninety-nine clerks out of a hundred would tell him—that "land speaking," and not imperfect dots or dashes, come most trouble and prove ...re by far the largest number of mistakes.

A B C D E F G H I

...I cannot digress to such an extent as would enable ...e to satisfactorily account for this failing, interesting ...the point is, but simply enquire, will Mr. Herring's system be less free from the same defect? Presuming the use of "tapper keys" for sending, I fear, the evil would be increased rather than diminished. For instance, look at the enclosed specimen "slip" taken in a somewhat similar manner to Mr. Herring's, except that the marks are horizontal, and are produced by the parallel printing discs one or both of which act as the left or right key is depressed at the sending station. This being my own device, and constantly joined up in "Bell" circuit, might be always "turned on," but is not. Why? Because the attendant labour of even winding up the machine, let alone paper, tear and wear, &c., would not justify the possible gain of, perhaps, tearing by it two or three errors in a twelvemonth. The whole question is, clearly enough, one of expediency. The Postal Telegraphic authorities find they can get on very well without these recorders, and it is, therefore, a thankless thing to put in their way what they don't want.

The retention of visual systems will, to some slight extent depart from automatic working, be unavoidable; but it is to the *ear* and not the eye that we now principally trust, and daily experience proves that our confidence is not misplaced. With sounders, receiving clerks are obviously obliged to "keep up" with the senders, and in the case of moderately sized offices, Postmasters or Superintendents are never at a loss to know what is going on, while as regards "calling," and liability to inattention, the voice of the sounder is not a thing to be ignored, its very importunity compelling attention.

With all respect, therefore, to Mr. Herring, I cannot help thinking that more quick garnier service he can render to practical telegraphy by "rising sounds," working out "his printing division," and betaking himself, heart

MR. HERRING AND THE POST OFFICE.

SIR,—You are quite right in maintaining the necessity for a "third party to mediate between inventors and telegraph officials." The letter of your correspondent "E" simply furnishes additional reasons for such necessity. He ignores my complaint altogether, and because I have resolved not to submit any further invention to the Telegraph department until the authorities have dealt with such complaint, he "deplores the apparent lack of practical familiarity with current telegraphic requirements," and asks me to "betake myself heart and hand to the improvement of sounders" in order to "win his admiration."

May allow me to inform your correspondent that an agreement exists between the Post Office and myself to refer to a third party all questions to Sir William Thomson; Professor Fleeming Jenkin, Mr. Latimer Clark, and Mr. Forde, and that until these eminent gentlemen have been called together and all the facts necessary for a full and fair trial of my system have been submitted to them as the official referees, it is not my intention to hold any discussion with anonymous correspondents. At present the Post Office has broken faith with me in regard to points: It promised that there should be a full and fair trial of my system. It invited me to make costly preparations for such trial. It induced me to engage and to pay two eminent scientific gentlemen to attend and act at the trial. It arranged and signed terms of reference. It promised to adopt my system if the trial proved satisfactory. It obtained possession of my instruments under a written promise to proceed with the trial. It broke all these promises. It has given no reason for doing so. It has never appointed a meeting of the referees. It has not replied to my application to be reimbursed for the consequent loss of my time and my money. It has neglected to deal with my petition for redress although such petition has been referred to by the Crown. What more can your correspondent "E" desire? Is this a satisfactory state of the Government Telegraph Department of England in which such proceedings are impossible, be they then rely upon my hearty co-operation in every endeavour to improve telegraphy. As a matter of fact, however, I do not like the Morse system at all, and Sir William Thomson and Professor Jenkin in a recent report state:

"We are far from believing that the present Morse system can be regarded as final. This opinion is also shared by the highest authorities in the working of land lines, Mr. Latimer Clark. Your correspondent "E," therefore, must be prepared for any difference of opinion which I may therefore express as to the policy of extending the use of his favourite Morse sounder. Many telegrams contain the pith of private matters which the sounder discloses to waiting ears. Even the Morse transmitting key, in a quiet suburban office, gives no unnecessary sound to a practised listener. I know several offices to which my remarks apply, where either under the pretence of waiting for an omnibus or preparing a telegram, secret information might easily be acquired either from a Morse key in sending or a Morse sounder in receiving.

RICHARD HERRING.

27, St. Mary's Road,
January 24, 1879.

[W. L., F. D. and F. J. S.—Your letters will appear in our next.—Ed. T. J.]

TÉLÉGRAPHIE ÉLECTRIQUE

Télégraphe imprimeur de M. Phelps

Les télégraphes imprimeurs, dont l'invention remonte à l'année 1837, n'ont été regardés pendant longtemps que comme des appareils curieux et on croyait qu'ils n'étaient pas susceptibles d'être appliqués dans la pratique. Dans l'origine, ils fonctionnaient très-lentement, ils étaient très-compliqués de construction et se dérangeaient tellement facilement qu'il aurait fallu que les employés fussent eux-mêmes mécaniciens pour en obtenir un service régulier. Cependant, grâce aux perfectionnements que leur apporta M. Hughes, on put acquérir la preuve que c'étaient les appareils télégraphiques les plus rapides et les plus commodes pour les dépêches privées, car elles sortaient de l'appareil imprimées en caractères romains et pouvaient être livrées au public sans transcription. Aujourd'hui, ces appareils sont employés dans tous les pays, et bien que leur usage se soit ralenti depuis la mise en pratique des télégraphes à transmissions automatiques et des systèmes duplex et quadruplex, ils occupent encore une place très-importante dans la télégraphie, et nous en avons la preuve dans le télégraphe de M. Phelps qui, malgré la répugnance des administrations américaines à employer ce genre de télégraphes, a reçu néanmoins d'elles un bon accueil.

Les télégraphes imprimeurs peuvent être classés en deux grandes catégories : les télégraphes à échappement et les télégraphes à mouvements synchroniques. Dans les premiers, la roue des types qui porte les caractères en relief ne tourne que sous l'influence d'échappements électriques successifs déterminés par un manipulateur mis en action à la station de transmission et qui font arriver devant un mécanisme après imprimeur, celui des caractères de cette roue qui doit être imprimé. Alors une action particulière déterminée soit par le fait même de l'arrêt de cette roue, soit par un renversement du sens du courant, soit par une interruption de celui-ci, soit par tout autre moyen, provoque l'impression de la lettre sur une bande de papier qui avance en même temps de l'espace convenable pour la succession des lettres de la dépêche. Ce système, comme on le comprend facilement, a l'inconvénient très-fort. Dans l'autre système, les deux mécanismes télégraphiques marchent synchroniquement aux deux stations en correspondance et les différentes lettres des deux roues des types peuvent de cette manière se présenter en même temps devant le mécanisme imprimeur; de sorte que, si à un moment donné un courant électrique est envoyé à travers les deux appareils, on peut obtenir une réaction électro-magnétique ayant pour effet d'imprimer aux deux stations la lettre qui se trouve alors à portée. Avant M. Hughes, il fallait, pour obtenir cette impression, arrêter le mécanisme, ce qui détruisait un peu le synchronisme de mouvement des appareils; mais M. Hughes, par une conception hardie et qui a réussi, est parvenu à imprimer en quelque sorte les lettres au vol sans arrêter les mouvements; et pour corriger les retards qui pouvaient résulter de cette réaction, il imagina sa roue correctrice qui non-seulement a résolu ce problème, mais encore a fait que plus les signaux envoyés se succèdent rapidement, plus la transmission de la dépêche est correcte. Toutefois, en raison de cette impression au vol, on ne peut imprimer beaucoup de lettres par chaque tour de la roue des types, et nous avons vu dans un article que nous avons publié dans ce journal que, pour augmenter sous ce rapport le rendement du télégraphe imprimeur, M. Olsen avait été obligé de le compliquer de certaines combinaisons mécaniques. M. Phelps a résolu le problème plus complétement en combinant, dans son appareil les deux systèmes que nous avons exposés précédemment. Comme dans l'appareil Hughes, cet appareil, est soumis en effet à une marche synchronique des deux instruments en correspondance, et chaque lettre s'imprime sous l'influence d'une seule émission de courant; mais, comme dans les systèmes à échappement, le mouvement de la roue des types est arrêté pendant l'impression de chaque lettre et relâché automatiquement à l'instant où l'impression a été effectuée, et il paraît que de cette manière on peut obtenir pour la rotation de la roue des types une vitesse beaucoup plus grande que celle qu'on pourrait atteindre au moyen d'un mouvement à échappement. Or, avec ce système on a l'avantage que les lettres qui se présentent successivement sur le clavier peuvent s'imprimer dans une même révolution. De cette manière, un employé habitué a pu obtenir, d'après M. Prescott, une vitesse de transmission dépassant tout ce qui, jusqu'à présent, a été regardé comme possible. L'appareil est, d'un autre côté, plus portatif que celui de M. Hughes, et il est beaucoup moins fatigant à faire manœuvrer, car c'est un électro-moteur qui fait les frais du mouvement et on n'a pas un poids assez lourd à remonter sans cesse.

En somme, l'appareil se compose d'une boîte plate en fonte assez large (46 c. sur 38 c.), qui est munie sur l'un de ses côtés d'un clavier semblable à celui du télégraphe Hughes et qui porte à sa partie supérieure les différents mécanismes lesquels sont adaptés sur trois colonnes distinctes. Sur la première, qui est le plus en avant, est monté le système transmetteur; sur la seconde, à droite, est fixé le mécanisme imprimeur, et sur la troisième, à gauche, le système moteur.

Les différentes touches du clavier sont mises en rapport par des tiges articulées qui s'élèvent verticalement dans la colonne du transmetteur avec des doigts d'arrêt rangés circulairement autour d'une sorte de collier à roue dentée mise en mouvement par le moteur avec une vitesse de 240 tours par minute. Le mouvement de ce collier est soumis à l'action d'un régulateur qui permet de l'uniformiser et de le synchroniser avec celui de l'appareil correspondant, et il est disposé lui-même de manière à pouvoir être arrêté par le doigt de la touche abaissée, mais sans pour cela déterminer l'arrêt du mécanisme moteur. Il résulte toutefois de cet arrêt une action mécanique qui a pour effet de soulever une tige agissant sur un interrupteur de courant, et ayant pour effet de faire réagir le mécanisme imprimeur. Un système de cames, disposé en conséquence, fait d'ailleurs en sorte qu'aussitôt l'action sur l'interrupteur accomplie le doigt qui avait provoqué l'arrêt se trouve dégagé et permet au collier de reprendre sa course avec le système moteur jusqu'à ce qu'une autre touche abaissée ait provoqué un nouvel arrêt.

Lors donc qu'une touche est abaissée, aucune action ne peut avoir lieu jusqu'au moment où le doigt en rapport avec la tige abaissée vient se présenter devant le collier et l'arrête, et ce collier reste ainsi arrêté pendant un quart de sa révolution, après quoi il se trouve dégagé; mais pendant son arrêt la tige commandant le jeu de l'interrupteur s'est élevée et a fourni un contact d'une durée de 1/28 de seconde qui réagit sur le mécanisme imprimeur de la station correspondante.

Le mécanisme imprimeur est disposé de manière que la roue des types marche synchroniquement avec le collier déterminant le jeu de l'interrupteur et que l'arrêt de celui-ci provoque celui de la roue des types; cette action est produite par une roue à encoches qui sous l'action d'un électro-aimant remplit la quadruple fonction d'arrêter la roue des types au moment précis où une lettre doit s'imprimer, de presser promptement la bande de papier contre le

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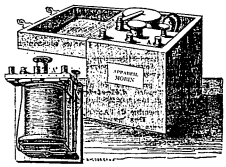

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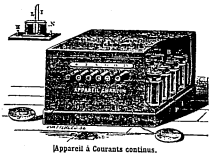

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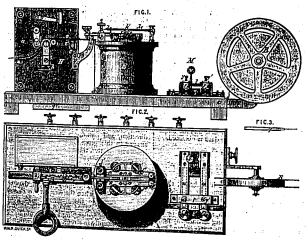
BRAUN'S TELEGRAPH INSTRUMENT.

This apparatus, the invention of M. Braun, telegraphist to the Austrian Government, has been in use for some considerable time on the Austrian railways. It is a step-by-step dial instrument, and is shown in elevation and plan by figs. 1 and 2 in the accompanying illustration. The transmitting apparatus is worked by the hand of the operator, and consists of the handle *a*, which is attached to the axle *b*, which terminates in a pinion *c*, gearing into the wheel *d*, which is fixed on the axle *e*, which carries the contact-wheel *f*, and the pinion *g*, gearing into the wheel *h*, which is fixed on the axle *i*, which carries the contact-wheel *k*. The contact-wheels *f* and *k* are insulated from each other, and from the rest of the apparatus, by being made of hard wood, pierced through with holes, and fitted with metal pins, which project on both sides of the wheel. The pins on the wheel *f* are connected with the line-wire, and those on the wheel *k* with the earth-wire. The pins on the wheel *f* are arranged in a single circle, while those on the wheel *k* are arranged in two concentric circles, and at the same time connected with each other in pairs, as shown in the figure. The pins on the wheel *k* are also connected in the ordinary manner with the pins on the wheel *f*, so that the pins on the outer circle of the wheel *k* are connected with the pins on the inner circle of the wheel *f*, and the pins on the inner circle of the wheel *k* are connected with the pins on the outer circle of the wheel *f*. The pins on the wheel *k* are also connected with the pins on the wheel *f* in such a manner that the pins on the outer circle of the wheel *k* are connected with the pins on the inner circle of the wheel *f*, and the pins on the inner circle of the wheel *k* are connected with the pins on the outer circle of the wheel *f*. The pins on the wheel *k* are also connected with the pins on the wheel *f* in such a manner that the pins on the outer circle of the wheel *k* are connected with the pins on the inner circle of the wheel *f*, and the pins on the inner circle of the wheel *k* are connected with the pins on the outer circle of the wheel *f*.

through at an average speed of 50 centimetres per minute. The paper is wound on the wheel R. After having this wheel the paper band passes through the opening *c d* formed in the base of the apparatus, rises in the plate *c*, and passes between the rollers *k B*.

The plate *c* acted upon by the spring *e*, presses the band lightly against the lower surface of the piece *f*, and places it on the receiving plane; the force of the spring *e* is determined by the screw *e'*. The lever *g* may occupy two positions, one raised and the other lowered; in the latter position it stops the clockwork mechanism and removes the band from the receiving plane simultaneously.

The electro-magnetic apparatus it is composed of an ordinary electro-magnet and a strong magnetic bar bent twice at right angles.



The poles *n n* of the magnet and the poles *p p'* of the electro-magnet are in the same plane, and are respectively placed at the extremities of two perpendicular diameters. These poles, divided in two in the direction of the circumference, freely contain the armature $a^1 a^2, r^1 r^2$ composed of two semicircles of cast iron $a^1 a^2, r^1 r^2$; these two semicircles are united by a copper cross *t* to an axis or arbor *s* in the centre of the apparatus.

The levers $f f^1$, figs. 1 and 2, are moveable in their axis $f \cdot f^{(1)}$, and by yielding to the action of springs $f^{(2)} f^{(3)}$ acting in contrary directions transmit, each on its own side, the action of these springs to the appendage *b* of the armature; this action is limited on both sides by the piece b^1, which by its lateral play, enables it to cause the direction which the levers $f f^1$ give to the appendage *b* to coincide with the position of repose of the armature. In case this does not happen this position corresponds to the moment when the extremities $a^1 a^2, a^3 a^4$ are arranged identically in relation to the poles $p p^1$ of the electro-magnet. The screws $f f^1$, at equal distances from the appendages *b*, limit each in its own direction the full movement of the armature. The appendage *b* is terminated by a holder or claw which supports the inker *m*, formed of a funnel-shaped cup, in which printing ink is poured. The buttons or knobs $e e^1$ partly regulate the tension of the contrary springs $f^{(2)} f^{(3)}$.

The manipulator or manipulating piece *M*, figs. 1 and 3, comprises two flexible springs $x x^1$, four contact pieces $l l^1, u^{(2)} u^{(3)}$, a commutator *v* furnished with two springs $u u^1$, and a pin or peg v^1.

The ends of the springs $x u^1$ of the commutator press against two insulated pieces which are fixed on the under surfaces of the blades $x x^1$.

The two blades are ordinarily in contact with the screws $x \cdot x^1$ of the piece *l*, and are consequently removed from the contacts of the piece l^1; the same separation also exists between the extremities of the springs $u u^1$ and the contacts of the pieces $u^2 u^3$.

When the spring *x* is pressed down the contacts of *x* with l^1 and of *u* with u^3 are simultaneously established; when the blade x^1 is lowered the contacts of x^1 with l^2 and of u^1 with u^2 are established in the same manner.

The screws $x \cdot x^1$, in constituting the contacts of the pieces *l* also serve to regulate the full movements of the springs $x x^1$. The pin or peg *v* serves to put the commutator *v* into metallic connection with the springs *x* or with the spring x^1 according to the side on which it is placed.

The spring *s* is a small picker for clearing out the orifice in the ink cup should it become clogged from disuse.

The following is the action of the apparatus:—

Supposing the regulator of the clockwork mechanism and the plate *c* free from the action of the lever *g*, which occurs when the latter is raised, the band unrolls uniformly in the receiving plane, and receives a continuous line or stroke from the very fine orifice of the inker *m*.

According to the movements of the armature, and consequently the displacements of the inker, this stroke or line is converted through the influence of the currents into angles to the right and bars or lines to the left; the signals produced in fact are very similar to those obtained by means of Thomson's Siphon Recorder.

In practice, if as in the "Morse" system a single manipulating key is used, the apparatus is precisely under the same conditions as the apparatus generally employed, the signals appearing on one or the other side of the line of repose, according to the direction of the current with which the apparatus is worked.

If the two keys are employed at the same time, but in such manner that each reproduces complete signals, the "Morse" alphabet may be reduced to 30 combinations for each side, which produces the 60 signals constituting this alphabet, without having to use combinations of more than four elements or emissions of current.

By using two keys, but so as to produce only elements of short emissions of current, the angle to the right in substitution of the dot, and the angle to the left in substitution of the dash is obtained.

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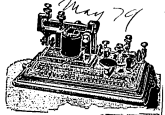

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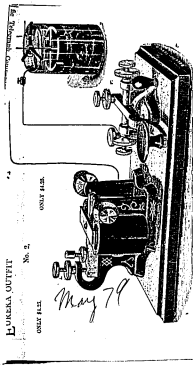

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76 Frankfort Street, CLEVELAND, OHIO.

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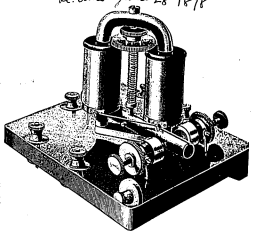
A New Electric Current Breaker.—A simple form of current breaker is described by Dr. F. Niemöller. To the axle of a fan, rotated horizontally by clockwork or similar power, which touches the mercury at every half a revolution, is fixed a platinum wire, which at every half revolution of the fan, when the current passes when all the apparatus is in normal state is a small magnet. This magnet, acting on the current, causes vibrations in the circuit so breaks and makes contact. The number of vibrations can be readily rectified by changing the length of the platinum wire. The number of breaks per second can be obtained. By passing an intermittent current over the wire, it can be set in vibration without the intervention of mechanical means. This happens when the fundamental note of the string is in unison with the pitch of the breaker.

A NEW SOUNDER.

The accompanying illustration represents a sounder for direct working or translation, and of which over one hun-

Sc. Amer. June 26 1875



A NEW FORM OF SOUNDER.

speed at dred have been constructed for the telegraph lines in India.

It differs from an ordinary sounder in the arrangement of the armature, which is supported by a vertical spiral spring. This spring serves to restore the position of the armature when the current ceases, as well as to relieve the lower bearing of nearly all friction. The prolongation of the armature acts as the beam, and plays between the two stops shown in the engraving.

To insure very good insulation for damp climates, the coils are rendered solid by repeated immersions in a compound of resin and beeswax (for hot climates, ten parts of resin and

one of wax answers well). The range of the instrument is shown by its working without fresh adjustment, either with one Daniell's cell through 6,000 ohms, or with 20 through 0. When very delicately adjusted, one Daniell's cell through 31,000 ohms is just able to work the instrument if the stops be extremely close together.—*H. Dickers, in Journal of the Society of Telegraph Engineers.*

43

Electric transmitter
Earliest date found 1880

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It has occurred to me that a vast amount of battery power is employed to produce comparatively trivial results. Why not do away with batteries altogether for telegraphic purposes, and rely on magnetic electricity for the transmission of signals? The labour expended in depressing a Morse key is surely capable of producing a magnetic current sufficiently strong to give a signal at a considerable distance. The suggestion may seem very unorthodox; but allow me, Sir, to explain more definitely what I mean. A magnetic current is generated in a coil of wire by bringing a permanent magnet near the coil. If, therefore, a number of magnets were to be brought simultaneously near a number of coils in one circuit, a strong current would be produced; and if a delicately balanced lever were constructed with a key at one end and a number of bar-shaped magnets at the other, the power required to move such a lever would be small. If then, say, fifty magnets were to be simultaneously withdrawn from the centres of fifty coils, each of considerable length, I venture to think that a sufficiently strong current would be generated in the coils to send a telegraphic signal from Land's End to John o'Groat's Land, or even further. Perhaps it would be advisable to complete the electric circuit only at the moment when the key was down in order to get the full effect of the magnetic current, and to prevent a second current being sent in the opposite direction when the key sprang back.—I am, &c.,

CHARLES STEWART, M.A.

59, Cadebrooke-row, N., 31st January, 1880.

1870 Cowpering, Telegraphing, and Recording Secret Telegrams,
E. J. Hobbins.—Dated 19 May, 1870.—(4 communications.) 5d.

The repetition consists of several alphabets or signs arranged in concentric circles on a transmitting or recording dial, on which circle the required letter is brought opposite a fixed point by means of a hand or governor key, the key being composed of as many letters of figures as there are sets of the alphabets employed, and their letters arranged in the order of the alphabets. Use is made of a combination of the Morse and Roberts systems of a dotted alphabet.

1871 Electric Telegraphs.—

Multiplex Telegraphs.—A company pursues to acquire and work the patented inventions of Frank Winfield Pancoast for "improvements in multiplex telegraphs for transmitting and receiving signals on slips of paper, and for other purposes." It was registered 30th ult., with a capital of £20,000 in £1 shares.

ELECTRICIAN

the condenser is moved by clockwork which causes it to act every five minutes, so that every hour twelve throws are observed on each galvanometer. At the end of every hour the ship reverses the battery so that the direction of the throws is changed.

In order to enable the ship to communicate with the shore, instructions are given that if at the end of the hour the throws do not become reversed, or if they become reversed before the expiration of the hour, it is a sign that the ship wishes to communicate with the shore; in this case, then, the shore disconnects the cable from the clock lever and connects it with the speaking apparatus, and at the ship does the same, the necessary communications can be carried on. If, on the other hand, the shore wishes to call the attention of the ship he can do so by moving a lever corresponding to the clock lever two or three times quickly by hand: the ship then observing that the throws on her galvanometer take place quickly, instead of at intervals of five minutes, immediately joins up her speaking apparatus, and thus communicates with the shore.

As it is advisable that the operation of disconnecting the cable from the clock lever contact and connecting it to the hand-worked lever shall be done without difficulty, the arrangement of the apparatus is such that this can be performed with great facility.

The whole of the arrangement is shown by fig. 3.

A is a brass tongue, whose normal position, while the clock-work is in operation, is on contact plate B; this plate is connected with the plate C, which plate is also connected by a small spiral spring with the lever L, L. D is a contact plate which is free while the clock is working. E, E is a brass tongue which in its normal position is in contact with the piece G. To the contact plate F the cable end is attached, and to G the condenser is connected. The lever L, worked by a ratchet-toothed wheel connected to a clock, makes contact every fifth minute on the contact at F, returning, after making this contact, to G. H' is a cam on the end of a hand lever, which is used for moving the tongue A from its normal position on B to the contact at K, thus switching out the connection with the lever L when signals are to be given by hand. H is a cam on the end of a second hand lever; this is used for giving signals by hand (when the clockwork and the lever are cut out), by pressing the tongue E down on the plate F, to which the cable is attached. When the clock is at work the current passes from F to lever L, on to plate C, and thence *viâ* B and A to condenser. When hand signals are given, the current passes from F to E, D and A, and thence to condenser. When E returns to normal position at G the condenser is discharged.

In order to render the motion of the lever, to or from a contact, quick and decided, the best spring on the plate C is provided; this has a conical piece at its end which presses against a pin on the lever; as the lever moves under the action of the clock wheel, the pin acts against the inclined side of the conical piece, and moves it until the apex is reached and passed, when the action of the spring immediately drives the lever over sharply against its contact. A similar action takes place when the lever moves in the reverse direction. The amount of play given to the springs at the end of the lever L is such that they do not break contact from F or G, as the case may be, until the point is passed at which the lever is thrown sharply over.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

Telegraphic Journal
Jour. Society of Telegraph Engineers

Sir W. Henley's Direct Instrument.

This form of instrument was patented by Mr. C. Bright (now Sir Charles Bright) in 1863, and was almost exclusively used by the "Magnetic" Company, it having superseded the Magnetic Needle instrument of Henley and Foster.

The instrument is an "acoustic" one, that is to say, it gives signals by sound, like the single needle instrument fitted with the Noble acoustic dial. To this latter form of apparatus indeed it is closely allied, inasmuch as the two forms are worked and read from in identically the same manner.

The apparatus consists of three parts, viz., "the Tappers," "the Relay," and "the Bells."

"THE TAPPERS."

Either of the two forms of tappers which are used in the "Single needle" instrument and which are fully described in Articles I. and II., can be used with the Bell instrument; the way, however, in which they are connected up to the apparatus differs slightly from the method employed with the single needles.

In the latter form of instrument the portion of the apparatus from which the signals are read, that is to say, the "Dial," is equally affected by the outgoing and the incoming signals; in the Bell instrument only the incoming signals or currents work the acoustic signalling apparatus, the outgoing signals pass direct to line without working the latter.

The way in which the connections are made in order to effect this result is shown by fig. 14, which represents the ordinary form of tapper keys joined up in circuit with the rest of the apparatus. Referring to this figure, it will be seen that in the key the terminals X and Y, which for the single needle instrument are kept connected together by means of a brass strap (seen in fig. 1, Art. I.), are in the Bell instrument connected to the B and U, that is, the "Down" and "Up" line, terminals of the receiving portion of the apparatus; the strap being of course disconnected from X and Y. The other connections are precisely similar to those shown in fig. 2 (Art. I.), which represented the connections for the single needle instrument; that is to say, the battery is connected to terminals Z and C, the "Up" line is connected to A, and the "Down" line is connected to Y through a single needle dial, S S, which dial is now attached to all of the Bell instruments, in order to enable the signals to be read visually if necessary.

Action of the tapper.

As regards the transmission of signals the action of the tapper and the course of the current is identical with that in the case of the single needle instrument, viz., when the left-hand pedal is depressed, then the Zinc pole of the battery becomes connected to the block, A, and thence by the end of the spring, Y, to the earth, / thence to terminal A and on to the "Up" line of the circuit. The Copper pole of the battery being in connection with the block supporting the spring, X, *F*, becomes con-

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seulement de physique des Enfants de France.

nous permettre de communiquer en peu de minutes entre le Nouveau Monde et l'Ancien Continent, se doutait-il qu'il avait été deviné ou plutôt annoncé dès l'an 1762?

plates, between which the hammer of the instrument plays, the upper plate corresponding to the upper screw stop, and the lower plate to the lower screw stop of the ordinary Sounder.

The connections of the instrument possess no peculiarities, being similar to those of an ordinary relay-worked circuit. The resistance of the relay is about 400 ohms; the local Bell has a resistance of 20 ohms.

The tongue of the relay being pivotted between two pointed screws, care should be taken that the upper one of the two is screwed sufficiently down to allow only a very slight amount of up and down movement or "end shake" of the tongue. If the play allowed is too great it will cause the contacts, and, consequently the signals, to be irregular. If, on the contrary, the screw be screwed down too tight, the tongue will be jammed and will not

FIG. 41.

respond at all. The lock-screw securing the upper screw should always be kept tight.

DOUBLE CURRENT SYSTEM.

Single Current working, with Relay, from its simplicity, is very useful for lines which are beyond the range of direct working; but which, at the same time, are not of an excessive length. Now, in the Single Current system, as has been pointed out, the line current has to work against a magnetic pull, or bias, which is of a fixed and unvariable strength, unless altered by turning the regulating screw, consequently variations in the line current have to be allowed for by changing the adjustment. On long lines, which are much and continually affected by climatic changes, the need of this continual alteration would prove very troublesome; besides, even if the current did continue constant for any length of time, it would often be too weak to work the tongue of the relay against the necessary bias; on such lines, therefore, the "Double Current" system is adopted. In this system the relay tongue is set neutral, or very nearly so, and the key, on returning to its back position, sends a reverse current, which carries the tongue back to the "spacing" side. To enable

Mr. W. T. Henley is manufacturing a 3-inch cable for the Montreal Telegraph Company. The dielectric of this cable is formed of an ozokerit compound.

According to some experiments made by M. Zloff, the magnetic co-efficient of an aqueous solution of perchloride of iron varies with the magnetising force.

Mr. James Sivewright, general manager of the telegraph between the Cape of Good Hope and Natal, has been gazetted to the most distinguished Order of St. Michael and St. George, for services rendered in South Africa during the late war.

The catalogue of the Ronald's library has been completed by Mr. A. J. Frost, and will shortly be ready for publication. The catalogue will be something more than a mere list of the works contained in the library, as many valuable notes have been compiled and printed in the volume.

A course of lectures on "Electrical Testing as applied to Telegraphy" is now been delivered by Professor W. C. Adams, at King's College, London. The series commenced on Friday, 23rd inst.

The report that the Western Union Telegraph Company have paid Mr. Edison 100,000 dollars for the sole right to use his electromotograph in connection with telegraphy, is stated to be incorrect. The company having paid only a nominal sum down, the remainder being conditional on their working the patent, which they are not likely to do.

MM. Leblanc and Loiseau have invented an automatic electrical railway block telegraph instrument. The apparatus consists of a lever or pedal, placed close to the railway metals, so that it can be moved by the action of the wheels. The movement of the lever sets upon a relaxing arrangement, which in its turn works a commutator. Thus the apparatus serves to put a battery in communication with an electric bell at the signal station. A peculiarity in the arrangement lies in the fact that the lever is moved by the action of the first wheel of the train, and then remains moved away to permit the last carriage has passed, thus the lever is not subjected to the hammering of each wheel as it passes, meanwhile would result in the disarrangement of the apparatus. In the position shown, the apparatus is ready for receiving signals. Supposing the current to come in from the "Down" line, its course is as follows:—From line, through the galvanometer, G, to terminal 3, from thence to lever l_1, and contact point 4_1, thence to terminal 4; and from there to terminal U of the relay, and through the latter to terminal U_2 and the "Up" line.

When it is required to send, by means of the key, the switch s_1 and consequently the levers l_1, l_2, connected to it, are moved to the positions indicated by the dotted lines. On depressing the key, the Zinc pole of the battery becomes connected to a_1, through z coming in contact with a; from a the current passes to lever l_1 through contact point d_{11}, and from thence to terminal 7 and the "Up" line. The "Copper" pole of the battery comes into connection with l_1 through contact point c_{11}, and the spring s_{11}, and thence through l_2 and l_1 with terminal 3 and the "Down" line.

The connections shown are those for an "Intermediate" station. If the apparatus is at an "Up" station, then terminal 7 of the key or terminal U_2 of

ENGINEERING.
FRIDAY, MAY 7, 1880.

VISUAL TELEGRAPHY.

WHEN the telephone became an accomplished fact, and persons were enabled to speak and hear by electricity, it did not require a great effort of imagination to predict the time when light as well as sound would be transmitted to a distance by wire, and images as well as words despatched by telegraph. To transmute into electricity and electricity again into light became the next great scientific problem. Recent rumours from America announce the invention of an apparatus whereby this feat has been performed in America, with all the real prodigies of ingenuity, is yet a hotbed of many abandoneries and "bogus" inventions, we are constrained to take these reports with all reserve. It is stated in the New York papers that a certain Dr. H. E. Ives, of Bethlehem, Pennsylvania, has invented an instrument called the "disphote," which has the power of showing, in a mirror at one end, the image of any object placed in front of a corresponding mirror at either end. These mirrors are composed, the one of selenium and chromium, the other of selenium and cells of silver—selenium is very sensitive to light and heat. Each mirror is, moreover, built up of a number of small plates, and the corresponding couples are connected by separate wires. The receiving mirror is placed in a camera, and receives from a lens the pictures of any desired object. The varying gradations of light and form falling on the plates of the mirror set up variations in the electrical currents traversing the connecting wires. These variations cause changes in the plates composing the reproducing mirror, which thereupon exhibits an image of the object. A public exhibition of the instrument is said to have been held at Reading, in the United States, and the images of various simple objects, such as a penknife, an apple, a watch, a collar, a printed handbill, and letter still, the head of a live kitten, were transmitted from a room below to the hall above, where they were rendered visible to an enthusiastic audience.

This rumour—and we do not require to be told that all the rumours of the New York papers are not to be taken as literal truth—has it appears some foundation in the fact that Professor Graham Bell, the famous inventor of the earliest speaking telephone, despatched some time ago with the Franklin Institute, U.S., a sealed packet containing a description of a new apparatus which has to do with the problem in question. Professor Bell's results are said to be due to his work in England during his visit here in 1878, so that our own country both is providing the men and the scene of his labours, will be fully entitled to the honour of the discovery whatever it may be, although it is first published in America.

The gossip about Professor Bell has called into publicity several theoretical plans and experimental attempts which have been recently devised and carried out by English men of science. One of these, originated a few years ago by Professor Perry and Ayrton, takes advantage of the well-known photo-electric properties of selenium. It was we believe first demonstrated by Professor Adams and Mr. Day that when a ray of light falls upon a piece of crystalline selenium a current of electricity is set up in the metal; and this effect has been closely studied by Mr. Willoughby Smith and Mr. R. Sabine. The transmitter of Messrs. Perry and Ayrton, based upon this fact, consists of a mirror made up of a mosaic of little squares of selenium, insulated from each other, and each connected with a separate telegraph wire. An image of the object to be "telephoted" is focussed on the mirror by means of a lens, and the resulting current started in each square of the mirror by the portion of the image falling on it is transmitted by the corresponding wire to the distant station. Here it is made to pass through a coil of wire and deflect a magnetic needle, the motion of which opens or closes an aperture allowing light to fall on the back of a sheet of frosted glass. There are supposed to be as many illuminated squares at the receiving station as there are selenium cells at the transmitting station, and the amount of light admitted to each square of glass is to be proportional to the strength of current, which in turn is proportional to the intensity of the light falling on the corresponding square of selenium. Thus the illuminated image at the receiving station would be to a certain extent a reproduction of the original image.

Professors Perry and Ayrton also suggest an application of Mr. Kerr's experiments on the distortion of the plane of polarised light by reflection from the polished poles of a magnet. The cousins in making the receiving mirror a mosaic of soft iron pieces, silvered, and causing the current from each selenium square to flow in a fine coil round each piece so as to magnetise it. This mirror is to be illuminated by a beam of light polarised by reflection from glass, and after being reflected from the mirror, the beam is to be received again on a glass mosaic corresponding to each selenium square by magnetising the corresponding soft iron square, rotates the beam of polarised light, and alters the intensity of the analysed light to an extent proportional to its strength. Here again, then, we have a mode of reproducing an imitation of the original image.

Both of these plans, though undoubtedly ingenious, and to a certain extent theoretically feasible, are yet too elaborate and expensive to be practicable. Moreover, the reproduced image would at best be but a clumsy sketch of the original one. Professor Bell's plan is probably much simpler, if we may judge by the simple means with which he effected the electric transmission of speech, and the scientific world will now await with great interest the publication of it.

One way of simplifying the problem would be to find out a way of transforming electricity directly back into light again, by the principle of reproduction which operates in nature and has been so extensively applied of late in the construction of scientific apparatus. If a beam of light falling on a mirror of selenium is transformed into electricity, why should not that electricity be as simply turned back again into light by a polyscope, not a mechanical process. A means of doing this would get rid of the necessity for complex receiving instruments like that of Professore Ayrton and Perry. Has any one ever tried to evoke light from selenium by an action the very contrary to that by which electricity is set up in it under light? This is another experiment well worthy of trial.

Another plan for transmitting light is that proposed by Mr. H. Middleton at a meeting of the Cambridge Philosophical Society on March 8. It is based on thermo-electric effects. The image to be sent is thrown by a lens on a mirror enclosed in a camera. This mirror consists of thermo-electric pairs, polished on their front surfaces and connected by separate wires to a second thermo-pile similar to the first at the receiving station. The image sets up thermo-electric currents in the mosaic of pairs, and these are reconverted into a similar image on the face of the receiving pile. Moreover, according to the manner in which the elements of the plates are arranged with respect to each other we can get a "positive" or "negative" photograph or image. The images thus produced may further be viewed directly, projected on a screen, or rendered permanent by photography. Full details of Mr. Middleton's method will, we believe, appear in an early number of the Cambridge Philosophical Society's proceedings.

The particulars of still another step in this direction of research were communicated to the Physical Society at its late meeting on Saturday, April 24th. For two years Professor Mitchin has been engaged in the transmission of light by means of the electric current produced by the action of light on certain sensitive photographic salts. Professor Mitchin prepares a small photo-chemical cell of two silver-foil plates immersed in a conducting solution of salt and water. One plate is rendered sensitive to light by coating it with an emulsion composed of chloride of silver. When a beam of magnesium light is allowed to fall on the sensitised plate of this cell, a current of electricity is observed to flow through the cell from the uncoated plate to the coated one. Bromide of silver was also used for the sensitive salt with like effect; the conducting liquid in the cell being in that case a solution of bromide of potassium.

The current thus set up is due to the photo-chemical action of the light on the sensitive plate; and Professor Mitchin also demonstrated that it could be made to effect a corresponding photo-chemical action on a second plate in a second receiving cell at a distance, but in circuit with the first or transmitting cell. He conducted the current thus obtained by means of wires to a second chloride of silver cell kept in the dark, and on developing the sensitive plate of the latter by means of pyrogallic acid, found it to exhibit a darkened surface due to the transmitted light. Professor Mitchin is still prosecuting these researches, and has procured a number of cells for the purpose, as well as a cabin containing a corresponding number of metallic conductors to isolate them from each other, to convey the currents from the separate cells. The currents originated by the photo-chemical action is considerable; the weak light from a match being sufficient to produce a decided deflection on a mirror galvanometer. Professor Mitchin's experiments are only on the threshold of the subject yet; but they are to be depended upon as far as they go, and are no mere theoretical schemes; moreover, the photographic method would have the advantage of yielding permanent portraits.

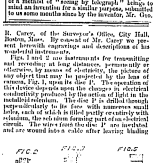
Guy Mitchin

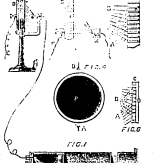
SEEING BY ELECTRICITY.

THE art of telephoning has already reached a point at which electric engineers is now at hand, the same state of advancement that the art of telegraphing by telephone had attained in 1876, and it remains to be seen whether it will develop as rapidly and successfully as the art of telephony. Professor Graham Bell deposited a sealed packet at the Franklin Institute a sealed description of a method of "seeing by telegraph." Extracts are sealed an invention for a similar purpose, submitted to us some months since by the inventor, Mr. Cox.

R. Cover, of the Surveyor's Office, City Hall, Boston, Mass. By means of Mr. Cover we yesterday received drawings and descriptions of his wonderful instruments.

Figs. 1 and 2 are instruments for transmitting and receiving at long distances, permanently or otherwise, by means of electricity, the picture of any object that may be projected by the lens of camera, Fig. 1, upon the disc P. The operation of the instrument depends upon the variations in conductivity produced by the action of light in the metallic selenium. The disc P is drilled through perpendicularly to its face with numerous small holes, each of which is filled pretty accurately with selenium, the whole then forming part of an electrical circuit. The wires from the disc P are insulated and are wound into a cable after leaving binding





screw B. These wires pass through disc C (Fig. 8, in the receiving instrument at a distant point, and are arranged in the same relative position as in disc P (Fig. 1).

A chemically-prepared paper is placed between discs C and P, and the image of any object presented to the camera is thrown upon the paper (Fig. 3 is a sectional view of Fig. 5, showing wires and the chemically-prepared paper).

Fig. 6 is a sectional view of disc P (Fig. 1) showing platinum points and conducting wires.

Fig. 4 is a sectional view of another receiving instrument, in which the chemically-prepared paper is dispensed with, there being a vacuum between glass disc D and insulating plate or disc C.

Note.—Points are numbered inconsistently in the

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Teléfonos.—Se encuentran entre nosotros los señores W. F. Clark y José D. Husbands, directores de la compañía Teléfonos de los Estados Unidos de Norte América.

El objeto de su venida es el procurar establecer algunas líneas telegráficas.

Anoche se hizo un ensayo del teléfono, comunicando al cuartel jeneral de bomberos, situado en la calle del Puente, con el de la 5.ª compañía, Arturo Prat, que está situado en la Alameda, dando un magnífico resultado.

Este ensayo se hizo a presencia de numerosas personas, reunidas tanto en el cuartel jeneral como en el de la 5.ª compañía.

Se conversó y se cantó, se tocó una corneta en este último lugar, reproduciéndose en el cuartel jeneral la voz y los sonidos de la manera mas perceptible aun para las personas colocadas a mayor distancia del teléfono.

Esperamos ver mui luego planteada entre nosotros esta útil invencion, adoptada ya por el comercio de Valparaiso y que ha dado tan oportunos y eficaces resultados.—(Novedades)

El teléfono.—Hemos tenido ocasion de presenciar anoche un nuevo ensayo de este asombroso descubrimiento de la ciencia moderna.

El Mercurio

La oficina del Telégrafo trasandino de esta ciudad, puesta en comunicacion telefónica con su oficina correspondiente de Santiago, fué el lugar del esperimento.

Asistieron once personas, entre las cuales estaba el señor ministro de los Estados Unidos.

El señor Husbands, jerente de la sociedad telefónica, se hallaba en la oficina de Santiago, a donde habia ido con el objeto de practicar el grandioso esperimento.

Puestas al habla ambas oficinas por una línea de ciento ochenta millas, empezaron los esperimentos con singulares pruebas de buen éxito. Se habló, se cantó y se tocó la música con perfecto resultado.

El señor Bolton, jefe de la oficina de Valparaiso, habló con el jefe de la oficina de Santiago. A las primeras palabras que éste le dirijió, reconoció su voz y le hizo notar que estaba ronco; a lo que le contestó su colega que efectivamente hacia dias que se hallaba constipado. Habló despues con su hermano, y tambien lo reconoció por el metal de su voz.

Desde Valparaiso se tocó una pequeña caja de música, y de Santiago contestaron que se oia con toda claridad. Desde Santiago cantó el señor Husbands una balada norte-americana, y se oyó en Valparaiso con entera perfeccion.

Puesta en correspondencia la oficina de Valparaiso con la central, se comunicaron con la mayor claridad. Una señora cantó el *miserere* del *Trovador* en esta oficina, y todos los concurrentes de la Trasandina pudieron gozar con asombro de esta dulce melodía.

En una palabra, el ensayo ha sido espléndido, un verdadero triunfo para el sabio robador de los secretos de la electricidad, el inmortal Edison, y tambien para su entusiasta propagador el señor Husbands, a quien Chile debe un voto de gracias por la introduccion de tan maravilloso como util descubri-

La distancia recorrida por las vibraciones del sonido era de ciento ochenta millas, que son las que mide el alambre telegráfico de Valparaiso a los Andos y desde aquí a Santiago.

Debemos advertir que la línea no se hallaba perfectamente aislada, a causa de los innumerables entorpecimientos que siempre tienen las líneas telegráficas y que nada importan para su uso perfecto por medio del sistema Morse. Lo que quiere decir que en una línea en completo estado de aislamiento, la intensidad de la voz habria sido mayor; pero así, tal cual ha sido la prueba, el teléfono de Edison es ya un aparato perfecto que nada deja que desear.

Lo volvemos a repetir: el señor Husbands, cuyo entusiasmo por su noble profesion se auna con la mas esquisita urbanidad para con el público que lo frecuenta, merece un voto de aplauso.

Es la flor de los *yankees*: sabe que es portador de un gran elemento de civilizacion, y no vacila en los gastos para difundirlo en un pais que él cree digno émulo de la gran nacion. En menos de mes y medio ha colocado en Valparaiso ciento veinte aparatos telefónicos, y ahora ha volado a Santiago a popularizar el portentoso invento de Edison, con la seguridad de que la capital no quedará en zaga de Valparaiso.

De desear seria que se repitiese el ensayo delante del señor intendente, para que pudiese palpar las ventajas que reportaria al buen servicio público que el palacio presidencial estuviese en comunicacion telefónica con la intendencia. A cualquiera hora del dia o de la noche podria el gobierno dar o recibir mensajes, sin interpósita persona, guardándose por consiguiente mayor sijilo que el que podrá jamas obtenerse en un telegrama ordinario.

Teatro.—E...

Las novedades del dia

Ayer ha sido firmado por el presidente de la república, el privilejio esclusivo concedido al señor don José D'Husbands, director i representante de Eedison, de Estados Unidos i autor i dueño del descubrimiento del teléfono.

Pronto se establecerá en Santiago una oficina para atender a los muchos pedidos de colocacion de teléfonos que el alto comercio de la capital tiene hechos al director, pues creemos que tanto el gobierno como los particulares se apresurarán a utilizar tan útil i ventajoso descubrimiento que está llamado a rivalizar con el telégrafo i a operar un trastorno favorable a las rápidas comunicaciones en los centros comerciales de la república.

57

Electrician

THE TELEPHONE COMPANY (LIMITED).

An extraordinary general meeting of the members of the Telephone Company (Limited) was held at the Guildhall Tavern, Gresham-street, on Tuesday, the 1st inst., Mr. James Brand presiding, for the purpose of considering, and if approved of, passing the following resolution, as an extraordinary resolution pursuant to the 82nd section of the articles of association of the Company:—"That an agreement, dated the 13th day of May, 1880, and made between the Telephone Company (Limited) (thereinafter called the Bell Company), of the first part, the Edison Telephone Company of London (Limited) (thereinafter called the Edison Company), of the second part, and a trustee for and on behalf of a company intended to be registered under the name of the United Telephone Company (Limited), of the third part, being a conditional agreement for the sale to the United Telephone Company of the business, goodwill, and property of the Bell Company, and of the Edison Company respectively (except as in the said agreement mentioned), for shares in the United Company, be confirmed; and that the directors be empowered to do all such things as may be necessary for carrying such agreement into effect, and for making an ultimate distribution of the shares of the United Company among the members."

The Secretary (Mr. W. T. Johns) having read the notice convening the meeting, as above,

The Chairman said he had very few remarks to make to recommend the resolution to their confidence. They had all felt since these two telephone companies were started that there were enormous difficulties in the way of the successful furtherance of their business, because the most profitable part of it they believed would be the central system; and when there were two rival companies, using two different sorts of instruments for the same purpose, and with different subscribers, it not only limited the gross number of subscribers, but caused competition for rates of subscription and enormous difficulties with respect to way leaves. This Company was in possession of the Bell patent, and the Edison Company were possessed of their own instrument, about which they (the Bell Company) did not think very much, but the Edison Company also had the property of the carbon transmitter, and it was the carbon transmitter which they thought was necessary for the completion of the central system, so that this Company having the undisputed possession of the best receiver, and the other company having the property in the best transmitter, they thought the wisest course was to avoid all future competition, bring their rates to one point, and amalgamate, and it was for that purpose that they had asked the shareholders for their attendance on that occasion, to consider the proposal re-

Teléfonos.—Se encuentran entre nosotros los señores W. F. Clark y José D. Hoskinsha, directores de la compañía Telefónica de los Estados Unidos de Norte América.

El objeto de su venida es el procurar establecer algunas líneas telegráficas.

Anoche, en vista un ensayo del teléfono, comunicando el cuartel jeneral de bomberos, situado en la calle del Puente, con el de la 5.ª compañía, Arturo Prat, que está situado en la Alameda, donde un ensayo semejante.

Este ensayo no hizo a pesarnos de numerosos personas, reunidas tanto en el cuartel jeneral como en el de la 5.ª compañía.

Se conversó y se cantó, si todo una concreta en este último lugar, reproduciéndose en el cuartel jeneral la voz y los sonidos de la manera mas perceptible una para las personas colocadas a mayor distancia del teléfono.

Esperamos ver muy luego planteada entre nosotros esta útil invención, adoptada ya por el comercio de Valparaíso y que la dado tan ventajosos y deseos resultados.—(NOVEDADES.)

El teléfono.—Hemos tenido ocasion de presenciar anoche un nuevo ensayo de este admirable descubrimiento de la ciencia moderna.

La oficina central telegráfica compañías de esta ciudad, puesta en comunicación telefónica con la oficina telegráfica de Santiago, fué el lugar designado para el ensayo.

Asistieron como personas, entre las cuales se encontraban el señor Bolton, jefe de la oficina de Valparaíso, el señor Hosbando, inventor del teléfono, el ayudante de la oficina de Santiago, a donde habia ido con el objeto de presenciar el grandioso esperimento.

Puestas en juego ambas oficinas por una hora de cuatro ochenta millas, empezaron los esperimentos con singulares resultados. Se oyó perfectamente la palabra de cada uno de los interlocutores; la música con perfecta claridad.

El señor Bolton, jefe de la oficina de Valparaíso, habló con el jefe de la oficina de Santiago; al oir las primeras palabras que este le dirijió, creyendo oir ver la voz de Hosbando que estaba cerca, rozó a lo que le contestó su colega que efectivamente hacia dias que era de nuestra residencia. Habló despues con los empleados, y tambien lo reconocieron por el dueño de su voz.

D. de Valparaíso se cantó una pequeña copla de mitico, y de Santiago contestaron que se oia una toda claridad. Desde Santiago cantó el señor Hosbando una bailadora perfectamente.

Puesta en comunicación la oficina de Valparaíso con la central, se comunicaron con la mayor claridad. Una señora cantó el vaterre del Trovador en esta oficina y todos los concurrentes de la Tesorería pudieron gozar con aquella dulce melodía.

En una palabra, el ensayo ha sido completísimo, con resultados dignos para el mas grande entusiasmo por el teléfono, de la electricidad, el inventor Edison, y tambien para los americanos, especialmente el señor Hosbando, a quien Chile debe un voto de gracias por la introducción de tan maravilloso descubrimiento.

Ya se encuentra concluido por los señores Clark y Hosbando, el contrato celebrado con el gobierno de Chile, para establecer líneas telegráficas entre Santiago, Valparaíso, Mendoza y los Andes y demás ciudades intermedias.

Debemos advertir que el Norte no se halla particularmente dotado, a causa de los innumerables accidentes que ofrecen sus líneas telegráficas, y que mas inmediatamente nos interesa, por ser nuestro centro de relaciones comerciales.

Lo veremos a repetir: el señor Hosbando, cuyo entusiasmo por su noble profesion es sino con la mas completa satisfaccion para con el público que lo reconoce, merece un voto de aplauso.

Es la flor de los yankees: sabe que es portador de un gran elemento de civilizacion, y no escatima en los gastos para difundirlo en su pais que el oro digan donde a la gran nacion! Es menos de dos y medio la colocacion en Valparaiso ciento, cuatro aparatos telefónicos, y ahora la oficina de Santiago, Quillota, Limache, Viña del Mar, Quilpue, Casablanca, Melipilla, Talagante, Isla de Maipo, con la seguridad de que la capital no quedará en zaga de Valparaiso.

De desear seria que, no satisfecho el enviado del señor Intendente, para que publicase palabras las ventajas que reportará el buen servicio público que el palacio presidencial esta hace en comunicacion telefónica con la correspondencia. A cualquiera hora del dia o de la noche podria el gobierno dar o recibir noticias, ordenes, instrucciones, pudiendo por consiguiente mayor ajilio que el que podrian obtenerse en un telégrafo diario.

Teatro

Ayer ha sido firmado el contrato por el cual el señor Bolton, jefe de la oficina de la república, el privilejio exclusivo concedido al señor don José D'Hosbando, director representante de Edison, de Estados Unidos i autor i dueño del descubrimiento del teléfono.

Pronto se establecerá en Santiago una oficina para atender a los muchos pedidos de colocacion de teléfonos que el comercio de la capital tiene hechos al director, pues creemos con tanto el gobierno como los particulares se apresurarán a utilizar, tan útil i valiosos descubrimiento que está llamado a revolucionar en el telégrafo i a operar un trascurso favorable a las rápidas comunicaciones en los centros comerciales de la república.

feneral to. They had no doubt whatever on the subject themselves, that it would be for the mutual advantage of both companies, and they hoped by this means that they would command all the telephones known and patents, or the most important of them, in the new United Country all their property and the shareholders to give their assent to the resolution. Mr. Crisp (the secretary) would explain the agreement. It was a novel kind of resolution. The enterprise of that kind of having unity of administration was the importance in an undertaking. He had in themselves very valuable elements—most valuable to them. The Board, especially the chairman, had devoted considerable time and energy to the consideration of the agreement, and they believed they had made a bargain which was fair to all, and to be satisfactory to both sides, inasmuch as it was a fair one, and recognised the value of the property of both companies. He believed they were unanimous in recommending it to the cordial approval of the shareholders.

Mr. Crisp said he might state that the general effect of the agreement was that the Bell Company on the one hand and the Edison Company on the other would amalgamate in the new United Company all their property and assets with one exception, which he would afterwards mention, for the following consideration—that the Bell Company would receive £625,000 in fully paid up shares of the capital of the United Company, and the Edison Company would receive £125,000, also in shares of the United Company. Each company sold its entire assets with this exception—that is effectively that each now in the possession of either company, or any debts due to them, or any moneys in bank or loan calls would not be sold. In the case of the Bell Company there was a considerable sum in their hands which would be applicable either for dividend or for dealing with hereafter. He then explained in general terms such clauses in the agreement, observing in the course of his remarks that the companies which had been formed in connection with Edison now would not have the benefit of the Edison name in agreement with transfer. The new company would take the liability, as the result of the costs of the suits of the action between the Post Office and the two old companies. The Bill of Sale was the day on which the matter was to be completed, but the agreement was to take effect as from the 1st May last. If the matter were not completed before the 30th of June it would fall to the ground. The agreement might be modified from time to time on the Boards of the two companies might decide.

Mr. Hubbard, the late president of the American Bell Company, said that the proportion on which the transfer was to be effected was in the present case 200 to 175. In America the Edison patents were held by the Edison United Telephone Company, who received 20 per cent. of the net profits earned, and stood in the right to use the telephones for their telegraphing business. He explained the manner in which that relationship had arisen and the same in the present case in those on which the Edison Company was taken over in America by the American Company. At night and that in America the telephone was considered as a necessity adjunct to the telegraph system, not as forming part of the telegraph system but as separate and entirely independent, though connected to it.

The Chairman, in reply to further questions, said that no arrangements were made with the Post Office. Negotiations with the Post Office—there was no notice pending with all the telephone companies. A great many negotiations were entered into respecting the subject, and they were continued from month to month, but they had not arrived at what they now saw. They could not accept the terms of the Post Office, as they thought they would "kill" them.

Mr. Carey, also in reply, stated that they were advised that the Post Office had no jurisdiction for their claim. It was provided that whatever arrangement was entered between the Bell Company and district companies, that no action would be taken ége by the United Company.

In answer to Mr. Galsworthy,

The Chairman said that by the amalgamation the subscribers would get the advantage of being able to use both instruments if they chose, and to talk to a great many more people for no more money.

Mr. Galsworthy thought that the whole of the details ought to left in the hands of the Board, who, he felt sure, must have given a great deal of time and attention to the matter. So long as they were not diminishing companies working with apparently the same object but with different means, so long did they prevent the public from deriving benefit from adopting either company, and when there was simply one to come, then in thought the number of subscribers would naturally be immensely increased. He regretted the resolution.

The Chairman, in answer to a shareholder, said that the matter would be brought before the Board if they had given the Edison Company £200,000, and they themselves have only received £125,000. The local was on the other foot. It took some degree of time to work out the matter, but he thought there was room to give the other side the larger sum. The intention as to the new company was to offer the first capital to the shareholders in the old Company and to the subscribers to the central system—the general existences. He then put the motion, and it was carried unanimously.

On the motion of Mr. Galsworthy, seconded by Mr. J. A. Gower, a vote of thanks was passed to the chairman and directors.

The Chairman, in reply, said he, on behalf himself, expressed his acknowledgements, and said that it had not been without difficulty and trouble that all these negotiations had been brought to an end; but the amalgamation of the two companies had been successful, and they would feel themselves amply repaid for their trouble.

Mr. Crisp, in reply to a question, said that a confirmation meeting would not be necessary.

The proceedings then terminated.

THE EDISON TELEPHONE COMPANY OF LONDON (LIMITED).

An extraordinary general meeting was held on the 1st inst. at the offices of Messrs. Price, Waterhouse and Co., Gresham-buildings, E.C., when a resolution agreeing to sell the business, goodwill, and property of this company to the United Telephone Company (Limited), and to empower the directors to carry such sale into effect, was considered.

[The resolution was similar to that referred to in another column as discussed at the meeting of the Bell Company's shareholders.]

two hundredths of a millimetre; the feed, therefore, is practically continuous and causes the light to be proportionally steady.

The pinion into which the wheel, n, gears is not fixed to the wheel, c, but is connected to the latter by a ratchet wheel, so that the rod, x_1, can be drawn up when it is required to insert a new carbon, without turning all the wheels in the train.

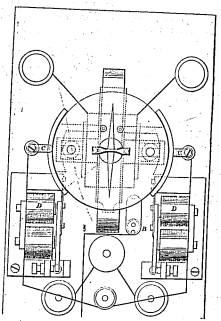
The course of the current through the electro-magnet and carbons is quite simple; thus, the current entering at w_1, passes through the electro-magnet, y_1, direct, thence to the frame of the apparatus and the upper carbon, and from there to the lower carbon and back to the dynamo machine.

The screw, s', when screwed down presses the strap, r, against the brake-wheel, s, and prevents it from turning; this is only required for security during transport.

Telegraphic Journal Dec. 15 1880

ROGERS' PATENT NEEDLE SOUNDER.

This invention is intended to afford a ready means of converting the ordinary single-needle instrument into a sound-reader at will. A reference to the accompanying illustration will explain the simple and inexpensive way in which this is effected. The local battery terminal is in metallic connection with the pillar, n, which makes a rubbing contact with the dial plate. The ivory pins controlling the play of the needle are removed and replaced by



platinum or silver pins soldered to brass strips at the back of the dial plate, but insulated from it by ebonite or waxed paper, and these strips are in

AN ELECTRICAL SPEED INDICATOR.*

By H. R. KEMPE.

May 15 1880

THE design of a Speed Indicator has often been attempted by various mechanicians, and many ingenious devices have been the result. One of the simplest forms of apparatus for the purpose is constructed on the principle of the governor of a steam engine, in which the angular deviation of the weighted arms represents the speed at which the instrument is turning. Such an instrument has been designed by Messrs. Elliott Brothers. Another form of instrument consists of a vertical glass tube partly filled with oil or coloured liquid, and which is rotated on its axis; the action causes the liquid to rise in the tube, the height to which it ascends representing the velocity.

The scales for such instruments are graduated by trial, and are not always correct under all conditions, as they are dependent to some extent upon variable quantities. It is also necessary that the indications be read at the place where the speed to be measured takes place.

In the instrument which I have to show you this evening the indications given are absolutely accurate under all conditions, as the apparatus is regulated by means of a clock, and, moreover, the instrument can be placed at any distance from the engine or apparatus whose speed it is required to indicate.

It would be impossible without elaborate diagrams to explain the action of the apparatus, but I will point out that the indicating hand points at every minute to the number of revolutions which the machine to which it is electrically connected has made during that minute, and the hand remains stationary at that indication till the next minute, when it advances or recedes according as the speed has increased or decreased during that minute. The apparatus is worked by a step by step motion, which moves a ratchet wheel forward one tooth at a time at each revolution made by the engine, the latter sending a current at each revolution. At the end of a minute the indicating hand is unlocked, and moves through the same angle which the ratchet has been turned through; the hand is then again locked, and the ratchet wheel allowed to run back to zero, when the same action is again gone through.

To prevent errors which may arise from the engine sending currents whilst the indicating hand is being set by means of the clock, an "accumulator" is employed which accumulates all the currents received from the engine during the time the clock is setting the hand; and then, when the latter action is completed and the ratchet wheel returned to zero, the amount accumulated is given

* Read before the Society of Telegraph Engineers, May 12th.

By this device, it happens that the sum of all the indications observed on the dial at each minute, during a number of minutes, will always equal the total number of revolutions given by the engine during that number of minutes."

By fixing a small grooved wheel on the axle of the indicating hand with a cord round it to which a pencil is attached, a record can be made of the speed. The size of the sheet of paper on which the indications are drawn can be made without difficulty of convenient dimensions. It need not exceed a size of about two feet by one foot, for indications given during twenty-four hours. On this diagram a line will be traced which will be straight if the engine is working uniformly, and wavy if the speed is irregular, the amount of the deviation showing at once the rate of increase or decrease in the speed.

The uses to which the apparatus, which is shown in front and back view by figs. 1 and 2, can be applied, are obviously numerous. It can be used for indicating the rate at which the paying-out drum of a cable ship is turning, the indicator being placed in the engineer's cabin; the rate at which the ship's engines are working can similarly be indicated.

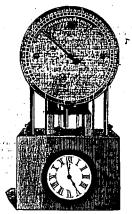


FIG. 1.

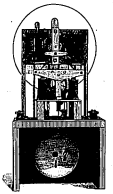


FIG. 2.

The lines of telegraph in the United States are reported as rapidly that it is difficult, even for their owners, to state the aggregate quantities at any particular time.

The best information, however, which can be obtained is that on the 1st of January, 1880, there were 112,642 miles of telegraph lines in the United States, and 280,858 miles of wire, without counting those lines specially used by the Gold and Stock Telegraph, and the District, the Fire Alarm and Burglar Alarm Telegraphs in the various cities.

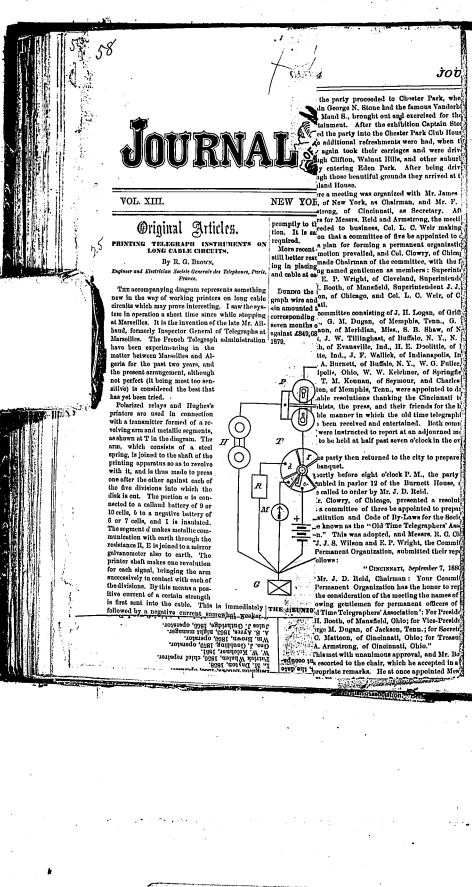
One telegraph company alone, the "Western Union," had, in June, 1879, 8,501 offices, from which were sent and received 29,070,108 messages during the preceding year.

Equally prompt has been the application of the telephone, which, looked upon doubtfully, or only as a toy, when it was first shown by Professor Bell at our Centennial Exhibition four years ago, has so rapidly become a necessity, that there are now in this country 121,000 instruments at work, connecting our business places and dwellings with each other, and with the central offices, by means of which we are almost instantly brought within speaking distance of the persons miles away, with whom we have to transact our business.

You are so familiar, however, with the telegraph and telephone, that it may be more interesting to you to call your attention to some of the house uses of electricity which are becoming part of our common life. Within the last few years we have been introducing electricity into our houses, and virtually make of it a new domestic servant, by what are called the burglar and fire alarm systems; not only does it ring bells, and summon the other servants (and in recent appliances, keep these bells ringing until the summons are answered), but as a burglar alarm, it is on the watch at night. Thus a house properly fitted with these contrivances, the whole or any part of which may be attached or detached at pleasure. The windows may be left partly open at top or bottom for ventilation, if desired; and when the servants have turned on, any attempt to alter their position, or to effect an entrance from the outside, causes an alarm, which can be stopped only by the person in charge. A glance at the annunciator determines the position of the burglar, or by pressing a knob at the instrument, it shows what doors or windows are open. To accommodate late comers, the front door can be disconnected, or with a special key it may be opened without causing an alarm. In the absence of the family the bell may be made to ring outside, or in a neighbor's house, or at the Police Headquarters; while the clock that calls the servants in the morning, at any hour desired, disconnects such parts of the house they are allowed to use, so as not to disturb the rest of the family.

Applied to safes in counting houses, or to stores containing valuable goods, the burglar alarm rings the bell at Police Headquarters, and at the same time indicates the point of attack. In a recent case in New York, the burglars, who had broken into a silk house, so promptly set off the alarm that they were surrounded by the police and captured as they were taking the goods down from the shelves. The system is being rapidly introduced in stores, counting and banking houses, and in connection with time locks on the safes, affords such good protection as to make watchmen almost superfluous.

Applied to fire alarm, electricity renders still more important domestic service; not only does it advise all the fire engines located in a particular district, whenever an alarm is sounded from a street corner, but it sets machinery at work which unbitches the horses from their stalls, wakes up the firemen (and tumbles them out of bed in some cities), harnesses the horse, lights and fires, and opens the doors of the engine house, so that the machine is ready to start in eleven or twelve seconds after the alarm is sounded; but the fire alarm is also extended to private houses, and there presents itself in the shape of three unobtrusive knobs. Push the first and you summon the fire department; touch the second and a police officer makes his appearance; press the third and a messenger comes to run your errands. Moreover, by means of the pyrostat, should a fire break out during your absence, the expansion of a metallic bar makes an electrical connection which sets off the alarm and summons the fire engine.—*O. Chanute.*



JOURNAL

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Original Articles.

PRINTING TELEGRAPH INSTRUMENTS ON LONG CABLE CIRCUITS.

By R. G. Brown,

Engineer and Electrician Societe Generale des Telephones, Paris, France.

The accompanying diagram represents something new in the way of working printers on long cable circuits which may prove interesting. I saw the system in operation a short time since while stopping at Marseilles. It is the invention of the late Mr. Allhand, formerly Inspector General of Telegraphs at Marseilles. The French Telegraph administration have been experimenting in the matter between Marseilles and Algeria for the past two years, and the present arrangement, although not perfect (it being about two sensitive) is considered the best that has yet been tried.

Polarized relays and Hughes's printers are used in connection with a transmitter formed of a revolving arm and metallic segments, as shown at H in the diagram. The arm, which consists of a steel spring, is joined to the shaft of the printing apparatus so as to revolve with it, and is thus made to press one after the other against each of the five divisions into which the disk is cut. The portion a is connected to a callend battery of 8 or 10 cells, b to a negative battery of 6 or 7 cells, and l is insulated. The segment d makes metallic communication with earth through the resistance R, E is joined to a sensitive galvanometer also to earth. The printer shaft makes one revolution for each signal, bringing the arm successively in contact with each of the divisions. By this means a positive current of a certain strength is first sent into the cable. This is immediately followed by a negative current somewhat weaker.

the party proceeded to Chester Park, where Mr. George N. Stone had the famous Vanderbilt Mansion, brought out and exercised for the entertainment. After the exhibition Captain Stone led the party into the Chester Park Club House, where additional refreshments were had, when they again took their carriages and were driven through Clifton, Walnut Hills, and other suburbs, finally entering Eden Park. After being driven through those beautiful grounds they arrived at the Island House.

Here a meeting was organized with Mr. James Hoyt, of New York, as Chairman, and Mr. F. Lovejoy, of Cincinnati, as Secretary. After speeches by Messrs. Reid and Armstrong, the meeting proceeded to business, Col. L. C. Waltz making the motion that a committee of five be appointed to consider and report a plan for forming a permanent organization. The motion prevailed, and Col. Cleevey, of Dixie, was made Chairman of the committee, with the following named gentlemen as members: Superintendent E. P. Wright, of Cleveland, Superintendent Booth, of Mansfield, Superintendent J. J. Dyer, of Chicago, and Col. L. C. Weir, of Cincinnati.

The committee consisting of J. H. Logan, of Grit, corresponding secretary of G. M. Dugan, of Memphis, Tenn., G. Matteson, of Meridien, Miss., S. B. Shaw, of Nashville, J. W. Tillingham, of Buffalo, N. Y., R. Booth, of Evansville, Ind., H. E. Doolittle, of Dayton, Ind., J. F. Wallick, of Indianapolis, Ind., A. Burnett, of Buffalo, N. Y., W. O. Fuller, of Indianapolis, Ohio, W. W. Kelchner, of Springfield, Ohio, T. M. Keenan, of Seymour, and Charles Wilson, of Memphis, Tenn., were appointed to draft suitable resolutions thanking the Cincinnati Press Club, the press, and their friends for the hospitable manner in which the old time telegraphers had been received and entertained. Both committees were instructed to report at an adjourned meeting to be held at half past seven o'clock in the evening.

The party then returned to the city to prepare for the banquet.

Shortly before eight o'clock P. M., the party reassembled in parlor 12 of the Burnett House, and was called to order by Mr. J. D. Reid.

Mr. Clowry, of Chicago, presented a resolution that a committee of three be appointed to prepare a constitution and Code of By-Laws for the Society, to be known as the "Old Time Telegraphers' Association." This was adopted, and Messrs. R. G. Clowry, "J. S. Wilson and E. P. Wright, the Committee on Permanent Organization, submitted their report as follows:

"Cincinnati, September 7, 1880.

Mr. J. D. Reid, Chairman Old Time Telegraphers' Association: Your Committee on Permanent Organization has the honor to report for the consideration of the meeting the names of the following gentlemen for permanent officers of the "Old Time Telegraphers' Association": For President, R. Booth, of Mansfield, Ohio; for Vice-President, George M. Dugan, of Jackson, Tenn.; for Secretary, G. Matteson, of Cincinnati, Ohio; for Treasurer, J. Armstrong, of Cincinnati, Ohio."

This was with unanimous approval, and Mr. Reid was escorted to the chair, which he accepted in a few appropriate remarks. He at once appointed Messrs.

IRON WIRE FOR TELEGRAPHS.*

In the very early and palmy days of electric telegraphs materials for the construction of the lines were bought regardless of cost, but of the best quality; foreign timber was used in poles, and charcoal iron wire for the conductors. As competition arose prices were reduced rather recklessly, without any careful specification. The consequence was that wire of such inferior mechanical quality crept into use that it would not stand the strain caused by snowstorms. The wire, tightened by the contraction from low temperature and loaded by snow, broke the last straw put on its back when a gale of wind occurred. In writing the specification for the mechanical qualities, experiments were made on the conductivity of different qualities of wire, and it was found that considerable difference existed in this respect, a foot which, as regards copper - had been previously found out and provided for. Careless welds, too, were found to be a great source of breakage. The specification of the wire for the Post Office Telegraphs is now a somewhat elaborate affair. The wire must gauge within 2½ per cent. of the specified gauge, must be made from charcoal puddled bars, must stand so many twists in six inches before breaking, must have a certain tensile strength, be of a certain length without any weld, and not give more than a certain electrical resistance per statute mile. A regular table, stating the amounts of each of these qualities for the different gauges employed, is given in the printed specification.

In the same way the Indian Government has a special specification for the wire required for the Indian telegraphs. This specification, up to within about a year and a half ago, though very stringent as regards mechanical qualities, did not specify the electrical resistance, but this was at about that date supplied. The price now paid, therefore, for telegraph wire for those Government land lines is very much greater than it was before those rigorous specifications were issued, and the cost is about the same now as it was for the earliest lines, whilst at one time, intermediate between those periods, wire, cheap and bad, was supplied for about half the present cost.

The colonial telegraphs, where extensions are rapid, consume a great deal of wire, and most of the colonies follow the Post Office specifications. The English railway companies require a little wire yearly for repairs and extensions, but their specifications are not generally as rigorous as that of the Government.

For the external covering or armour of submarine telegraph cables a large quantity of wire is yearly consumed by the manufacturers, such as the Telegraph Construction Company, the India Rubber, Gutta Percha, and Telegraph Works Company, Messrs. Siemens Brothers, and Henley's Telegraph Works Company. The Telegraph Construction Company alone in one year made about 6,000 miles of telegraph cable, which would probably represent about 7,000 tons of wire.

For submarine cable wire a very different class of wire is used from that used for land lines. For deep sea work the wire known as homogeneous iron is largely used, and for the types of cable known as intermediate and shore ends iron wire known in the trade as "BB" is used. The engineers who draw up the specification for the telegraph companies specify the breaking strain of the homogeneous wire, but scarcely ever give any other specification for the wire than the very rough one of "BB." No tensile strength or twists to prove ductibility or elongation are mentioned for this wire. The manufacturers themselves make a few tests, but their principal test in practice is the time that the covering machines will run without a wire breaking. For this wire foreign competition has for a considerable time interfered largely with our Lancashire wire drawers. Thousands of tons come yearly from Germany to the banks of the Thames at a price which it is impossible for our English firms to quote. This is partly due to the cheaper labour in Germany, but also to the price which it is required to pay in this country for the wire can be brought from Cologne to the Thames for about ten shillings per ton cheaper than from Manchester or Warrington. It is also a curious fact that the carriage for wire from Lancashire to London for export is about half the price that it is for wire brought to London for manufacture, and it would appear to us that if it is the interest of the railway companies to bring wire cheap to London for export, it should also be their interest to bring it cheap to the banks of the Thames for manufacture into an article which is exported as soon as it is made. If the price of carriage was thus reduced, it would be, perhaps, possible for our English firms to compete with the Germans, and the railway companies would obtain the carriage of thousands of tons of wire from Lancashire to London which they at present lose. As it is, the wire trade is leaving the country, so far as the submarine cable business is concerned, and this forms a considerable item in the whole trade.

IRON WIRE FOR TELEGRAPHS.*

In the very early and palmy days of electric telegraphs materials for the construction of the lines were bought regardless of cost, but of the best quality; foreign timber was used in poles, and charcoal iron wire for the conductors. As competition arose prices were reduced rather recklessly, without any careful specification. The consequence was that wire of such inferior mechanical quality crept into use that it would not stand the strain caused by snowstorms. The wire, tightened by the contraction from low temperature and loaded by snow, broke the last straw put on its back when a gale of wind occurred. In writing the specification for the mechanical qualities, experiments were made on the conductivity of different qualities of wire, and it was found that considerable difference existed in this respect, a foot which, as regards copper - had been previously found out and provided for. Careless welds, too, were found to be a great source of breakage. The specification of the wire for the Post Office Telegraphs is now a somewhat elaborate affair. The wire must gauge within 2½ per cent. of the specified gauge, must be made from charcoal puddled bars, must stand so many twists in six inches before breaking, must have a certain tensile strength, be of a certain length without any weld, and not give more than a certain electrical resistance per statute mile. A regular table, stating the amounts of each of these qualities for the different gauges employed, is given in the printed specification.

In the same way the Indian Government has a special specification for the wire required for the Indian telegraphs. This specification, up to within about a year and a half ago, though very stringent as regards mechanical qualities, did not specify the electrical resistance, but this was at about that date supplied. The price now paid, therefore, for telegraph wire for those Government land lines is very much greater than it was before those rigorous specifications were issued, and the cost is about the same now as it was for the earliest lines, whilst at one time, intermediate between those periods, wire, cheap and bad, was supplied for about half the present cost.

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Original Articles.

PRINTING TELEGRAPH INSTRUMENTS ON LONG CABLE CIRCUITS.

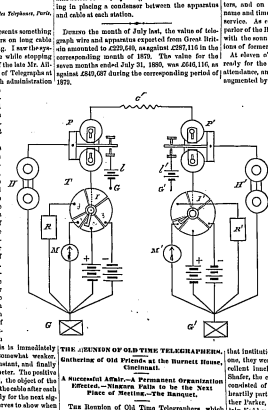
By R. G. Brown,

Engineer and Electrician Société Générale des Téléphones, Paris, France.

The accompanying diagram represents something new in the way of working printers on long cable circuits which may prove interesting. I saw the system in operation a short time since while stopping at Marseilles. It is the invention of the late Mr. Abband, formerly Inspector General of Telegraphs at Marseilles. The French Telegraph administration have been experimenting in the matter between Marseilles and Algeria for the past two years, and the present arrangement, although not perfect (it being most too sensitive) is considered the best that has yet been tried.

Polarized relays and Hughes's printers are used in connection with a transmitter formed of a revolving arm and metallic segments, as shown at T in the diagram. The arm, which consists of a steel spring, is joined to the shaft of the printing apparatus so as to revolve with it, and is thus made to press one after the other against each of the five divisions into which the disk is cut. The portion a is connected to a called battery of 9 or 10 cells, b to a negative battery of 6 or 7 cells, and 1 is insulated. The segment 2 makes a positive connexion with earth through the resistance R. 3 is joined to a mirror galvanometer also to earth. The printer shaft makes one revolution for each signal, bringing the arm successively in contact with each of the divisions. By this means a positive current of a certain strength is first sent into the cable. This is immediately followed by a negative current somewhat weaker. The cable is then insulated an instant, and finally put to earth through the galvanometer. The positive battery alone produces the signal, the object of the negative being simply to clear out the cable after each positive impulse, and leave it ready for the next signal. The mirror galvanometer serves to show when the clearing has been properly done. If it marks the presence of a current, one or the other battery, or the resistance R, must be changed until the needle is no longer deflected when the compensation is known to be right. The connections are so arranged that the polarized relay at the home station is not affected by the sending current, but responds promptly to the received current from distant station. It is said that a battery of low resistance is required.

More recent experiments have been attended with still better results, by a slight modification consisting in placing a condenser between the apparatus and cable at each station.



During the month of July last, the value of telegraph wire and apparatus exported from Great Britain amounted to £220,540, as against £287,116 in the corresponding month of 1879. The value for the seven months ended July 31, 1880, was £956,116, as against £849,687 during the corresponding period of 1879.

THE REUNION OF OLD TIME TELEGRAPHERS.

Gathering of Old Friends at the Burnett House, Cincinnati.

A Successful Affair.—A Permanent Organization Effected.—Niagara Falls to be the Next Place of Meeting.—The Banquet.

The Reunion of Old Time Telegraphers, which has occupied the attention of past and present members of the telegraphic fraternity for some months, took place at Cincinnati, Ohio, on the 7th inst., and was highly successful in every respect. Many who were expected, and who intended to be present, through the exigencies of business were compelled to be absent, but notwithstanding, the gathering was a notable one, and all who were so fortunate as to participate felt that it was good to be there.

The morning was cool and refreshing. Delegates were present from all sections of the country. The Burnett House had been selected as the headquarters, and on arrival each delegate registered his name and time and place of entering the telegraphic service. As early as eight o'clock A. M. the large parlor of the Burnett House was well filled and lively with the sound of fraternal greeting as the company, sons of former years met and saluted each other.

At eleven o'clock A.M., when the carriages were ready for the drive, seventy-five delegates were in attendance, and later in the day this number was augmented by the arrival of some fifty others. The services of fifteen carriages and the immense coach "Highland Chief" barely sufficed to furnish needed accommodations for the company.

After leaving the Burnett House the visitors and local representatives, under the polite and skillful guidance of Col. L. G. Weir, hiring self an old time telegraphist, now Superintendent of Adams Express, were driven up Vine Street. Passing the Western Union telegraph office, they were enthusiastically saluted by their younger telegraph brethren and sisters, always at every door and window in the huge five story building being occupied. Proceeding up Vine to Fifth, thence to Race Street, the party was driven to Mosebach's brewery, and were shown through the establishment, after which they resumed their journey. Walking up the Bellevue Incline Plane, bowing the carriages at the foot, they soon found themselves of the opportunity to view the city from the platforms surrounding the buildings.

Descending, the party were driven to the Work-house. After inspecting the various departments of that institution, with director Parker as their cicerone, they were escorted to the chapel, where an excellent lunch had been prepared by Miss Mary Shafer, the competent Matron. The lunch, which consisted of a large variety of good things, was heartily partaken of by all of the party. Mr. Luther Parker, director, assisted by Col. Morgan, Captain Kudd and Secretary Thompson, entertained the visitors handsomely, and courteously guided the party through the different departments of the great building. It was curious that at such a place the delegates found in an ample load of blooming roses the means of adding a fresh decoration to the handsome badges they wore.

After bidding their hosts at the Work-house farewell, the party returned to the Burnett House, and at 6 P. M. sat down to the banquet, which was a most elaborate affair, and reflected great credit upon the management of the house. The tables were arranged in the form of a horseshoe, and were loaded down with the choicest viands that the market could afford. Mr. Thomas Clark, of Cincinnati, presided, and at his right sat Mr. Thomas T. Eckert, President of the Western Union Telegraph Company, and at his left Mr. Norvin Green, President of the American Union Telegraph Company. Among the guests at the table were Mr. Jay Gould, Mr. Russell Sage, Mr. Wm. H. Vanderbilt, Mr. Frank Work, Mr. Wm. Orton, Mr. Edward Lauterbach, Mr. Wm. Walter Phelps, Mr. Wm. H. Baker, Mr. Wm. Dowd, Mr. Wm. Wheeler, Mr. Wm. Barnes, Mr. Wm. Hamilton, Mr. Wm. Hoffman, Mr. Wm. Bingham, Mr. Wm. Hunter, Mr. Wm. Bliss, Mr. Wm. Bowen, Mr. Wm. Bell, Mr. Wm. Bruce, Mr. Wm. Cary, Mr. Wm. Cook, Mr. Wm. Cowan, Mr. Wm. Cowper, Mr. Wm. Crane, Mr. Wm. Culver, Mr. Wm. Dickson, Mr. Wm. Dinsmore, Mr. Wm. Dunn, Mr. Wm. Eaton, Mr. Wm. Edwards, Mr. Wm. Ellis, Mr. Wm. Fisher, Mr. Wm. Foster, Mr. Wm. Gamble, Mr. Wm. Gilbert, Mr. Wm. Gilmore, Mr. Wm. Gray, Mr. Wm. Green, Mr. Wm. Hall, Mr. Wm. Hamilton, Mr. Wm. Hanna, Mr. Wm. Hardy, Mr. Wm. Harris, Mr. Wm. Hart, Mr. Wm. Hayes, Mr. Wm. Hedges, Mr. Wm. Hill, Mr. Wm. Hoffman, Mr. Wm. Hopkins, Mr. Wm. Howard, Mr. Wm. Hunter, Mr. Wm. Jackson, Mr. Wm. Jones, Mr. Wm. Kelly, Mr. Wm. Kennedy, Mr. Wm. Kerr, Mr. Wm. Kimball, Mr. Wm. Lamb, Mr. Wm. Lee, Mr. Wm. Lewis, Mr. Wm. Lindsay, Mr. Wm. Lloyd, Mr. Wm. Long, Mr. Wm. Lowe, Mr. Wm. Lyon, Mr. Wm. Mackey, Mr. Wm. Mann, Mr. Wm. Marsh, Mr. Wm. Martin, Mr. Wm. Mason, Mr. Wm. Matthews, Mr. Wm. Maxwell, Mr. Wm. Miller, Mr. Wm. Mills, Mr. Wm. Moore, Mr. Wm. Morgan, Mr. Wm. Morris, Mr. Wm. Morrison, Mr. Wm. Murphy, Mr. Wm. Nelson, Mr. Wm. Nichols, Mr. Wm. Norris, Mr. Wm. Norton, Mr. Wm. Oliver, Mr. Wm. Owens, Mr. Wm. Parker, Mr. Wm. Parsons, Mr. Wm. Patterson, Mr. Wm. Peck, Mr. Wm. Perkins, Mr. Wm. Phillips, Mr. Wm. Pierce, Mr. Wm. Porter, Mr. Wm. Price, Mr. Wm. Quinn, Mr. Wm. Reed, Mr. Wm. Reid, Mr. Wm. Rice, Mr. Wm. Richards, Mr. Wm. Richardson, Mr. Wm. Roberts, Mr. Wm. Robertson, Mr. Wm. Robinson, Mr. Wm. Rogers, Mr. Wm. Ross, Mr. Wm. Russell, Mr. Wm. Sanders, Mr. Wm. Scott, Mr. Wm. Shaw, Mr. Wm. Shepherd, Mr. Wm. Simpson, Mr. Wm. Smith, Mr. Wm. Stanley, Mr. Wm. Stevens, Mr. Wm. Stewart, Mr. Wm. Stone, Mr. Wm. Taylor, Mr. Wm. Thomas, Mr. Wm. Thompson, Mr. Wm. Tilden, Mr. Wm. Tracy, Mr. Wm. Turner, Mr. Wm. Vance, Mr. Wm. Wallace, Mr. Wm. Ward, Mr. Wm. Watson, Mr. Wm. Webb, Mr. Wm. Wells, Mr. Wm. West, Mr. Wm. Wheeler, Mr. Wm. White, Mr. Wm. Williams, Mr. Wm. Wilson, Mr. Wm. Wood, Mr. Wm. Woods, Mr. Wm. Wright, Mr. Wm. Young, Mr. Wm. Zimmerman, Mr. Wm. Zinn, Mr. Wm. Zoller, Mr. Wm. Zook, Mr. Wm. Zumbro, Mr. Wm. Zwick, Mr. Wm. Zwicker, Mr. Wm. Zwinger, Mr. Wm. Zwirner, Mr. Wm. Zwolle, Mr. Wm. Zwoyer, Mr. Wm. Zwyer, Mr. Wm. Zyck, Mr. Wm. Zyer, Mr. Wm. Zyerly, Mr. Wm. Zyers, Mr. Wm. Zyerson, Mr. Wm. Zyerton, Mr. Wm. Zyertown, Mr. Wm. Zyerville, Mr. Wm. Zyerville, Mr. Wm. Zyerville

the party proceeded to Chester Park, where
th George N. Stone had the famous Vanderbilt
, Maud S., brought out and exercised for their
tainment. After the exhibition Captain Stone
ed the party into the Chester Park Club House,
a additional refreshments were had, when the
' again took their carriages and were driven
gh Clifton, Walnut Hills, and other suburbs,
by entering Eden Park. After being driven
ugh those beautiful grounds they arrived at the
stand House.

ere a meeting was organized with Mr. James D.
, of New York, as Chairman, and Mr. F. A.
sterup, of Cincinnati, as Secretary. After
re for Messrs. Reid and Armstrong, the meeting
eeded to business, Col. L. G. Weir making a
on that a committee of five be appointed to de-
a plan for forming a permanent organization.
motion prevailed, and Col. Cleary, of Chicago,
made Chairman of the committee, with the fol-
ng named gentlemen as members: Superinten-
E. P. Wright, of Cleveland, Superintendent
I. Booth, of Mansfield, Superintendent J. J. S.
on, of Chicago, and Col. L. G. Weir, of Cin-
ati.

committee consisting of J. H. Logan, of Griffin,
, G. H. Dugan, of Memphis, Tenn., G. W.
man, of Meridian, Miss., R. B. Shaw, of New
, J. W. Tillinghast, of Buffalo, N. Y., N. R.
h, of Evansville, Ind., H. B. Doolittle, of La-
ite, Ind., J. F. Wallick, of Indianapolis, Ind.,
. A. Burnett, of Buffalo, N. Y., W. G. Fuller, of
ipolis, Ohio, W. W. Kelchner, of Springfield,
T. M. Keenan, of Seymour, and Charles A.
ise, of Memphis, Tenn., were appointed to draft
able resolutions thanking the Cincinnati indi-
ists, the press, and their friends for the hos-
ble manner in which the Old Time telegraphists
been received and entertained. Both commit-
were instructed to report at an adjourned meet-
to be held at half past seven o'clock in the even-

he party then returned to the city to prepare for
banquet.

portly before eight o'clock P. M., the party re-
mbled in parlor 31 of the Burnett House, and
called to order by Mr. J. D. Reid.

r. Cleary, of Chicago, presented a resolution
a committee of three be appointed to prepare a
stitution and Code of By-Laws for the Society,
e known as the "Old Time Telegraphers' Associa-
n." This was adopted, and Messrs. D. C. Clow-
, J. S. Wilson and E. P. Wright, the Committee
Permanent Organization, submitted their report,
llows:

"CINCINNATI, *September* 7, 1880.

'Mr. J. D. Reid, Chairman: Your Committee
Permanent Organization has the honor to report
the consideration of the meeting the names of the
owing gentlemen for permanent officers of the
d Time Telegraphers' Association': For President,
II. Booth, of Mansfield, Ohio; for Vice-President,
gus M. Dugan, of Tennessee, Texas; for Secretary,
C. Mattoon, of Cincinnati, Ohio; for Treasurer,
A. Armstrong, of Cincinnati, Ohio."

is name with unanimous approval, and Mr. Booth
s escorted to the chair, which he accepted in a few
propriate remarks. He at once appointed Messrs.
R. Pliem, of Chicago, Col. R. C. Clowry, of Chi-
o, and E. P. Wright, of Cleveland, as the Com-
ttee on Constitution and By-Laws. The matter
the time and place of the next meeting was then
nsidered, entailing considerable discussion. It
s finally decided to be held on the third Wednes-
y of September, 1881. Nominations for place
re made and Niagara Falls, Cincinnati, Chicago,
Atlanta, Utica, Louisville, Cleveland, and Jeffersonville, Ind., were named. The last fell to Niagara Falls by a vote of twenty-nine. The other cities ranged in this wise: Atlanta, 2; Chicago, 8; Cincinnati, 6; Cleveland, 5; Louisville, 3; Utica, 2; and Jeffersonville, 1.

The question of the eligibility of membership came up, and it elicited quite a warm discussion. Right at the outset the inquiry was made, What was the object of the gathering? Was it a mooting of pleasure, or was it a society the members of which could be continually renewed from the youthful ranks? The general feeling seemed to be in favor of limiting the membership to those who had been engaged in the telegraphing business previous to 1850, and this, it is understood, includes the ladies so engaged. And it was further resolved that all the names on the registration book be the charter membership of the society.

A committee was appointed to attend to the arrangements of the next reunion—J. W. Tillinghast, S. B. Gifford, and E. P. Wright.

Col. L. G. Weir was appointed a committee of one to see after securing the photographs of present and prospective members.

The following resolutions were adopted:

Resolved, That the thanks of the Old Timers assembled on the occasion of their first reunion in Cincinnati, are due and hereby tendered to the local committee of Cincinnati for their untiring energy and perseverance in making the reunion the success it is.

The committee do not wish to individualize, but deem it proper to make special mention of George T. Williams and John C. Mattoon, who have been particularly instrumental in perfecting all necessary arrangements to entertain the Old Timers.

Resolved, That we tender a vote of thanks to the press of Cincinnati—*Enquirer*, *Gazette*, *Commercial*, *Star-Times*—for complimentary notices and other gratuitous advertising, and we also extend our thanks to Luther W. Parker and Col. James C. Morgan, of the Work-house, and to the Burnett House for courtesies extended to the visitors.

A complimentary resolution was also tendered to Capt. Bates for his exhibition of Mond S. at Chester Park.

A picture of Prof. S. F. B. Morse, taken at the time he brought out his telegraph system, was silenced at one end of the parlor, attracted much attention. It is the property of Col. J. J. S. Wilson, of Chicago, and the fact that there are but three instances of the kind in existence was incidentally mentioned.

At the conclusion of the proceedings in the parlor the company adjourned to the dining-room, where the banquet had been prepared.

A superb floral piece graced the dining room, the gift of Adams Express Company. It followed the popular fancy for realistic flower work, and it has rarely been better illustrated. Upon a solid bed of rich blue blossoms eight feet long and four feet wide were placed two railway stations, rails, walls and roads, of sacred flowers, white immortelles for the floors and windows framed by scarlet balsams. Connecting these stations across the silver waves of the W. U. Telegraph, and the keynotes dropped from the wires. In pendant blossoms were the words: "Welcome, Old Timers."

This pretty conceit was due to Mr. Alfred Gaither and Col. Weir.

Following are the names of those present, the date of their entry into service, and their present occupation:

Gen. A. Burnett, 1852, telegrapher.
J. H. Logan, 1849, editor.
J. W. Chaplin, 1849, lineman.
Chas. B. Billings, 1850, operator.
M. J. Waldron, 1848, operator.
A. Heywood, 1851, Superintendent O. & M. Railway.
N. Hecker, 1847, manager.
O. H. Booth, 1852, Superintendent.
Jas. D. Reid, 1845, Superintendent.
E. C. Bush, 1847, broker.
W. G. Fuller, 1858.
S. B. Shaw, 1855, Superintendent N. Y., P. & O. Railroad.
W. H. Mendell, 1857, constructor American Fire Alarm Telegraph.
John Bayld, 1848, operator and railroad agent.
John H. Parnell, 1852, manager.
E. P. Wright, about 1850, Superintendent.
John A. Townsend, 1852, manager.
J. H. Tinker, 1852, Clerk United States Court, Waco, Texas.
Wm. C. Long, 1852, night manager.
James Fenwick, 1852, manufacturer of telegraph instruments.
Gen. T. Williams, 1852, Superintendent.
G. F. Stamm, 1852, chief operator.
C. P. Hammond, 1852, superintendent.
J. C. Hall, 1867, manager.
W. H. Allison, Superintendent of telegraph of L. & N. R. R.
E. W. McKenna, Superintendent of telegraph of Pittsburgh, Ft. Wayne & Chicago.
Phil. Renner, 1865, M. O. T. U. & P. Railroad.
John F. Wallick, 1851, Superintendent.
Dan. G. Hendeles, 1861, chief clerk W. U. T. Co.
L. A. Eaglebee, 1853, division manager of J. M. & I. railroad.
T. W. Keenan, 1853, train dispatcher, O. & M. R. R.
J. C. Wilson, 1852, manager at Union Depot, Indianapolis.
W. H. Marble, 1849, assistant chief operator.
E. N. Smith, 1849, operator.
M. Patten, 1851, manager.
D. H. Bingham, 1852, manager.
John E. Clarke, 1852, operator.
C. D. Thomas, 1858, operator.
Geo. T. Irwin, 1851, assistant chief operator.
W. H. Armstrong, 1850, second assistant bookkeeper.
C. W. McClain, 1852, railroad clerk and operator.
Chas. A. Cromwell, 1852, operator.
W. H. Corey, 1853, manager.
D. J. Willis, 1857, manager.
George Gilliland, 1853, journalist.
J. A. Mattoon, 1851, operator.
L. C. Witt, 1853, superintendent.
C. A. Tinsley, 1853, train manager.
E. H. Gordon, 1854, operator.
T. W. Coolidge, 1859, Superintendent Telegraph Central Southern Railroad.
R. C. Clowry, 1852, General Superintendent.
J. J. S. Wilson, 1852, District Superintendent.
H. B. Doolittle, 1851, manager.
Wm. Rockey, 1853, Superintendent Telegraph.
E. P. Nottnkles, 1851, manager.
E. L. Norrcross, 1855, manager.
Frank C. Jones, 1850, operator.
W. B. Dunn, 1852, operator.
J. F. Mellwain, 1853, operator and railroad agent.
Jas. Gallagher, 1853, operator.
Gen. H. Dugan, 1852, Superintendent Telegraph C., St. L. & N. O. Railroad.
Chas. A. Gwinn, 1860, railroad operator Mississippi Central Railroad.
E. J. Lane, 1853, manager.
Gen. E. Allen, 1847, manager.
E. L. Ryder, 1853, manager.
J. A. Armstrong, 1853, manager.
D. Hudnut, 1853, Superintendent Construction.
B. H. Johnson, 1860, chief operator.
W. H. Russell, 1864, ticket agent.
Jas. H. Cox, 1853, railroad agent and operator.
E. C. Johnson, 1859, Superintendent Police Telegraph.
W. B. Higgins, 1866, Superintendent Telegraph.
A. T. Sewell, 1861, night manager.
W. W. Smith, 1853, manager telephone exchange.
W. H. Johnson, 1866, Superintendent manufacturing.
J. Gus Fuller, 1858, night chief.
Leighton Brooke, 1855, operator.
L. D. Boyles, 1853.
Thomas Whalen, 1854, chief repairer.
W. H. Gardner, 1851.
Geo. J. Goulding, 1850, operator.
Wm. Brown, 1851, operator.
A. S. Ayres, 1855, night manager.
Jules J. Gutridge, 1855, operator.

author of "The Telegraph in America," while
e right was O. H. Booth, Superintendent of the
, & St. L. system of telegraph lines. There were
at 150 gentlemen at the table. During the ser-
of the bill of fare excellent music was furnished
the Cincinnati Orchestra.

llow is the bill of fare:

MENU.

ces on half shell.

Green Turtle Soup.

Sherry.

led Spanish Mackerel.

Mashed Potatoes a la Burnett.

d Sweet Breads, with French Peas.

Sorbette.

Larded Fillet of beef, with Mushrooms.

Champagne.

at Prairie Chicken.

Saratoga Fried Potatoes.

ie. Assorted Cake.

Ice Cream. Cigars.

Coffee.

ad before 11 o'clock the chairman, Col. Weir,
d the gathering to order. Letters of regret were
from a number of leading telegraphers, stating
inability to attend, among them being a very
cross communication from Mr. Chas. Osborne,
d of the Western Associated Press at St. Louis.
Weir then stated that but one regular toast—
egraphy as it was"—had been chosen, it being
ght that it would be too much of an infliction to
ivery one present give his reminiscences of tel-
phy. He then introduced Mr. James D. Reid
e responder.

r. Reid made a very happy response. His
ch at times was intensely humorous, and elicited
of laughter. In an impressive manner he re-
d to the significance of this national reunion of
raphers. They had come from the North, the
h, the West, and the East (at least from as far
Buffalo, if not from New York). They had come
d each other "good-night" After the lapse of
ber year they would meet again at the great
, and, finally, when all earthly reunions were
hey would be hoped, gather on the "immi-
hors" to part nevermore. As he recalled the
of his youth the speaker grew strong in his pa-
but now, he said, his aim was declining low-
the west; his career was nearly run. Still it
great pleasure to him to bring back the days
early experience. The trials he underwent as
intendent years ago were forcibly portrayed,
sketches were given of telegraphers who have
e prominent both locally and nationally. Al-
g to Prof. S. F. B. Morse, he said that he
ed it as one of the honors of his life that he
able to speak of him as his friend. Several
s of illustrious telegraphers were mentioned,
great enthusiasm was aroused by the name of
ran Orton. Said he, "Among the men who did
to elevate telegraphy to its present high stan-
the name of William Orton must always occu-
distinguished place. His is a name no man
an afford easily to forget. His life was a sacri-
e to work to which he gave only success and
tion."

present were greatly affected at the pathos of
Reid's concluding remarks.

e Chairman, after Mr. Reid had finished, feelingly remarked that as the Poet had the last reputation, it was in order to give the Exit "the big
of the horn." He, therefore, called upon Mr. Flanagan, of the *Utica Herald*, to explain how
e that his hair had turned gray.

Flanagan was equal to the occasion. He said
one of his gray hairs could tell a tale, and he

would tell the tale were he sure that the young men present would take warning thereby. Anyhow, he retorted, gray hairs at the meeting were no more prominent than bald heads.

Mr. N. Hecker, of Buffalo, and E. B. Wright, of Cleveland, made short speeches.

W. W. Smith, despite his native modesty, was forced, through the raillery of the Chairman, to make a speech. He, in response, gave some interesting reminiscences of telegraphy, paying a glowing tribute to that eminent telegrapher, now dead, James P. Leonard, of Louisville.

The memory of Mr. Leonard was dwelt in silence.

J. C. Mattoon, of Cincinnati, paid the compliment to Mr. C. Taylor, of Frankfort, Ky., as having originated the idea of the present reunion. A telegram was read from that gentleman expressing his regret at his inability to attend on account of family afflictions. In his telegram Mr. Taylor asked that the deceased old time telegraphers be remembered at the gathering. Mr. Mattoon offered a resolution expressing regret at the enforced absence of Mr. Taylor, which was adopted unanimously.

E. R. Gorton, of Cincinnati, gave a review of the history of the Western Union Telegraph Company. He gave also a humorous description of I. R. Elwood, otherwise and better known as "Uncle Ira."

The rest of the speeches were of an informal character, but all very interesting to those present as illustrating the difference between telegraphy of the present and of the old days.

The assemblage did not adjourn until an early hour in the morning.

The reunion in its entirety was a grand success, and the local Committee are entitled to great praise for their management.

a ready index of the commercial prosperity or otherwise of any country or even locality. It is usually the first affected whether for good or bad. The annual report of the New Zealand Telegraph Department, which, for the present occasion, covers a period of nine months only, owing to the termination of the financial year having changed from the 30th of June to the 31st of March, correspanding with that of the home Government, shows that whereas the revenue for the year was estimated at 80,000l. the nine months' receipts have produced but 53,314l. The value of Government telegrams transmitted during the year amounted to 10,797l. This with subsidies for special wires, private lines, and incidental receipts, brings the total earnings of the department up to 77,767l.

The gross earnings of the department for the year ending 30th March, 1879, were 112,832l. comparing this with the total receipts for the nine months of the present year, a falling off of something more than 20 per cent. is visible. This, it is remarked, is only to be expected during the commercial depression which has so strongly felt throughout the colony. It is, however satisfactory to note that the revenue is again on the increase, showing a revival of trade.

The total number of messages of all codes transmitted during the nine months was 1,058,909, being a proportional decrease, in comparison with the previous year, of 188,432.

For the first time for many years, expenditure of the department exceeds the revenue by 2382—not a very large sum, but still sufficient to mark the extent to which the general depression has affected trade. As this failure in revenue has, however, been very justly regarded as of a temporary character, it has not been thought desirable to in any way reduce the operations of the department, and consequently no change has been made in the office arrangements.

Comparing the number of telegrams transmitted with the number of letters posted during the same period, it appears that the proportion of telegrams to every 100 letters was 14.27 as against 19.64 for the previous year.

The number of money order telegrams dealt with during the nine months was 11,691, representing a value of 46,425l., again showing a slight proportional decrease in comparison with the preceding year, both in messages and value. Wellington stands first as having issued the largest number of orders; then Auckland, Dunedin, and Christchurch in the order named. Referring to a letter which appeared some time since in the London *Times*, describing the facilities afforded by the New Zealand Telegraph Department for the transmission of money, and suggesting that a similar system should be adopted by the English telegraph offices, it is observed in the report that "there is no reason why it should not be adopted wherever a telegraph system exists, nor is there any reason why the same facilities should not be afforded between foreign countries, or between colony and colony. There is no doubt that great advantage would be taken of such a system, while it would prove highly remunerative to the various telegraphic administrations." We fully endorse Dr. Lemon's observations on this subject. Why the British postal department should ignore the advantages of a system of money telegrams is inexplicable. There is no system better qualified for the transaction of such a business, and we hope soon to see it in operation. It is clear that its introduction would be an additional source of revenue to the Telegraph Department, whilst the slight loss which the Post Office Department would incur would be almost inappreciable. In the end it would prove a means of additional revenue to the State, and a great advantage to the mercantile community.

The railway telegraph system connected with the Middle Island railways, a department formerly independent of the Public Telegraph Department, has now been taken over by the Government department.

The system of "urgent" and "delayed" codes, adopted by the New Zealand colonies, now, some two years since, continues to increase in public favour. "The former is taken great advantage of during business hours by the commercial branch of the community, while the latter is made a circulating medium for advices by travellers and trade representatives, and for other matters where a night's delay is of no importance."

Since the 1st of April the word rate on all international telegrams has been introduced into New Zealand and on the Australian cable, but this system does not apply to the messages sent to spare places within the colony, nor to messages between New Zealand and the Australian colonies. During the year, 79 miles of line carrying 83 miles of wire were erected, together with some 800 miles of wire on previously erected poles. The total mileage of line is thus increased to 3038, and of wire to 3933. The number of stations open on the 31st of March was 214. The cost of maintenance per mile of line was 4l. 3s. 1d. for the nine months, against 4l. 9s. 9d. for the preceding year. The nominal strength of the department was 342, against 301 for the previous year. This increase is stated to be owing to the additional stations which have been opened chiefly in the North Island and eleven in the new cadetship, and to the enrolment of cadets, who are being trained for future service in the department. The duplex continues to work with increasing success, and is in use on No. 1 and No. 4 cables, 46 miles each; Wellington to Napier, 231 miles; Napier to Auckland, 349 miles; Wellington to Auckland, 640 miles; Christchurch to Dunedin, 215 miles; with other wires of less length. The new cable from Wanganui to Wakapuaka (the New Zealand terminal station of the Australian cable) was successfully laid and completed on the 13th of February. The total length of this cable is 105.09 knots, and the contract price 24,500l.

Sanitary Amendment Act, 1880

Alarm Telephones.

A Chicago police officer suggests the addition of telephone boxes to the system of alarm telegraphs in use in our cities. In connection with the alarm a reserve force is to be maintained at the stations with wagons and ambulances, and all the paraphernalia necessary for riot or accident. Should a fire, a murder, robbery, or any other crime, the perpetrators of which have escaped, the alarm is to be given to every man in the district by sounding a large bell, which is to be placed upon the roof of the station. Upon hearing this, every officer on duty is to run to the nearest telephone box and correspond with the station; and it is also proposed that they report by the same means every hour, whether anything occurs on their beats or not.

Sanitary Amendment Act, 1880

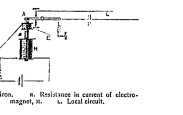
COLONIAL TELEGRAPHS.

The extent to which the recent depression in trade has proceeded may be judged by the fact that in New Zealand, business as exemplified by the telegraph service of that colony, has been affected fully as much as in England. The telegraph service in

VYLE'S RELAY.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In your last issue, November 15th, a description is given of a new form of relay, invented by Mr. C. C. Vyle, of the Postal Telegraph Department, the idea conveyed being that this form is quite original. Will you allow me to point out that this is scarcely correct, as two years ago I constructed a relay on the same



A. Soft iron. B. Resistance in current of electro-magnet, 80. C. Local circuit.

principles, and worked it on two circuits of 300 and 500 miles respectively, where, for a roughly-made apparatus, it worked exceedingly well, both single and double current. I may mention that the receiving coil was a small one of not more than 20 ohms resistance, showing the extreme sensitiveness of this system. I beg to attach sectional view of the relay, the only distinction between this and Mr. Vyle's being the substitution of electro for permanent magnet.

I am, Sir,
Yours truly,
W. BOLTON.

22, Athelstane Road,
N. Bow, E.

GILBERT'S NEW TELEGRAPH WIRE BINDER.

THE main objects of this Wire Binder, the invention of Mr. Gilbert, of the Dundee and Arbroath Joint Railway, are:—

1st. To facilitate the erection and taking down of telegraph wires.

2nd. To reduce friction at the insulators, and the consequent breakages of the wires which occur with the ordinary wire binder.

3rd. To reduce surface contact of wires with insulators, and thereby to diminish the leakage of current in damp weather.

As will be seen from figs. 1 and 2, which represent respectively the elevation and plan of an insulator with the new binder attached, the latter is of a bow shape. It is constructed of malleable iron, and has its free ends hooked so as to embrace or grip the wire some inches on each side of the insulator. It can be applied to any insulator having a side groove, and by the most inexperienced workman in a few seconds.

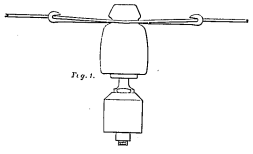


Fig. 1.

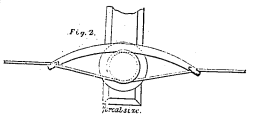


Fig. 2.

Digitized by the Internet Archive in 2011 with funding from Kahle/Austin Foundation

M. Wilde a fait usage d'une disposition qui avait été déjà proposée et dont le principe a été appliqué sous diverses formes pour des relais de courant; je ne sais trop quel en est le premier auteur, mais je sais au moins certain que M. Tommasi l'a utilisée presque sous la même forme que M. Wilde dans le relais qu'il a combiné il y a quelque temps. Elle consiste essentiellement en une aiguille aimantée, mobile sur un axe entre les deux pôles contraires d'un électro-aimant, assez-el ayant une dimension aussi grande que la longueur de l'aiguille. Cet agencement avec la disposition que lui a donnée M. Wilde est représenté ci-contre figure 2 en élévation et plan. En regardant le plan on voit que, en supposant que le pôle A de l'aiguille soit Nord et le pôle B de l'électro-aimant Sud, l'aiguille a quatre raisons pour occuper la position AB. Le pôle A est attiré par R, repoussé par S, le pôle B est repoussé par R et attiré par S. Si les pôles de l'électro-aimant viennent à changer, sous l'action de quatre forces analogues, l'aiguille prendra la position CD. Or, les courants qui viennent des bobines d'induction et que la chef Morse envoie dans la ligne étant sans cesse inversés, il s'ensuit que l'aiguille pendant leur passage est animée d'un frémissement qui donne lieu à un bruit très-distinct. Les signaux employés suivant l'alphabet Morse, c'est-à-dire composés de points et de traits, sont donc transmis sous forme de bruits continus, de durée différente, très-faciles à reconnaître.

A bien étudier ce système, on trouve quelques objections qui ne sont pas sans importance, celle-ci par exemple : en supposant au poste central disposé comme il vient d'être dit, comment fera pour répondre le poste correspondant qui ne possède pas de machine génératrice? Il y a des moyens sans doute; il peut répondre avec les courants même de poste central; il peut faire usage d'une bobine de Ruhmkorff, etc.; ces questions accessoires demandent un complément d'étude; mais on peut reconnaître dès à présent au système des qualités très-intéressantes; la disposition est nouvelle, au moins comme réalisation, car je ne sais pas sûr que l'idée n'ait pas été émise déjà. (Mais quelle idée n'a pas été émise depuis quelque temps?) Il y a là un emploi divisé d'une force unique qui semble susceptible d'être très-utile, et cela à l'aide de moyens excessivement simples et peu coûteux.

Je n'espère pas beaucoup voir le système essayé en France où tout serait perdu si l'employé et non l'appareil écrivait les dépêches sous la dictée de l'électricité, mais nous le verrons peut-être appliqué ailleurs avec succès.

FRANK GERALDY.

L'ÉLECTRICITÉ A LA GUERRE

2e article (voir le numéro du 15 septembre 1880).

Les applications de l'électricité à la marine qui me restent à citer sont de moindre importance que celles que j'ai énumérées et d'ailleurs moins strictement limitées à l'action militaire.

C'est d'abord le système entier des sémaphores, stations installées sur le rivage en des points élevés et susceptibles de communiquer par des signaux visibles avec les navires en mer et par des fils télégraphiques avec les ports voisins. Ce réseau actuellement fort utile à la marine marchande, a été dans l'origine constitué afin de pouvoir correspondre sans cesse avec les navires de guerre chargés de croiser le long des côtes.

Je cite particulièrement le sélénitère électrique permettant de déterminer constamment de la terre la position d'un navire en marche; c'est un organe indispensable dans la défense des côtes, spécialement avec les torpilles. Plusieurs systèmes sont employés dans les divers pays. La *Lumière électrique* (1er janvier 1880) en a décrit en très-bons termes dû à M. Legaz-ary de Tromelin.

Il est bon de discuter ici un emploi en projet qu'on a proposé des appareils électriques pour le soulage (il y en a plusieurs systèmes dus à MM. Heidein, Siemens), pour la mesure de la vitesse d'un navire en marche (loch électrique de MM. Leupe et Koch de Legeazeau, etc.) pour le lancement des navires. Toutes ces applications sont aussi utiles dans la paix que dans la guerre et je ne dirai pas un mot ici à leur sujet. Pour la même raison je n'insiste pas sur l'emploi de la lumière électrique dans les travaux sous-marins et sur l'application qu'on en a faite pour rendre lumineuses les boules placées en mer.

Je dirai quelques mots de l'essai du téléphone qui a été fait à Cherbourg. On l'a employé pour mettre en correspondance la digue et les divers forts isolés en mer avec la terre ferme; les résultats ont été très-satisfaisants et si je suis bien informé la communication subsiste, et reste en usage. On a proposé de se servir du même moyen pour relier entre eux les navires d'une escadre au mouillage; mal douté que le procédé ne réussisse si l'on juge utile de l'employer.

Je laisse complètement à part la question de l'éclairage électrique des phares, elle ne tient que de loin à la guerre et, d'ailleurs, elle vaut une étude moins rapide.

Les applications de l'électricité dans l'art de la guerre terrestre sont peut-être moins nombreuses, mais elles sont d'une sérieuse importance.

Pour simplifier, je passe d'abord en revue celles qui ont le moins d'intérêt.

Comme dans la marine, on a employé l'électricité pour produire l'inflammation de la poudre, mais avec moins de suite et de généralité. La précision absolue dans l'envoi d'un coup de canon ou de fusil n'a pas la même importance sur terre que sur un navire sans cesse en mouvement; d'autre part, il est extrêmement incommode et difficile de charger les soldats d'un matériel électrique compliqué, tandis que, sur mer, un cela du navire peut le tenir toujours à portée. On a cependant fait quelques essais, pour les fusils on peut citer deux systèmes déjà anciens dus l'un à M. Baron, l'autre à M. Martin de Brettes; le premier se servait d'une bobine d'induction et envoyait une étincelle dans la cartouche, le second employait une petite pile de quantité renfermant un fil de platine. Tous deux renfermaient les organes nécessaires dans la crosse de l'arme. Ces essais n'ont pas eu de suite.

On emploie fréquemment l'électricité au tir des mines;

A NEW RELAY.

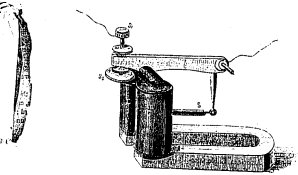
THE relay, a drawing of which is given below, is the invention of Mr. C. C. Vyle of the Postal Telegraph Department, London, and is really an adaptation of the principle used by Professor Hughes in the electro-magnet of his type-printer, though we believe the inventor was not aware of this fact for some time after his idea had taken practical shape.

In its appearance and build it is certainly not suggestive of the great delicacy which it undoubtedly possesses, as proved by exhaustive comparative trials with Post-office Standard Relays, and in actual working upon some of the longest and lightest circuits in the United Kingdom.

With slight alterations in the adjustments it is also claimed to work well as a direct double current sounder, and satisfactorily so in all weathers.

The general construction is as follows :—

An ordinary horse-shoe magnet, N, is laid horizontally beneath the base of the instrument, each leg of



the magnet being fitted with a cylindrical soft iron core-section which rises perpendicularly through the base and goes to form the cores of the electro-magnet, c, c. The coils of the electro-magnet are wound differentially to 200 ohms each, and may therefore be worked singly or duplex. At one end of the lever, f (which works in jewelled bearings), and immediately over the cores, is fixed a soft iron armature, a, which is attracted by the induced magnetism of the cores.

Towards the opposite end of the lever is attached a spiral spring, s, and adjusting screw, by means of which the force of the magnetised cores over the soft iron armature may be varied or counteracted as circumstances require. Still nearer this end of the lever are the limiting stops, s_1, s_2, inserted in the usual way.

The most delicate adjustment of the relay is said to be arrived at when the tension spring just balances the attraction of the cores and the lever lies indifferently in either position, and when the limiting stops are just sufficiently apart to break contact and prevent ill effects from the spark from the local battery.

For sounding purposes, the stops of course require opening out considerably.

From the foregoing it will readily be understood that if a current be sent through the coils tending to strengthen the polarity already induced in the cores by the permanent magnet, the soft iron armature will be drawn to or retained upon the cores against the tension of the spring ; if, however, the current should be in such a direction as to tend to neutralise the existing polarity, then the attractive power will be lessened and the spring will do its work by drawing up the lever to the top stop.

The relay, when well made and well adjusted, will give good signals with one Daniell cell working through a resistance of 10,000 ohms, and if the latter be all removed the relay will still respond properly without requiring to be re-adjusted ; this is a great point.

Although Mr. Vyle may not have discovered any new principle in his relay, yet he has certainly shown that there are still some old ones to be worked out.

until the commutator brushes are moved, so as to reduce the exciting current, and consequently diminish the current in the lamp circuit. Should the current diminish beyond the normal strength the armature is released, the spring moves the scale upper ratchet wheel, when the result will be opposite to that just described.

The incandescent lamps, in connection with which this regulator is more especially intended to be used, are connected in multiple arc ; that is, they are connected across two parallel wires, so that the current is divided up between all of the lamps in the same circuit. Now, it is obvious that, when a number of the lamps are removed, the current would, under ordinary circumstances, be much stronger in the lamps that are allowed to remain in the circuit, but when the regulator is applied there is no perceptible difference in the light given out by the lamps, whatever may be the number in circuit.

As many as 64 lamps have been brought up to over 30 candle-power each in a single circuit by one large machine, and the lamps have been removed from the circuit until only one remained and then all replaced, the regulator meanwhile adapting the current perfectly to the widely varying conditions.—*Scientific American.*

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XXI.

THE UNIVERSAL BATTERY SYSTEM.

WITHIN the last two years the system of working several circuits from one set of batteries has been revived with great success. This system, which was tried many years ago, appears to have failed on account of the unsubtleness of the batteries employed for the purpose, and also, no doubt, on account of the imperfect state of the insulation of the lines at that period, which rendered heavy battery power necessary for working a single line when the weather was bad and leakage considerable. At the present time, when the lines are kept in a high state of efficiency, the Universal system is entirely successful and economical.

The possibility of the Universal system is dependent upon the fact that when a battery has a low resistance the connection to it of several lines of equal resistance reduces the *total* resistance in the circuit of the battery nearly in direct proportion to the number of lines connected up, and as this reduction of resistance increases the amount of current flowing out of the battery proportionately, the total amount of current when split up amongst each of the lines gives to each a current of nearly the same strength as that which would be obtained on a single line connected to the same battery. If we suppose the current from the battery with one line connected to it to be 1, then 1 will be the current working the line. If now we connect two lines to the battery the resistance in the circuit of the latter becomes halved, consequently the current

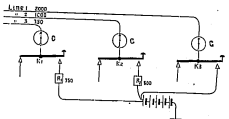


FIG. 70.

flowing out will be 2, and half of this will flow through each line—that is to say, there will be a current equal to 1 flowing through each. Similarly, if we have three lines, the current out of the battery will be trebled, and a third of this, or a current equal to 1, will flow through each line, as at first.

If the resistance of the battery were equal to 0, then no matter how many lines of equal resistance we added on, the current through each would still remain the same. But it is, of course, impossible to get a battery of a resistance equal to 0 ; as long, however, as the joint resistance of all the lines is not *less* than the resistance of the battery, the current flowing through each line will not be very much less than that which would flow through a single line, supposing the latter were the only one connected to the battery. In fact, so long as the joint resistance of all the lines worked from the battery is not less than the resistance of the battery, then no matter how many lines we connect to the

particular with, and are in form similar to, the vibrations of ordinary matter when transmitting the same sounds. Indeed, the mathematical expression of the electric current at any point of the telephone wire is the same as the mathematical expression of the movement of the air at any point outside the telephone. Without studying the use of the words, we may say that the currents in the telephone wire transmit sound in the same sense that the movements in the air around us transmit sound. In the case of writing telegraphs and printing telegraphs the case is very different; the electrical effect on the wire have no similarity to or other than a wholly conventional and artificial correspondence with the form or printed character."

At the conclusion of the reading of the evidence it was agreed between the counsel counsel on both sides that there should be an cross-examination of the witnesses, who were thereupon released from further attendance.

(To be continued.)

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XXIII.

THE WHEATSTONE AUTOMATIC SYSTEM.

THIS important instrument is now very largely used in the United Kingdom for the transmission of ordinary and press message work over the main trunk wires, and also at rare nuncliups where a large amount of work is required to be done in a short time; indeed, without the help of the Wheatstone instrument it would be impossible to transmit, without heavy delays, the large amount of work which has daily to be carried on. At the present time over 170 automatic instruments are in daily use, working up to a speed, in some cases, of 250 words a minute. At present this rate of working is found sufficient for all purposes, but there is but little doubt that a much higher speed can be obtained if necessary; indeed, a speed of 250 words has actually been attained between London and Glasgow with the existing form of apparatus.

The Wheatstone apparatus consists of three parts, *viz.*, the *punches*, the *transmitter*, and the *receiver*. The former is employed for preparing a slip of paper for transmission through the transmitter, and it is worked either by direct blows or by pneumatic action controlled by finger keys.

To understand thoroughly the action of the apparatus it will be convenient to consider first its general principle.

Fig. 86, represents a facsimile of the punched paper strip for the transmitter, and the corresponding slip with the recorded signals as it passes out of the receiver.

On the punched paper strip there are three rows of holes; the holes in the centre row are equidistant, and are for the purpose of enabling the paper slip to be drawn forward at a uniform rate through the transmitter. For this purpose the latter is provided with a small star wheel turned by perforations in the slip, and drive the latter forward by a rack and pinion movement.

The upper and lower sets of perforations, which are rather larger than the middle row, are for the purpose of controlling the currents sent out by the transmitter.

Figs. 87, 88, 89, represent the controlling mechanism in the transmitter.

c_1, c_2 are two bell-crank levers, pivoted at the angles and connected to the zinc and copper poles respectively of the battery. The spiral springs, s_1, s_2, make of stiff brass wire, tend normally to pull the two longer ends of the levers together; the inside part of these ends are faced with platinum and between them are two platinum pins, p_1, p_2, fixed to the disc, b.

Referring to fig. 88, it will be seen that if the two platinum faced ends of the levers could both rest at the same time against one or other of the pins, p_1, p_2, that the battery would be short circuited; this is prevented by means of a small screw, a, which is screwed through the end of the lever, c_1, and whose end touches against a small piece of ebonite, e, fixed in the end of the lower lever, c_2. The screw, a, is so adjusted that the distance between the two platinum faces is rather greater than the diameter of either of the pins, p_1, p_2; thus the circuit of the battery cannot be closed through either of the pins.

The disc, b, is divided into two halves insulated from each other, so that the pin, p_1, is insulated from the pin, p_2. The disc is axed behind at its centre so that it can rotate through a small angle to the left or right as required. A steel tail piece projects from the top and bottom of the disc, and against the top one a locker wheel, r, set at the end of a spring, presses; the object of this wheel is to keep the disc firmly in either of the two extreme positions it may assume—that is to say, with the top tail piece against either the left or right-hand stops between which it plays.

It will be noticed that when the disc is in the position shown in fig. 87 that the copper pole of the battery is connected to the pin, p_2, and the zinc pole to the pin, p_1. When the disc is rotated until the top tail piece comes over against the left-hand stop pin, as shown in fig. 89, then the zinc pole is connected to pin, p_2, and the copper pole to pin, p_1; thus the right and left-hand movement of it reverses the battery relative to the pins, p_1 and p_2, that is, relative to the two insulated halves of it. The "Up" line being connected to the right-hand half of the disc, the rocking of the latter connects the zinc and copper poles alternately to it.

Y is an ebonite beam which is caused to rock at its centre by means of the train of clockwork which drives the star wheel before referred to. The beam is provided with two platinum studs or pins, p_3, p_4, the left-hand one of which is connected permanently to the "Down" line. These two pins normally press against two bell-crank levers, a, b; the horizontal arms of these levers are pulled upwards by means of the springs, s_3, s_4.

The levers being hinged directly on to the frame of the apparatus are in electrical contact with one another.

To the crank, a, a rod, n, is hinged, whose end passes through a hole in the tail piece, r. A small collet, n', is screwed on to it, which, when it is moved to the right by the action of the crank, a, presses against the tail piece, r, and rotates the

A NEW RELAY.

THE relay, a drawing of which is given below, is the invention of Mr. C. C. Vyle, of the Postal Telegraph Department, London, and is really an adaptation of the principle used by Professor Hughes in the electro-magnet of his type-printer, though we believe the inventor was not aware of this fact for some time after his idea had taken practical shape.

In its appearance and action it is certainly not suggestive of the great delicacy which, in reality, it possesses, as proved by exhaustive comparative trials with post office standard relays, and in actual working upon some of the longest and heaviest circuits in the United Kingdom.

With slight alterations of the ordinary form it is also claimed to work well as a sounder double current sounder, and satisfactorily as in all other matters.

The general construction is as follows:—

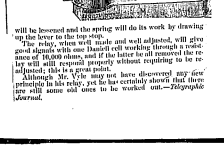
An ordinary horseshoe magnet, M, is laid horizontally beneath the base of the instrument, each leg of the magnet being fitted with a cylindrical soft-iron electromagnet which rises perpendicularly above it, the two cores being so fixed to form the cores of the electro-magnet, C, C. The coils of the electro-magnet are wound differently to 200 ohms each, and supply, therefore, he needed double or duplex. At one end of the lever, I (which works on a knife-edge bearing), and immediately over the cores, is fixed a soft iron armature, a, which is attracted by the induced magnetism of the cores.

Toward the opposite end of the lever is attached a spiral spring, S, and adjusting screws, by means of which the force of the magnetism across over the soft iron armature may be varied at pleasure. These screws, s_1, s_2, work against stops, S_1, S_2, insulated from the lever are the limiting stops. S_1, S_2.

The most difficult adjustment of the relay is said to be arrived at when the armature, a, is adjusted sufficiently close to the cores and the lever long enough to give sufficient position, and when the limiting stops are set sufficiently apart to break contact and prevent the spring from the stuck from the local battery.

For sounding purposes, the stops need course, require opening out considerably.

From the foregoing it will readily be understood that if a current be sent through the coils tending to strengthen the polarity already induced in the cores by the permanent magnet, the soft iron armature will be drawn to or attached upon the cores against the tension of the spring; if, however, the current should be in such a direction as to tend to neutralize the existing polarity, then the attractive power



will be lessened and the spring will do its work by drawing up the lever to the top stop.

The relay, when well made and well adjusted, will give good signals with one Daniell cell working through a resistance of 10,000 ohms, and if the latter be all removed the relay will still respond properly without requiring to be readjusted; this is a great point.

Although Mr. Vyle says he has certainly shown that there principle in his relay, yet he has certainly shown that there are still some end ones to be worked out.—*Telegraphic Journal.*

Scientific American.
NEW YORK, SATURDAY, MARCH 19, 1881.
Scientific Progress in England, &c.

Lecturing recently on "Electricity and the Electric Telegraph," at Kensington, Mr. Robert W. Johnson, Postmaster of the Eastern Central or "City" district, quoted some of the statistics of the Postal Telegraph system, which are interesting and instructive at the present moment. He showed that whereas the earliest telegraph of which we have any account required a separate wire for each letter of the alphabet, and that in the first really practical telegraph two wires were necessary for the transmission of a single message, as many as four messages can now be sent on a single wire at the same time—that the 6,000,000 telegrams forwarded by all the companies in their palmiest days had increased to more than 31,000,000 forwarded by the Post Office last year, and that whereas it might be transmitted when the charge for a message from Edinburgh to London was something like 12s. 6d., it was now possible to telegraph from Selby to Shetland, or from Jersey to John o'Groat's for 1s. Fifty thousand miles of wire in 1870 had increased to considerably more than 100,000 in 1880; 2,200 instruments worked by all the companies had increased to nearly 9,000 worked by the Post Office; and 2,500 telegraph offices under the old régime had increased to more than 5,500 under the new. Four thousand persons of all classes employed by the companies had increased to nearly 12,000 employed by the Post Office, and of these about 1,000 were women, of whom 600 are employed in the Central Telegraph Office alone. As to the transmission of news for the press, the Post Office had converted into an attractive monopoly what used to be a rather repulsive combination on the part of the old telegraph companies, and on one occasion quite recently as many as 7,000 words, equal to 28 average columns, had been transmitted from the Central Office alone. The former, which was of a thoroughly popular character, was illustrated by specimens of most of the instruments in use by the Post Office, as well as by a working model of the pneumatic tube system, telephones in circuit, and some minor experiments with the electric light.

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THE ENGINEERING AND MINING JOURNAL.

extent of

OCT. 8, 1881.]

Dynamo-Electric Machines in Telegraphy.—About a year since, the officers of the Western Union Telegraph Company introduced the use for telegraphing of currents generated by machines instead of batteries, and thus realized a very important step in advance. Now Herr Joseph Kraemer, of Vienna, comes forward in the *Elektrotechnische Zeitschrift* with a claim that he successfully employed the currents obtained from a Gramme dynamo-electric machine for telegraphy as early as 1876.

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...n Journal of Chemistry
AND
...PULAR SCIENCE REVIEW.

BOSTON, MAY, 1881. NUMBER 5.

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in all parts of the country, and the call for the appliances for this method of lighting is far beyond the ability of manufacturers to supply.

Twenty years ago the only available agent for the supply of explosive force was gunpowder. The army of miners and excavators, employed in digging for the precious metals or in cutting through mountains for railroad transit, felt the need of some more effective and powerful agents to tear the rock masses asunder; but it was not until some accidents on shipboard startled the world by the terrific nature of the explosions that it was known that chemists had discovered nitro-glycerine, an agent possessing a force ten times greater than gunpowder. This substance has now almost entirely displaced gunpowder in all great mining and engineering works the world over, and it would be difficult to dispense with it as an article of every-day use for many purposes.

Nickel is a metal long known to chemists and metallurgists; but it was regarded as exceedingly unpromising in its industrial applications, and treated with neglect. It is less than a score of years since one of its salts, the double sulphate, was prepared, and from its solution the bath which made possible the deposition of the metal by the electric battery. This despised metal is now of inestimable value, as it affords a surface more beautiful and enduring than silver on implements and utensils of the widest range.

The discovery by Bessemer of a cheap, quick method of making steel is quite recent, and yet we know that it has revolutionized track construction on railroads. No road with any considerable amount of traffic can afford to use iron rails; and, indeed, so important is this discovery that it would be impossible to pay dividends on most roads without an increase of traffic rates, if iron alone was used. Steel, by the Bessemer method can be made as cheap as iron, and the difference in price is now inconsiderable.

In agriculture the discovery of the mineral food of plants led to the discovery of the vast beds of phosphatic rocks in the ancient sea-basins of Charleston, S. C., and an industry was developed which is of great magnitude and importance. We could greatly extend the list of important discoveries and inventions which have been made within the memory of most persons of adult age, all of which have given fortunes to the parties interested in originating and developing them. The slow appreciation of new discoveries in a former age has passed away, and no longer do the many decades of years elapse before they are turned to practical account.

Henry discovered the electro-magnet in 1819, and it was not until 1844 that it was utilized in the construction of the telegraph. Faraday discovered electro-magnetic induction in 1831, but it was not until 1851 that a practical dynamo-machine was made of small dimensions. Since 1850 the world has progressed with giant strides in the practical application of the results of scientific discovery, and it is probable that no diminution of interest will be experienced in the course of the centuries which are to come.

A RAPID TELEGRAPH.

"As quick as a flash" is a familiar expression used to denote instantaneous action, and practically we may consider the action of electricity as instantaneous. It is claimed that on a single telegraphic wire between this city and New York over 500 pulsations per second are transmitted and received. The pulsations of light waves in the luminiferous ether can alone be compared with it.

It is also claimed that a speed of 1000 words per minute has been attained on regular work, by the American Rapid Telegraph Company, whose office is in Devonshire Street, in this city. Upon calling at the office, Mr. Pettangill kindly explained the apparatus and its workings to us, and we will attempt to describe it for the benefit of our readers.

The method employed for transmitting messages is that known as the "rapid system." The messages are first prepared by the use of perforating machines, operated by a key-board, and made to puncture two lines of perforation in a narrow strip or ribbon of paper. Upon the perfection of these machines, which are the invention of Mr. Frank Anderson, of Peekskill, N. Y., the success of the system largely depends. Although of very complicated mechanism, any person can operate them at sight, and with a few week's practice can prepare messages for the transmitter with the same rapidity that messages are sent by the Morse system, and with far less liability to error.

This perforated ribbon is then used as a stencil in the transmitter, every puncture appearing as a dot or dash on the chemically prepared paper at the other end of the line. This method of automatic telegraphing is not new, but it was found that a limit to the speed of sending signals was soon reached, owing to the line becoming "clogged" or surcharged either with the battery current or an earth current. In other words, when a current of electricity is sent over a long wire for a very short space of time, say the one hundredth part of a second, it does not all leave the line at the other end within that space of time, and a discharge continues at the receiving end of the line after the battery circuit has been completely broken at the transmitting end, so that the next impulse sent over the line overtakes the first one. The result is a long or indistinguishable dash or line. To obviate this difficulty Messrs. Foote and Randall, in 1874, conceived the idea of employing a second current of opposite polarity to free the line and cut off each dot or dash quickly and sharply. In 1876, these gentlemen farther improved their process

Menlo Park Scrapbook, Cat. 1040

No. 26. "Telegraph Construction"

This scrapbook covers the years 1873-1881. The book contains clippings relating to the construction of telegraph lines, the management and financial condition of telegraph companies, and foreign telegraph development. There are 132 numbered pages.

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Telegraph Construction

Lines N.Y.

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NEWARK INK MANUFACTORY & BLANK BOOK MANUFACTORY,
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FIRST CLASS BLANK BOOK MANUFACTURERS.
LITHOGRAPH CHECKS, BONDS, NOTES, &c.

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Tel Journ Feb 15, 1878

"515. "Improvements in telegraph posts, and in the method of fixing the same."—J. M. Newman, dated, Feb. 7, 1877. 6d. This consists in forming light and strong telegraph posts by driving two uprights of angle or trough iron into the ground, a short distance apart, and tying them together at the top by cross bars, provided with holes for the reception of insulators. In soft ground, the base of the poles in the hole is filled round with concrete, cement, or asphalt.

522. "An improvement or improvements in fixing the insulators of electric telegraphs."—J. H. Coxeaxe, Feb. 7, 1877. 6d. By this plan the bolt supporting the insulator is formed with a screw thread at its end, and screws into the insulator, a washer of india-rubber or other yielding material being placed on the screwed end of the bolt so as to be compressed between the insulator and the shoulder on the bolt, when the insulator is screwed home. This serves to keep the insulator tightly on. The insulator may be readily removed by unscrewing.

Tel Journ Aug 15. '3

"512. E. A. Merrill, East Lyme, Connecticut. *Insulator for telegraph lines.* Dated October 19, 1877. The telegraph wire is confined in a curved groove in the top of the glass insulator, and a glass cap held in position by a screw bolt secures the wire in its position.

Tel Journ Mar. 15, '78

DANGER FROM OVERHEAD TELEGRAPH WIRES.

On the afternoon of the 12th instant a singular accident happened in Farringdon-street. Charles Holmes, a coalman, was driving a hansom cab, and, when near the Viaduct, one of the Post-office telegraph wires passing over the road snapped, and fell about the horse's head and body. The animal took fright, and bolted for some distance down the road, until it got entangled in the wire in such a manner that it was thrown completely over. It was with great difficulty that it could be extricated, and it was then found to be so severely injured that it will probably have to be killed. The driver had a narrow escape.

A similar accident occurred about the same time in St. Bride-street. A telegraph wire broke, and a hansom cab driver was caught round the neck by the broken wire, but fortunately he was not injured.

Another accident of the same kind in Islington was unhappily fatal. A Brompton omnibus, after finishing its journey at about five minutes past two o'clock, pulled up as usual at the York Hotel, and one of the horsekeepers, named William Stevens, was driving it to the stables when a telegraph wire was blown away, and it felt round the poor fellow's neck, and nearly cut his head from his body. Mr. Incle, and nearly cut his head from his body. Mr. George Born, of Colebrooke-row, promptly attended, but death took place before his arrival. The body was conveyed to the stables prior to removal to the parish mortuary to await the coroner's inquest.

Sir William Fothergill Cooke, who constructed the first telegraph line in England in 1838, is dead, at the age of 72. The line in question extended from Paddington to West Drayton, and the man-

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Tel Journ July 15, '3

PHOSPHOR BRONZE WIRE, AND ITS APPLICATION TO TELEGRAPHIC PURPOSES.—It has long been the aim to produce a wire which possesses greater conductive capacities than the ordinarily used iron wire, and of greater strength than copper wire, which, by its soft and ductile nature, requires—except for short lengths —to be supported. A combination which unites a compound wire is largely used, as called for in the laying mode of steel wire covered with a sheathing of copper, the strength being regulated by the thickness of the steel, and its conductivity by the thickness of the copper covering. The manufacture of this wire, however, requires the utmost care in order to enclose the steel wire perfectly. A slight defect permits moisture to enter between the two metals, galvanic action sets in, and the wire corrodes. Messrs. C. J. A. Dick and G. A. Dick undertook a series of experiments with wire drawn of phosphor bronze, and the tensile strength these gentlemen obtained with this material led them to experiment also on the respective capacities of these wires (of varied compositions) for conducting electricity. Compared with iron wire, phosphor bronze wire showed more than double its tensile strength, and about three times more its conductive capacity. As to the metallurgical treatment of the metals composing the wire, they say:—"Phosphor is added to either zinc or carbon,—the former by the oxidation which takes place whilst the metal is in fusion, as the carbon which is left from the melting process,—although contained in but very small quantity in the wire, nevertheless materially affects its qualities, and is particularly detrimental to its strength and elasticity; they therefore add an oxidising agent, if necessary, to reduce the carbon, and then a sufficient amount of reducing agent, such as phosphorus. Wire drawn from such metal will be found to be tougher and more elastic than wires formed of metal containing oxides or carbon; but yet greater strength and elasticity is obtained with alloys of copper and tin which are phosphoried, or, in other words, which contain a given amount of phosphorus. Although the conducting capacity is somewhat impaired by the presence of phosphorus, the following proportions of the metals may be made when used within the following specifications:—(1). When not more than 2 per cent of tin is used, the component quantity of phosphorus may amount to not more than 0·5 per cent. (2). When not more than 4 per cent of tin is used, the component quantity of phosphorus may amount to not more than 0·3 per cent. (3). When 5½ per cent of tin is used, the component quantity of phosphorus must not exceed 0·235 per cent.

Tel Journ Aug 1. '8

TELEGRAPH POSTS IN JAVA.

THE supports used for carrying the system of telegraph wires through the Island of Java merit a short description.

These are formed of the trunk of a tree known as the "Kayee" tree, which derives its name from a species of short fibred cotton which it produces. This tree possesses the two following advantages, which fit it admirably for the purpose. In the first place, when a tree is cut down, and the upper or branched part cut away, it possesses such an amount of vitality, that when placed in the ground it will at once form new roots and branches, thus effectually protecting it from the ravages of the white ants who would soon make very short work of an ordinary telegraph post. Secondly, the branches always speculating out horizontally never come in contact with the wires or insulators.

Another advantage lies in their elegant appearance as contrasted with a similar number of bare poles.

When once planted, probably no further attention would be necessary, and unless blown down by a gale (which their form would render unlikely) or damaged by lightning, they would last for very many years.

The traffic receipts of the West-coast of America Telegraph Company for the four weeks ending April 8 were at 408 per dollar, £1,499.

The report of the Eastern Telegraph Company for the half-year ended 31st March last shows a balance of £99,136, which with £22,580 brought forward, leaves available for distribution £121,122. The preferential and debenture interest absorbed £7,639, the interim dividend already paid £46,112, and it is now proposed to pay a further dividend of 2s. 6d. per share (making 5 per cent. for the year), and carry £22,179 to the reserve fund, which is thus raised to £185,565.

The traffic receipts of the Western and Brazilian Telegraph Company Limited for the month of June were £9,623 against £9,088 for the corresponding month of last year. It is stated (July 3) that the interruption between Bahia and Pernambuco does not interfere with the traffic to the Brazils and South America generally, as messages are sent over land lines between those places without extra charge and without delay. The repairing ship has left to restore communication. The cable was interrupted in shallow water.

The first annual report of the magnetic observations at the new observatory of Zi-ka-wei, in China, has lately reached Europe. An account of the result obtained—which are of considerable interest to those engaged in the study of terrestrial magnetism—is furnished by Father Perry to *Nature* (June 29).

The number of messages passing over the lines of the Cuba Submarine Telegraph Company Limited during the month of June was 2,539, estimated to produce £2,600, against 2,491 messages, producing £2,490, in the corresponding month of last year. The traffic receipts for the month of April, estimated at £2,500, realised £2,991. The half-yearly report of the same Company recommends a dividend at the rate of 7 per cent. The sum of £5,623 is placed the reserve fund, increasing it to £12,000, and £1,439 remains to be carried forward to the next account. The Report adds, that the Company's lines have continued in good working order, and that no interruption of importance has occurred on the lines of contiguous Companies.

The Directors of the Anglo-American Telegraph Company have resolved, after receiving £30,000 for the renewal fund, to declare an interim dividend, for the quarter ending June 30th, of 1½ per cent. on the Consolidated Stock, and of 3½ per cent. on the Preferred Stock, both free of income-tax, payable on the 1st August, leaving a balance of £12,000 to be carried forward to next quarter's account.

The traffic receipts of the Great Northern Telegraph Company for the month of June amounted to 365,428 francs, as against 390,076 francs in the same month last year. The total traffic receipts from 1st January to 30th June were, this year, 2,239,397 francs; last year, 1,933,269 francs.

The traffic receipts of the Direct Spanish Telegraph Company for June were £541 10s. 11d., against £1,464 3s. 2d. in the corresponding period of last year.

THE TELEGRAPHIC JOURNAL.

Vol. I.—No. 15.

WOODEN TELEGRAPH POLES.

By E. T. BOLLS, Assoc. S.c. Tel. Engineers.

THE importance of a proper selection of this article for the construction of telegraph lines cannot but be admitted, and yet the subject in practice does not appear to receive the consideration it merits.

The introduction of the "creosoting" process has no doubt been a great step in the right direction, yet even here there is certainly room for improvement. It is a plan that doubtless, under certain conditions, answers almost every purpose, but these conditions are not always fulfilled. A "creosoted" pole is by many accepted as representing *no fell wrought*, in respect of nearly everlasting preservation. This is not necessarily so. The repetition of "creosote" included to the cubic contents of the timber, the description of wood selected, and the quality of the creosote itself, are all points of chief importance to the life of a pole, but are frequently disregarded. Experience has shown that those woods which of themselves are the most lasting are least adapted to the creosoting process, as from the presence of their fibre it is impossible at any ordinary pressure to saturate them with the antiseptics. I have had to renew creosoted poles less than ten years old, where well grown spruce had been set, and the remains of these poles clearly showed that their early decay was due to the creosote having been unable to penetrate to a sufficient depth. At the ends the wood remained sound for some distance, for here the creosote had forced its way up through the capillary tubes of the wood, as well as from the surface; but as the longitudinal distance increased, the "creosote" was found only in the less dense sapwood, having failed to enter transversely the older and more solid heartwood; consequently except at the ends, and for a distance of about three inches from the pole, the wood showed no trace of creosote, and was more or less decayed. Evidently, then, where poles are to be creosoted, it is better and generally cheaper to select soft woods; one easily obtained in this country is Scotch pine (*Pinus sylvestris*), which is admirably adapted to any creosoting process. It is of very coarse grain; its annual rings are wide apart, and the intervening soft wood soon exhibits great absorption. It does these soft and spongy spars as cheap as larch, but it is not generally cheaper to select soft woods; one easily obtained in this country is Scotch pine (*Pinus sylvestris*), which is admirably adapted to any creosoting process. It is of very coarse grain; its annual rings are wide apart, and the intervening soft wood soon exhibits great absorption. It does not produce as strong a spar as spruce or larch, but it is strong enough for ordinary purposes; and where extra strength is necessary to place extra strength, by doubling, staying, or stratting.

The quality, or rather description, of the "creosote" I find to bear most materially on the subsequent condition of a pole. Mostly in the manufacture the distillation appears to have been carried on too gently, resulting certainly in a liquid containing a greater proportionate amount of creosote than if would had the pressure been urged. But this slowly distilled liquid can contain only the most volatile products of the coal tar. The pole impregnated with this soon under the influence of sun heat presents a bleached appearance, the heat volatilises a great proportion of the oil of coal tar, and the wood, though showing no sign of ordinary organic decay, is severely affected by the resi and corrosive action of the preparation it has imbibed. The vegetable tissue is partly destroyed; the wood fibre desiccated; moisture and air, two of the active agents of decay, find easy access; and although a coat of coal tar will offer a slight remedy, the result is by no means satisfactory.

Now were the distillation of the "creosote" urged, a small portion of tarry or less undecomposed coal tar would pass over from retort to receiver, and the "creosote" would then contain some pitchy matter. A pole will require greater pressure to saturate it with this product, but afterwards well repays the trouble. The weathering, as before, drives off a portion of the more volatile parts, but the pitch remains in the interstices of the wood; the pole keeps black, is perfectly waterproof—the aqueous only to make it the harder, and apparently it will last for an indefinite period.

With plain poles the conditions are of course quite changed; the wood which could be best creosoted would probably be least lasting if unprepared. There are many descriptions of foreign grown pines and firs which make excellent spars, but as a rule their price precludes their use. Norway spruce (*Abies excelsa*) is generally straight and well grown, and makes a nice looking pole, but in point of durability has little to recommend it. Scotch pine is hardly much more grown at home; the looseness of its fibre renders it peculiarly liable to the absorption of moisture and air, and to subsequent decay. Larch (*Abies larix*) is—in my opinion of, and no doubt, if properly selected, is both well; but, unfortunately, this species is seriously affected by the disease fungi and in which it is grown. Reared in the southern counties of this island, where warmth and moisture are more prevalent than in districts further north, and where the soil is less too stimulating, the larch fir produces timber more or less worthless for telegraph purposes, and poles cut from it will not stand long. I have had in renew Devon larch after seven years. But the tree grown in Scotland or Wales, on poky or stony districts, at an altitude of about 1500 feet above the sea level, yields poles of most excellent quality, which, if cut in the fall, and of about thirty years' growth, will often last fifteen years or more. It is a wood very subject to warping, and shakes under exposure to the sun, and must be preserved by coal tarring or painting—preferably the former—which will to a great extent prevent shakes in which wet would lie to the destruction of the pole. Before tarring, however, the pole should be "charred" at the butt. This process, if well performed, is of a great service, but, unhappily, the prevalent idea appears merely to burn the outside wood; this causes a lot of little cracks. The pole should at first be roasted slowly at a considerably distance from the fire, not permitting the wood to burn; the effect will be to evaporate the greater part of the aqueous portion of the sap and at the base of a tree the sap is always more watery, not having commenced solidification by inhalation and exhalation in the leaves to solidify and render insoluble its albuminous constituent, and possibly to destroy the fibrilla of fungi, *Polyporus destructor*, and variets species of *Sporotrichum*, also to mount the capillitia of the ligneous cells to admit fresh

JOHNSON AND PHILLIPS' PATENT INSULATORS.

ALTHOUGH the production of an efficient form of insulator for aerial wires is a most interesting and important problem, the advance made in this branch of practical telegraphy has by no means been as great as could be wished.

The employment of a liquid repellent of moisture placed in a recess formed around the ordinary cup form of insulator was, we believe, attempted some years ago; but either through the imperfect way in which the experiment was made or in consequence of the utility of a very high state of insulation, not being so apparent as it is at the present day, when economy of battery power and the employment of the duplex and quadruplex systems of working are points of great importance, the idea was not carried into practice. Messrs. Johnson and Phillips, who have paid considerable attention to the production of an efficient form of insulator on the above principle, have so far succeeded as to obtain patterns which have proved efficient under conditions which would be fatal to those of the ordinary form.

Although these insulators require the test of continued use under conditions that exist in ordinary aerial telegraph lines, yet the success that has been obtained is so remarkable as to deserve notice.

Figs. 1, 2, and 3, show forms of these insulators.

Fig. 1. This insulator is fixed above its arm or support in the usual manner. The lower edge of the porcelain A is turned up inwards so as to form a chamber, shown at B, in which oil or some other insulating fluid is placed.

Fig. 2. In this insulator the porcelain consists of two parts. A, the head, is firmly cemented to the bolt F, which passes freely through the second part B, containing the insulating fluid S. B is held in position by the nut N; when this nut is unscrewed B may be lowered so as to expose the oil chamber S to view for the purpose of examination or for the introduction of the oil.

In both cases the insulators are easily filled with the oil or other insulating fluid by means of a long-necked syringe.

Fig. 3 shows how an ordinary porcelain insulator may have the insulating fluid principle applied to it. The cup-shaped space S is partly filled with the fluid. C is a dished metal cover resting upon the porcelain tube T. This cover is not fixed, but is free to rotate round the bolt P; a fan F, attached to this cover causes it to rotate from time to time by the action of the wind, the object being to break any spiders' webs or filaments which might cause a leakage from the surface of the insulator to the cover. An india-rubber ring W prevents the rain from entering the oil chamber by means of the hole in the cover through which the bolt passes; it also, when properly placed, prevents the cover C from being lifted up by the wind and touching the porcelain. This form of insulator is especially adapted to districts infested with spiders or other web-spinning insects.

The following tests taken on twenty of the patent insulators and on four ordinary white porcelain insulators with a porcelain tube round each bolt speak for themselves.

The loss obtained on the four ordinary insulators is multiplied by five, to make it comparable with the twenty patent insulators, which are assumed to represent a mile of line.

The tests were taken with eighty cells, and an astatic mirror galvanometer.

The absolutely uniform insulation shewn for the patent insulators, is not strictly correct, but the deflection obtained on them never being more than two divisions, it was impossible to detect small alterations in the insulation.

FIG. 1.

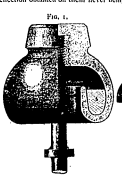

FIG. 2.

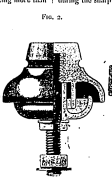

FIG. 3.

Date.	Resistance in Megohms per mile. (20 insulators)		Remarks.
	Patent.	Ordinary.	
January 15	—	—	Insulators fixed.
" 21	about 12000	250	Thaw morning;	clear evening nearly all night.
February 1	"	1·6	Bright morning.
" 3	"	0·08	Thaw; damp.
" 5	"	0·82	Thaw; fog overnight;	fog raised in night.
" 7	"	0·72	Dull; overcast.
" 10	"	1·25	Fine; overcast;	rain dew.
" 12	"	0·61	Thawing; windy.
" 13	"	2·58	Dull; overcast.
" 14	"	1·60	Shower of rain.
" 23	"	0·62	Dull; overcast.
" 24	"	0·61	Dull; overcast; damp.
" 26	"	3·12	Uncertain.
" 27	"	4·63	Fine.
" 28	"	3·72	Raining yesterday, and during night; snow first.
" 29	"	3·72	Dull; overcast;	has been unsettled.
" 26	"	7·1	Hail and hail	strong wind	doubtful measure by fog when shortly after rain ceased.
" 28	"	1·33	Fine;	bright; sharp frost.

The above figures show the great effect which surface leakage has upon the insulation of an ordinary line; the test taken on February the 12th was very marked, when the insulation of the ordinary insulators fell from 23 megohms to 1·1 megohm in a few minutes after the rain commenced. On the 26th it was equally instructive to notice how the insulation rose, when, the rain and hail ceased, and the strong wind blowing at the time, dried the surface of the insulators; the change in this case also took place in a few minutes.

The rain on the 26th had cleaned the surface of the insulators, hence the high insulation obtained during the sharp frost on the 28th.

The tests were taken at about 7 a.m.

Whilst all these changes were taking place in the ordinary insulators, it will be noticed that the high insulation given by the patent insulators, remained perfectly constant (as far as could be detected).

It should be noted that under the influence of frost the insulation still remained good, although it might have been expected that the congelation of the oil would have prevented such a favourable result being obtained.

During the late storms the Great Western line appears to have suffered the most from the destruction of the telegraph. About 150 poles were thrown down between Paddington and Reading. The block system was suspended and the old time system adopted. At one time messages could only be sent from London to Southall, they then had to be conveyed to Slough, whence they were transmitted to Bristol. Mr. Spagnoletti has been actively employed on the re-erection of the line, In addition to the ordinary staff some sappers were employed. Gov 76

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Le Jour Oct 15-87

ON TELEGRAPH CONSTRUCTION.

BY JOHN GAVEY.

IRON wire, as it well known, has hitherto been almost wholly used for the conductor of an open line of telegraph. Although offering a much higher resistance to the passage of a current of electricity than a copper wire of equal section would do, its superior tensile strength, and its cheapness as compared with the latter, have caused it to be universally employed.

It is very important for many reasons that iron of a good quality alone should be used, hence wire specifications generally contain very definite stipulations as to the tests which it should withstand with success. Hitherto none but its mechanical qualities have been regarded, it being doubtless considered that the difficulty and expense involved in the electrical testing of long lengths of iron wire, in the electrical testing of long lengths of iron wire, would be greater than the advantage to be derived from the introduction of a standard of electrical conductivity for each gauge. Iron differs from other metals, unless much in its electrical resistance, according to the state of purity in which it may be obtained. Inasmuch, however, as uniform mechanical qualities are insisted upon in purchasing wire for telegraph purposes, and these qualities depend, to a great extent, on the state of purity of the metal, the per centage of variation in the conductivity of various lines, is not so great as it might be, were the conditions of the contracts less stringent than they usually are. That the resistances do vary, however, is shown by the different results given by wires erected at different periods with varying clean-as of metal.

The manufacture of iron wire is a very simple, but very interesting process. In the first operation—that of rolling—a bar of malleable iron, about 2 feet 6 inches to 3 feet long, mixed to a welding heat, is passed rapidly backwards and forwards through a series of rolls which contain grooves, varying by regular increments from three inches to one-fourth of an inch in diameter. At each passage the iron bar becomes less in diameter and increases correspondingly in length, until in the course of a few seconds it issues from the last groove, when it is wound on a drum, and appears in the form of coil of wire of somewhat large gauge. The whole operation is performed at one heating of the original bars.

The wire in this state is hard and brittle, and the next process is that of annealing. To effect this the coils of wire are enclosed in a kind of air-tight furnace, in which they are exposed to a considerable temperature, then cooled gradually. They are thus rendered soft and pliable and are in a fit state for drawing.

The drawing is a very simple operation. A number of plates of steel perforated with conical holes are fixed vertically on convenient benches, opposite to which are revolving drums of iron. A coil of the rolled annealed wire is taken, one extremity by a few dexterous blows with a hammer is reduced sufficiently in size to admit of its passing through the first hole in the draw-plate; it is then seized by a pair of tongs attached to the drum, which latter being put in rapid motion, the wire is drawn through the plate, and reduced to a uniform diameter, equal to that of the hole through which it has passed. This operation is repeated as often as is necessary, using smaller gauge draw-plates successively until the requisite size of wire has been obtained. For telegraph purposes the wire is annealed after the drawing is complete.

The final operation is that of galvanizing. To effect this the iron is first thoroughly cleansed in a caustic lye, to remove the grease which adheres to its surface in drawing. It is then immersed in a bath of *acide*, composed of hydrochloric and sulphuric acids, to remove all traces of oxide, and to leave a chemically clean surface. After being washed in pure water to remove any adhering acid, it is finally passed through a bath of melted zinc, the surface of which is covered with ammonia chloride. The zinc unites with the clean surface of the iron, and on emerging from the bath, the wire is run through a bank of sand, which cleans off the superfluous zinc, and leaves that smooth bright surface which new galvanized iron presents.

Galvanized iron is invariably used for telegraph purposes in England, although in some countries plain iron wire is employed. The preservative action of the zinc covering arises from the formation of a coating of zinc oxide on its surface. Being insoluble in water, this coating protects the remainder of the zinc, and consequently the iron from further oxidation. In smoky places, however, the sulphuric and other acids, which are developed by combustion, attack the oxide and form sulphate or other like salts of zinc These salts being soluble, are washed off by the first shower of rain, and a fresh surface of zinc is exposed to like influences, the result being that the whole of the coating is rapidly destroyed, and the oxidation of the iron of course follows. Per contra localities the wire is frequently protected by being coated with lamp or tape saturated with bituminous compounds. A simple application of coal tar, followed by dusting over the wet surface with clean sharp sand has been found effective; the difficulty with this is, however, to keep the protecting covering unbroken, for at all places where the metal is exposed rust sets in, which ultimately causes a break in the wire.

A compound conductor, consisting of a steel wire, covered with copper, has within a few years been used in America. A high conductivity with small bulk, and consequently, diminished strain on all supports is thereby attained. But little experience of its value in this country has yet been obtained.

The size or gauge of wire is denoted by numbers which correspond with various diameters. These numbers are entirely arbitrary, and several gauges are in use. That most commonly employed in this country is known as the Birmingham wire gauge. The following table, extracted from Mr. Culley's well known "Handbook of Practical Telegraphy," gives valuable information as to the section, weight, and breaking strain, of various sizes:—

IRON WIRE.

Gauge. Birmingham Wire Gauge.	Diameter.	Area of Section.	Weight per Statute Mile.	Weight of 1 Mile.	Breaking Strain.	
					Hard wire.	Soft wire.
	Inches.	sq. inches.	lbs.	lbs.	lbs.	lbs.
00	0.365	0.105	102.90	1,791	8,040	6,800
0	0.331	0.086	84.51	1,470	6,700	5,750
1	0.300	0.071	69.75	1,214	5,700	4,800
2	0.276	0.059	58.00	1,010	4,830	4,000
3	0.252	0.052	50.63	882	4,000	3,360
4	0.219	0.045	44.00	775	3,400	2,960
5	0.220	0.038	37.00	651	2,950	2,792
6	0.200	0.031	30.50	538	2,580	1,888
7	0.182	0.0262	25.45	461	2,200	1,530
8	0.172	0.023	22.10	389	1,750	1,260
9	0.153	0.0192	18.36	323	1,500	950
10	0.140	0.016	14.97	261	1,260	920
11	0.125	0.123	11.95	211	870	650
12	0.110	0.010	9.21	163	710	510
13	0.095	0.0071	7.01	124	540	390
14	0.083	0.0057	5.51	97	410	358
15	0.072	0.0041	4.29	76	410	300
16	0.065	0.0033	3.22	57	350	260
17	0.058	0.0026	2.61	44	270	150
18	0.049	0.0020	1.91	34	205	115
19	0.042	0.0013	1.55	27	160	85
20	0.035	0.0010	1.22	21	110	60
21	0.033	0.0009	0.91	17	85	50
22	0.028	0.0007	0.62	12	65	40

On account of the indefinite and varying sizes, which frequently correspond with certain gauge numbers, the diameters of wires are often given in decimals of an inch whose accuracy is desirable.

In preparing specifications for telegraph wire, the following rough general rules may be based upon it—It should be free from scales, flaws, splice, inequalities, cinder, and other defects, should be cylindrical throughout, and should conform within certain specified limits to the diameter ordered. Specimens from certain coils, either to be gauged with a decimal scale, or by feet lengths to be weighed, and the limits of variation to be defined. It should be highly annealed, soft, and pliable, and should stretch 18 per cent. without breaking. The wire should be manufactured in certain definite lengths, varying according to the gauge, which lengths should be marked on each coil or parcel of any description. Tensile strength and ductility to be specified. The former to be measured by the direct application of weights, the latter by gripping a certain length, say six inches of wire in a pair of vice, and counting the number of twists it takes to break the wire. In this country it is customary to *kill* or slightly stretch wire before use. This is sometimes done in the factory by running the wire from one drum to another slightly larger in diameter, both being geared to revolve at the same axial speed. This removes all bends and kinks in the wire, giving it a smooth regular appearance, which not only improves the look of the line when erected, but causes a lesser liability to interruption from wind contacts. Flaws and bad places are likewise detected by the operation, which might otherwise pass unnoticed until they caused a fault through breakage when in actual

TELEGRAPHY AND SLEDGING.

To the Editor of the Herald:—

Wide circulation has recently been given in the newspapers to a suggestion made by Mr. James Gamble, superintendent of the Western Union Telegraph lines on the Pacific coast, that the electric telegraph be used to maintain communication between Jenny sledge parties and their base of supplies. Mr. Gamble proposes that each party be equipped with a quantity of light steel wire, weighing twenty pounds to the mile, to be unreeled on the snow from a moving sledge just as a cable is laid from an ocean steamer. By means of this wire, and a portable Morse instrument at the sledge, he proposes to keep a sledge party in constant communication with the camp or its base of supplies. Even in a telegrapher's point of view this scheme would appear to be of doubtful practicability. A line of wire, even laid as suggested, over ice or snow, cools undoubtedly in a manner somewhat analogous to a cable's core, I think, take into consideration the peculiar difficulties which would arise in an Arctic region from the nature of the climate and the inadequacy of all existing means of transportation. An Arctic sledge party starts out into the winter or early in the spring, when the thermometer ranges from zero to fifty degrees below (Fahrenheit). It is, to say the least, very doubtful whether a steel wire of No. 20 gauge could be unreeled from a sledge in a temperature of fifty degrees without snapping at every turn of the reel. Admitting, however, for the sake of argument, that wire could be laid and spliced even in temperatures which render metal almost as brittle as glass, there still remains the persistent inquiry, "How would you carry wire enough to be of any use without crippling your party by enfeebling its supply of food?" It is and should be the aim of every sledge party to travel to the front of the explorations as far as possible with the least possible weight of dogs and provisions. It must carry the largest possible quantity of food and the smallest possible quantity of camp equipage. Every ounce of weight is counted. Every daily ration is allowed a thorough sparing. It is the custom to carry the smallest allowance which will keep the men in health and strength. Now, I have travelled for days in sledging parties, according to the condition of the snow, from 10 to 20 miles, and I have never yet found a sledge load of wire enough to make up over seven feet per mile. Add to this the weight of insulators, and you will find that the distance you can cover. One mile of wire, with insulators, will weigh 25 pounds. Ten pounds constitutes a weight not to be sniffed at for a team of ten dogs. If you leave the wire and insulators behind you, you will find that the moment you intend to find the wire the wire will not be there to find. In other words, for every mile of wire you lay you must carry a mile of wire, which might increase the team-load to fifty pounds, and twenty-five or thirty miles of distance which might be covered in a season by the best organized sledging party would be the maximum limit of its operations. Add to this the fact that every mile of wire carried is a high price to pay for telegraphic communication, and I think you will find that the expedition of the arctic regions, whether Jenny sledges and two or three hundred days of courage-testing travel are considered, will be found to be an unpracticable accident in the way of Morse. I say this is not practicable. I understand that Lieutenant Greely, of the Signal Service, has charge of the telegraphic outfit of the party at the ship's rendezvous. Twenty-five days under him drew over sufficiently rough for the sledge of Mr. Gamble's wire without any line, camp equipage or food. I am not prepared to say that the Signal Service has not the telegraphic outfit of the party at the ship's rendezvous. Twenty-five days under him drew over sufficiently rough for the sledge of Mr. Gamble's wire without any line, camp equipage or food. I am not prepared to say that the Signal Service has not the telegraphic outfit of the party at the ship a satisfactory arrangement for table board, sums they will not be found in the sledging parties. Of course if it could be devised without sacrificing anything else, would be of very little use. A sledge party must travel light. Every pound of weight taken from its base of supplies must be either very intact or very unessential. Lieutenant Melville, who has been the most successful sledge traveller in the Arctic regions, and who, with Lieutenant Nicholson, drew the same ship, succeeded a thousand miles, and Weyprecht, in 1872-73, were repeatedly in distances of three hundred miles from their base of supplies. Lieutenant Greely, or Master Brainard, may have had enough to undertake communication with sledge parties at the distance mentioned, but I doubt it. I have no doubt a thousand pounds of wire would have drawn up or fifteen sledges to the exclusion of everything else. Of course, I am not familiar with the extent to which the service have put through to accurately to enter to the resistance which metals and probably would have to a wire laid over ice and snow, such as Mr. Gamble proposes to use in the Arctic regions. But I am quite convinced by the opening of lines of water. The objections founded upon the insufficiency of existing transportation facilities to meet local needs in the matter of wire, and the weight of wire as an impediment to the "storm sledge" recently brought to the attention of the Navy Department in connection with the search for Lieutenant Greely, are, I think, fatal.

GEORGE KENNAN.

WASHINGTON, May 22, 1881.

axis of the former will then take the direction of the magnetic meridian. As soon, however, as the needle is fixed up, the former varies from its position, and the pole withdrawn from the needle. In order to bring back the magnet to its original position, another magnet, which we may call the compensator, is approached on the side opposite to the needle. Suppose that the needle was at the point *b*: if it is moved from its place, the suspended magnet deviates again from the direction of the meridian. But if the needle is moved further, a new position *a* can be found for it, in which the magnet returns to the meridian. If the compensator remains barely unmoved, the action of the needle upon the pole of the magnet is the same at *a* and at *b*.

(To be continued.)

EARTH-BORING FOR TELEGRAPH POLES.

By JOHN HAYES.

The usual method of digging a post-hole with the pick and spade requires but a brief description. A rectangular opening, averaging 4 feet by 2 feet, is made in the ground, and the earth moved uniformly throughout to a depth of 2 feet 6 inches, where, by a step-like arrangement, the length of the hole is gradually shortened, until at the bottom it does not exceed 1 foot.

The depth at which it is customary to plant telegraph poles may roughly be considered to vary from 4 feet 6 inches for a pole 24 feet long, to 5 feet 6 inches for one 28 or 30 feet; 6 feet serving up to, say, 40 feet, and 7 feet for any height.

It may be taken, as the result of experience, that the average number of holes which a workman will dig in ten hours is represented in the following table:—

Soil.	No. of Holes per Day.	
	4 ft. 6 in. to 5 ft. 6 in.	5 ft. 6 in. to 7 ft.
Clay	6	5
Digging soil ...	5	4
Hard gravel ...	4	3 to 3½

The digging of a pole-hole 4 feet 6 inches deep may be said to involve the removal of 30 cubic feet of soil, which will represent a weight varying from 2850 lbs. to 3600 lbs., according to the nature of the soil; whilst one 5 feet 6 inches deep will contain 44 cubic feet, with a weight of 4180 lbs. to 5280 lbs. This allows for the sloping manner in which such a hole is generally dug.

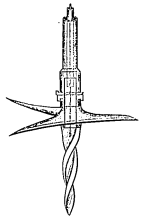
To reduce the great amount of unnecessary labour here involved, the most obvious step is first of all to effect a reduction in the size of the hole. The first instrument invented for carrying out the object was the "Spanish spoon." It consists of a circular metal disc, the chord of the arc forming a cutting edge. The periphery of the disc was provided with a ledge about 2 inches high, to retain whatever might accumulate on its surface, and the whole was fixed at right angles to a long handle.

Various modifications in the form of the spoon have been introduced with more or less success; but the principle of all forms of this apparatus is the same, namely, loosening the soil with a suitable bar, and collecting and raising to the surface the *débris* thus broken away.

* Abstract of a Paper read before the Society of Telegraph Engineers.

The most marked improvement in the method of opening holes for telegraph poles appears to have been the introduction of earth-borers, amongst which may be mentioned those invented by Spiller by Marshall, and by Baldhan.

Spiller's is but a modification, on a large scale, of the ordinary ship's auger: Marshall's and Baldhen's are both constructed on the same principle, but are essentially different from Spiller's. A general idea of their construction can be obtained from the accompanying diagram of Marshall's apparatus.



Spiller's borer the author found to be very effective in sand, clay, and ordinary soil, but ill adapted for gravelly or stony ground. Marshall's borer was very effective in ordinary soil, clay, and gravel.

These borers have obviously one defect; they cannot be worked close to a wall or a hedge, position where—in most telegraphic especially—it is frequently necessary to erect poles. This difficulty has been overcome by fitting one of the borers with an ordinary ratchet handle, lightening each of the parts as admit of it, and replacing the long tapering point by a shorter one. This modified instrument will bore in clay and ordinary soil, but in gravel it only acts as a spoon, the soil having to be broken up with a bar.

The advantages of these apparatus may be summarised as follows:—

1. Speed: a number of pole-holes can be opened out to a given depth, with the same force of men, in less time than by ordinary methods.
2. Diminution of labour in filling in.
3. Greater solidity of the pole thus erected.
4. Less disturbance and mixing up of the soil,—a point of some consequence in erecting lines of telegraph through private property.
5. The advantage of being able to work in wet soils without baleing or pumping.

to a force in the direction shown by the arrow-head.

In reply to Mr. *Culley*,

The PRESIDENT further said—If the force was always in one direction, then there would be nothing to loosen the pole *n a*. The pole *n a* would give the full resistance. I think that if there were forces acting always in the one direction and sometimes in the other, it is even possible that there would be less resistance with the two poles than from the one alone, from the fact that if the pole *a* would get loosened by forces acting in the direction of the arrow-head. It seems to me that although both poles become loosened, the resistance might be less than with a single pole. If the force is always in one direction (as that shown by the arrow-head), then, when the pole is loosely joined at the top, the resistance would be greater undoubtedly than with a single pole; but probably not quite so much greater as double. Although this is not a good arrangement, it would be better than the arrangement shown in the diagram. I think that if the poles were close side by side, there would be less than double the resistance of one pole, because the whole amount of the resistance of the earth that one pole would experience would be diminished by the presence of the other. If the two were placed at a considerable distance from one another, and if they were not coupled so as to give the leverage action upon which I have commented, then the force would still be not quite equal to the half of the two because the whole force could be calculated exactly on the two poles in proportion to their maximum resistance. The leverage action of the ordinary hammer fork for drawing nails is almost precisely the same in principle as that which I have indicated in this case. I have listened with very great interest both to Mr. Gavey's paper and to the communications, and also to the general information with which other speakers have followed it up. Although it is not clear that in distant countries, and in a variety of soils and in circumstances in which division of labour, and consequent subdivision of appliances are not available, the method of making holes by the pick and spade is that upon which most reliance should be placed. Still I think that Mr. Gavey has made out an exceedingly good case for the borer in a very large class of applications. What Mr. Culley has said with reference to the trials that have been made shows that there is a large province still left for the borer. It must be remembered that the borer is a comparatively new thing; it is now only a few years; and when so much can be said in favour of the borer as Mr. Culley has said, and as has been brought forward in the paper, I think we must agree that it is a most important appliance. In a large district of country, covered with a great many lines of telegraph may have to work, and where the soil is generally of a suitable character, the borer will be of considerable value. There can be no doubt whatever of the figures which Mr. Gavey has put before us, and they show a very great increase in the quantity of work done by the labour of a certain number of men through the use of the borer in favourable circumstances. The advantage of bringing forward and describing new appliances before this society is well illustrated by the interesting information and new ideas which we have received from Mr. Gavey himself, and the light which has been thrown on the subject by the different speakers. I propose a cordial vote of thanks to Mr. Gavey for his paper.

bination with various substances, and known under the general name of iron ores, it is widely distributed. The ordinary method of obtaining the metal from these ores, consists in exposing the latter to a very high temperature, in contact with compounds calculated to enter into chemical combination with the earthy or gaseous substances united with the iron. Sometimes the ore is first calcined, or roasted in great heaps, to expel the more volatile compounds; sometimes it is filled direct into the furnace, which is a large structure, varying from fifty to sixty feet in height, and of a corresponding width. This furnace, when once started, is kept in uninterrupted action until the necessary repairs, or the reduction for the demand for iron renders it necessary to blow it out. The charges of material, consisting of fuel, ore, limestone, &c., are fed in regularly at the top, the liquid iron and other compounds being withdrawn from convenient openings near the base. The necessary draught is obtained by powerful blowing engines, which force strong currents of air, generally heated to a temperature of about 600 degrees, into the furnace. A very high temperature is attained within the furnace; the metallic iron melts and drops on the hearth, whence it is periodically drawn off and run into moulds, whilst the slag, resulting from the combination of the earthy portions of the iron ore with the fluxing material which has been added, floats on the surface of the iron, and is drawn off through a convenient opening, and passes to the "waste tip."

The pig or cast iron thus obtained, is an indefinite compound of iron, with quantities of carbon, varying from two to five per cent. The properties of cast iron are well known. It has a brittle appearance, possessing great hardness, and offering considerable resistance to a crushing force, but with a comparatively small tensile strength, or power of resisting lateral or transverse strains.

Iron deprived of its carbon and some other impurities, is known as malleable or wrought iron, and the operation by which this change is produced is called puddling. The cast iron is placed in a reverberatory furnace, which is so arranged as to cause the heat and flame from the combustion of the fuel to impinge on the surface of the metal. The latter speedily melts, and when in this state it is kept stirred, so as to bring fresh surfaces of iron constantly under the influence of the flame and hot gases. The effect of this is to consume the carbon in the iron, which latter gradually loses its fluidity, and becomes viscous and pasty. In this state portions of the iron are worked up into rough sponge balls, and placed under powerful hammers, which squeeze the sponge into rough plates. These plates are cut into smaller pieces, which being tied together, are again heated, and either rolled or hammered, the operation being repeated in some cases several times. The quality of the iron is much improved by this, and it thereby acquires that fibrous appearance, which is a characteristic of good wrought iron.

Wrought iron has very different qualities to cast iron. The power of resisting crushing strains is diminished, but its tensile strength is enormously increased; in fact, when of good quality, none of the brittleness of cast iron, it is easily bent, it becomes malleable, is readily rolled into sheets or bars, is susceptible of being drawn into wire, and possesses the quality of welding at a white heat, although it has less that of fusing or melting at the comparatively low temperature which the combination with carbon gave to it.

Steel is a certain definite mixture of pure iron and carbon, the proportion of the latter being much less than in cast iron, but varying very considerably according to the purposes to which the finished metal has to be applied. The higher class of steel is made from the best malleable iron, by exposing the latter to heat in contact with carbon, the process being known under the name of cementation; but within the last few years, systems of manufacturing steel direct from cast iron have been largely introduced. One process, due to Mr. Bessemer, consists in consuming the carbon, by forcing a quantity of atmospheric air through the melted metal, then by the addition of a definite proportion of highly carburetted iron, the exact quantity of carbon needed for the formation of steel is restored to the liquid mass.

Steel possesses many and various qualities, dependent to a great extent on the purposes for which it is manufactured. Its tensile strength and resistance to crushing forces are much greater than those of wrought or cast iron. It also is susceptible of receiving any given degree of hardness, by the process known as tempering, from that which is sufficient to scratch glass to very little above soft iron. The strength of iron, whether cast or wrought, and of steel, varies between very wide limits, according to the purity of the metal, the method of manufacture, &c.

Cast iron has been produced with an ultimate tensile strength of 11 to 13 tons to the square inch, but this is rare. The average may be taken at seven tons, though it is occasionally as low as four to five tons. The force necessary to crush short cylinders, varies from 35 to 50 tons per square inch, and the average may be taken at 42 tons.

Wrought iron may be said to have, in extreme cases, a maximum tensile strength of 30 tons, and in ordinary or average strength of 22 tons to the square inch, although this sometimes falls as low as 18 tons. These figures do not apply to the strength of wire which, within certain limits, is greater in proportion as the sectional area is less.

Steel may be said to have a tensile strength varying from 30 to 55 tons per square inch of section.

A form of cast iron, known by the name of malleable cast iron, is frequently used in minor fittings for telegraph work. It is prepared by exposing castings, immersed in a bed of iron, or other substances rich in oxygen, to a high temperature, and allowing them to cool gradually. The oxygen combines with a portion of the carbon, and the withdrawal of the latter imparts a remarkable degree of toughness to the material so treated.

Iron pole. These have not to any great extent been used in England. The principal objection to their extended introduction, is the heavy cost of that material as compared with wood. At first sight it might appear that their increased durability would counterbalance this, but except in localities where ornament is an object, it is not so. Creosoted timber is so durable, that it is quite possible that it may equal the duration of wrought iron, and even though it do not, the difference in cost is so striking, that the balance of advantages remains in

favour of the former for use in this country. Abroad, and especially in tropical countries, iron poles are very extensively used, as they present many advantages over timber. The use of iron admits of the material being so disposed, as to obtain the maximum strength, with the minimum material; the poles are likewise generally constructed in sections, so that by those means great facility of transport is attainable, a point of much consideration in countries which have not well developed systems of roads, and means of transport. Moreover, iron is of course proof against that great enemy of timber, the white ant, which is so common within the tropics.

In the application of iron to Telegraph poles, the advisability of the destructive effects of oxidation, and the distribution of the materials in such a form as will combine strength, lightness, and elasticity.

These two objects are generally attained by constructing poles of a combination of wrought and cast iron, the latter being used for that portion which is fixed in the ground, and which rises some height above it, and the former being employed for the upper portion of the pole. The advantage of cast iron for the lower piece, consists in its durability, it not being subject to oxidation under the influences which generally affect Telegraph poles, and also, location an ornamental character is, where necessary, readily and cheaply imparted to it. Wrought iron is used for the upper portions on account of its greater strength, and its superior elasticity, whereby it is better able to resist the sudden strain and jerks to which it is subjected during rough gales. The various sections of which an iron pole is constructed, may either be held together by friction, tapered joints being provided, or they may be fitted with sockets and secured by lead or other suitable cement.

Iron has, however, been applied in many ways wrought into various forms, rolled tapered tubes, bars, ribbons, angle iron, and cast iron cylinders, being variously combined. As an example of each class, we will notice briefly a few of the best known.

Hamilton Standards are examples of poles constructed principally of sheet iron. They are formed of plates varying from 1 to 2 of an inch in thickness, bent into a circular form and riveted, so as to furnish tapered cylinders about eight feet long. The sections for each post vary slightly in mean diameter, so that when fitted one over the other, poles of a uniform taper, varying from 16 to 40 feet long may be constructed.

The base consists of a cast iron taper cylinder, over which the lower section fits, and it is provided at the bottom, either with two cross pieces of angle iron, or with a base plate, which adds to the groundhold of the pole. The poles are, for convenience of handling and transport, shipped in sections, and fitted together *in situ*.

These poles are now generally galvanized, as if right it might appear that their increased durability would counterbalance this, but except in localities where ornament is an object, it is not so. Creosoted timber is so durable, that it is quite possible that it may equal the duration of wrought iron, and even though it do not, the difference in cost is so striking, that the balance of advantages remains in

base piece, at the bottom of which is bolted one of Mallett's hooked plates. These plates consist of strips of rolled iron, about three feet in diameter, to which great stiffness is imparted by their being dished, or bent into a dish-like curve. The upper portion of the pole consists of a continuous rolled taper tube, which fits into a socket in the upper portion of the cast iron base piece, into which it is cemented by means of a mixture of sulphur and oxide of iron.

Cast iron cylindrical tubes, strengthened by collars or bands of wrought iron, and lifting tabs, occasionally, have been employed as well as wrought iron, either in a taper form or varying by graduations, and attached to a cast iron cylinder fitted into the ground.

Some poles have been constructed of a species of lattice work, somewhat similar to those frequently used for signalling purposes on railways. These, however, are too costly for general use. A modification of this, formed of round rods, has been manufactured. It is of an identical form, constructed with thin bars or rhombs of iron, crossing one another at regular angles, riveted together, and strengthened with angle irons. The facility with which these poles could be climbed would perhaps be found objectionable on high roads, even though the advantages they might possess rendered their use advisable. Little or no practical experience has been obtained of their value.

For light work, we have manufactured iron poles from a few lengths of different size cast and wrought iron gas pipes, fitted telescopically. These, with the aid of ornamental cast collars, have occasionally met the required purposes in emergencies.

Iron is largely used for overhead work, and with advantage. For this purpose, rolled taper tubes, either whole or fitting telescopically, are the most advantageous. They fit at the base into a semi-cylindrical iron casting, which can be adapted, either for use in a roof gutter, or fixed on a ridge. The wrought iron height, is dished, and requires less attention than wooden supports.

The proportions which should be given to iron poles, either of cast or wrought iron, will be considered when we deal with the pole as part of a complete structure.

As has been previously remarked, iron poles in this country are used primarily in localities where the ordinary wooden structure being objected to, something of an ornamental character is needed. This involves certain difficulties, for in traversing a town the ordinary facilities for adding to the assembly exist, and if an iron pole be made sufficiently large and strong, to withstand of itself the strain of the wires it will have to carry on curves and at angles, it becomes so unwieldy as to render one. This difficulty is met by reducing the size and consequent strain of the wires, and then by using two or more sizes of poles, one, as light and airy a structure as is suitable for straight lengths, the other heavier, for curves and angles. As a rule, two dimensions of poles should serve for any given work, and uniformity of design, should for such work be preserved, the strength only being varied. The stiffness of light poles may be increased by trussing.

Iron Sockets to screw into the ground, and adapted for holding wooden poles, have been ex-

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IRON TELEGRAPH POLES.

WHEN the progress of telegraphic extension rendered it necessary to construct long ranges of lines through the semi-civilised regions of India, Central and South Australia, and South America, where it is often difficult, and even impossible to procure suitable timber for poles, or where the peculiarities of climate insured the speedy decay of wooden poles, even if it were possible to make use of them, the economy of using iron poles became so apparent as to scarcely require discussion. When we consider the difficulties of transportation, labour, and maintenance, in these partially civilised countries, inhabited by a rude and scattered population, and compare the relative first cost and duration of wooden and iron poles under such conditions, the saving which must result from the employment of the latter is readily seen. But in the more thickly settled countries of the world, where transportation is abundant and cheap, and the cost of inspection and maintenance is comparatively low, the question of relative economy becomes a much more complicated one. It is not proposed to enter into an extended discussion of the relative cost and advantages of iron and wooden poles, for the reason that so many different considerations enter into the question that perhaps nothing short of a somewhat lengthened experience with the two systems of construction under corresponding conditions would enable results, even approximately correct, to be arrived at.

One of the earliest inventors who turned his attention to the subject of iron poles was that eminent telegraphic engineer, C. W. Siemens. Considering that the object in view would be most completely met by a design which should combine lightness and convenience of construction, with the maximum degree of stability and resistance to sudden strains, as well as to oxidation, he was led to abandon the ordinary method of securing poles by setting a considerable length of them in the ground, and to make use of a horizontal wrought-iron foot-plate buckled or corrugated into the form of a shallow or inverted dish, which combines a great degree of rigidity with a peculiar elasticity, which enables it to yield without injury to sudden and considerable strains. The portion of the post which is partly buried in the ground, and is therefore exposed to the action of moisture both from the earth and the atmosphere, is made of cast-iron, and of a tubular form. This tube is fastened to the foot-plate by three bolts, and is provided at its upper end with a socket for the reception of the upper tube. The latter, which forms the principal part of the pole, above ground, is made of wrought-iron. The upper tube is cylindrical for a distance of about a foot above the socket, and from thence tapers gradually to the top. This form ensures a distribution of metal, which, with a minimum expenditure of material, gives a maximum degree of rigidity or resistance to a horizontal strain. The upper and lower tubes are cemented together by means of a fused mixture of sulphur and oxide of iron.

The height and dimensions of these poles vary according to circumstances. If only one or two wires are required, and economy is an object, poles having a total length of 19 feet 8 inches are used, standing 17 feet above the ground in their position, it being usual to place the pole 2 feet 8 inches in the ground. The total weight of such a pole is 183 lbs., as it may be conveniently in three separate parts, the weight of the heaviest piece not to be less than 100 lbs. At all points where the line is exposed to an extraordinary strain, a heavier pole, weighing 258 lbs., is made use of. For a heavier class of lines a larger-sized pole is made, weighing 334 lbs., with extra poles weighing 500 lbs. The ordinary number of poles to a mile is about twenty-one.

Iron poles of this description were first erected by the firm of Siemens Brothers, in Spain and South Africa, as long ago as 1865. Since that time more than 180,000 of these poles, representing over 9000 miles of line, have been erected in New Zealand, Ceylon, India, Persia, Russia, Mexico, Brazil, the Argentine Republic, Chili, and Peru, and are said, in all cases, to have remained in perfect working order ever since their erection.

As a rule the Siemens poles are estimated to cost from two to three times as much as good wooden poles of corresponding strength,—say from 6·50 to 17·50 dollars each, according to size and strength.

In many countries, however, where both wooden and iron poles would have to be transported over great distances, the latter means are usually available in half-civilised countries, as poles become as cheap as wooden ones at the point of destination, owing to their weight being so much less, and their transportation so much easier, on account of being carried on a comparatively insignificant weight and bulk. It will, therefore, be seen under what in tropical countries where wood is subject to rapid decay, and where wooden poles have to be renewed every few years, that the relative advantages of iron poles of this description are very great indeed. In civilised countries, however, the advantages to be gained by the use of these poles instead of wooden ones is not so obvious, and we do not find that they have as yet been introduced to any considerable extent.

The rapidity with which wooden poles were found to decay, and the expense and interruptions occasioned by the continual renewal of the poles and the transfer of the line from the old poles to the new, led the telegraphic administration of Switzerland to construct an experimental line upon iron poles, as early as 1858.

The experiment was continued up to 1868, but the T iron which was employed for building the line proved was replaced by two or more cylindrical poles screwed together by means of a threaded coupling. After an experience of three years, which served to demonstrate the fact that this manner of joining the poles did not insure a sufficient degree of rigidity, this form was in turn abandoned. After successive trials made with specimens of various designs, it was at length decided upon to use conical tubular poles formed of a single piece, as this seemed likely to fulfill all the necessary conditions.

The length of these poles varies, according to circumstances, from about 6 feet 4 inches to 24 feet 7 inches, but practically they have always remained within the limits of 21 feet 4 inches and 18 feet 8 inches. The minimum diameter measured just below the top of the pole is invariably 4 inches; it increases regularly towards the base in all cases, so that a pole 10 feet long has a diameter of 7·56 inches, and one of 18 feet 8 inch pole a diameter of 9·25 inches, at the base. The thickness of the iron is uniformly 0·2 inch.

The poles are firmly secured in the ground by means of sockets of stone whose dimensions depend upon the length of the poles. For the small sizes these sockets are about 2 feet square. The insulator brackets are placed in round holes drilled transversely through both sides of the pole, and are fastened by iron wedges or keys.

The durability of these poles is of course almost unlimited, provided they are properly covered, from time to time, as may be required, with a coat of varnish for the protection of the iron. The results obtained in regard to the insulation are said to be not unfavourable, and the Swiss administration has had reason to be very well satisfied with this system of construction. It protects, however, one inconvenience, which could hardly have been foreseen, which will nevertheless be somewhat difficult to remedy. This inconvenience results from the comparatively small number of wires that these poles are capable

3476. S. C. Denis, of Surrey. *Improved means o preserving telegraph signal posts and other wood post from dry-rot and decay.* Dated October 22, 1873.—This invention has reference to improved means o preserving telegraph, signal, posts, and other wood posts, the lower ends of which are inserted in the ground, from dry rot or decay. According to this invention the lower parts of such wood posts are sur rounded with a collar or casting of zinc or othe suitable metal, the upper and lower edges of suc collar being bevelled off and either forced into the wood, or caused to enter a saw cut or channel formed at an angle in the surface of the post around which it is placed. When the plate or collar of zinc is fixed around the post, the edges are soldered together to form a perfectly water-tight joint.

3437. E. T. Hughes, of the firm of Hughes and Son, London. A communication from *L. B. Blythe*, of Bordeaux, France. *Treating wood and vegetable fibre in general by "carbureted steam" and compression, to strengthen and preserve such matters from decay.* Dated October 22, 1873.—I construct an apparatus consisting of a strong iron chamber forming an oven, and a long boiler extending the whole length of the oven is set in the brickwork below it. Flues are arranged around the oven to heat it externally, and are connected with a furnace or furnaces. Pipes with stop-cocks connect the top of the boiler with the upper part of the oven, and a return pipa also provided with a stop-cock connects the bottom part of the oven with the bottom part of the boiler. Safety valves are provided to the boiler, the chamber or oven and the boiler is charged with water, to which is added from one-third to one-fifth by weight of heavy hydrocarbon oil. The water and oil is heated together, making "carbonetted steam," which passes into the oven by the upper pipes, while the liquids condensed in the oven return to the boiler by the lower pipes which connect them together. After the temperature in the oven has attained 212° F., the heating is continued till all the albumen and sap in the wood is decomposed into resin, acetic acid, and oleaginous matter, which are distilled for after treatment.

3083. A. Wilkinson, of Middlesex, engineer. *Improvements in Coating and Preserving Telegraph Wires, Ropes, and Cables.* Dated September 19, 1873. This consists, first, in coating the fabric-covered wire with a solution of white lead, pitch, boiled or raw linseed oil, tallow, and asphalte, and afterwards coating the threads or strips of fabric over the wire by passing the wire through a bath containing white lead, pitch, and boiled and raw linseed oil; thirdly, in first coating threads in a solution of white lead, pitch, or its equivalents, until they become dry, these threads being then wrapped on to the bare wires, which are afterwards further coated by lead or other metal.

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ART.

In science is systematised knowledge, art is applied knowledge, or the application of universal laws to particular facts. It is derived from *ars*, strength, the primary sense of power, and therefore of skill. It is the modification of things by human skill to serve some intended useful purpose. There are many branches of art as there are of science. Thus we have the art of shipbuilding, of gardening, of painting, of engraving, of printing, of telegraphy. And not only have we the art of producing, but that of criticism, or of testing the genuineness, truth, or correctness of things done by others. A judge of pictures tests the truth of a production before him, by comparing it with certain laws that he has learnt from observation, or has been taught by experience; and an electrician tests the value of an instrument submitted to his inspection, by comparing it with certain principles or conditions that he has acquired by his scientific training. A scientific training increases many times the pleasure produced by an inspection of the beautiful productions of ancient and modern skill. The telegraph engineer invents a certain instrument by applying those particular facts that observation and study have brought to his notice, and the telegraphist applies his art in making use of the instrument so invented. Universal laws and particular facts are the extremes both of science and art, but science ascends from phenomena to conditions, and art descends from conditions to phenomena. Telegraphy may be

There are the useful arts and the fine arts—the former, besides the various trades, include telegraphy, and the latter comprehend those productions of human genius and skill which are addressed to the sentiment of taste or to the imagination. In fact a science teaches us *to know* and an art *to do*, and all the more perfect sciences lead to the creation of corresponding useful arts. Psychology is the basis of the art of education, physiology is the foundation of the art of medicine, astronomy leads to the art of navigation, and heat to that of railway locomotion. Chemistry is the root of many useful arts, and electricity is the foundation of the art of telegraphy. Although the primary position has been given to science, it must not be forgotten that art is usually the precursor of science, and that it is from the art itself that the science has often been evolved. The fact that science is systematized knowledge implies the existence of isolated facts upon which the mind is able to generalize, and these facts are usually the consequence of the pursuance of the arts. Hence an expert in the art by no means implies an expert in the science, and unfortunately the two are rarely combined, especially in the telegraphic world. It is a very regrettable fact, for none have such opportunities of acquiring a knowledge of the science of electricity as those who are engaged in pursuing the art of telegraphy.

ON TELEGRAPH CONSTRUCTION.

By JOHN CLAYTON.

(Continued from vol. iii. page 291.)

4.—DISTRIBUTION AND LAYING OUT OF STORES.

The survey being complete, the consents obtained, and the stores selected, the next operation in the construction of a line is the distribution and laying out of the materials.

In a line to be erected along the highway, it becomes necessary to select, at convenient distances, say fifteen or twenty miles apart, temporary store depôts, for accumulating the smaller stores which it would be unsafe to leave exposed to possible depredations or damage. These depôts should be selected with regard to the facility with which the stores can be collected, either from an adjacent railway station or canal, and with which they can be distributed as required over the work as it proceeds. Poles, wire, and such like heavy materials, the cartage of which is costly, should be sent to the nearest railway or canal stations along the route, independantly of the sub-depôts previously referred to: the length of the poles and

The Eastern Telegraph Company have just opened a new route to Egypt across France, *viâ* Marseilles and Malta. They have leased a special wire for this purpose from the French Government.

PNEUMATIC TELEGRAPHS FOR LONG DISTANCES.

Paper read at the meeting of the Society of Civil Engineers of Paris, on the 4th June, 1875.

By M. L. CHIDDEN.

(Concluded from page 208.

I now proceed to the considerations of the speed with which the boxes will travel in a pneumatic line of unlimited length, in which, by the methods described above, the vacuum will be kept at 0·5 metres of mercury, and the pressure, admitted by the relays at intervals of 7,000 metres, equal to 0·76 metres of mercury; the tube to be one-tenth of a metre in diameter.

My point of comparison will be the speed in the tubes of the Paris system, where a pressure of 0·4 metres of mercury gives a speed of 20 metres per second, in a line 1,000 metres long, and 0·008 metres in diameter.

The increase of diameter will increase the speed in the proportion

$$\frac{100}{65} = \sqrt{\frac{10}{8}}$$

say 25 metres per second.

The fact that the line if kept exhausted of air will reduce the friction in each length of 1,000 metres to an average equal to that of 600 metres at most, for at the beginning of each section, that is to say, at the moment when the train passes the pressure relay, there is no column of air travelling with it; at the termination of the section only, will the column of air which drives the train have a length of 1,000 metres. If the vacuum were perfect, the average friction length of the column of air would be but 500 metres. The diminution in the frictional length of the column of air gives an increase of speed in the proportion

$$\frac{1000}{600} = \frac{33}{24}$$

The speed, raised to 25 by the increase of diameter, now becomes

$$25 \times \frac{33}{24} = 36 \text{ metres.}$$

We have then the increase of the difference of pressure, which is also in the ratio of the roots

$$\frac{26 + 50}{40} = \frac{115}{65}$$

The application of this last ratio indicates a speed of nearly 70 metres per second.

This is an enormous speed, and would in all probability be attended with some inconveniences, but it is evident that we should work with the highest speed possible.

Now, observations made with trains running under similar circumstances at speeds of 50 to 55 metres, have shown that these practical speeds are quite admissible in regular working. It is only necessary to employ a very strong material, arranged in such a way that it shows shall wear without wearing the line; this end is attained by fitting the rubbing parts of the boxes with a cutter useful than that composing the line.

The New Western Union Office of Cincinnati, Ohio.

The well known building at the northwest corner of Fourth and Vine streets, formerly occupied by Rogers & Eckstein in the drug business, has lately undergone, in a recasting of its stone facings, and in the manipulations by carpenters and joiners, frescoers, paper hangers, etc., so complete a change that, with its well restored raw materials, the rejuvenation renders it better than new. The last credit was given on account of its proposed occupation principally by the Cincinnati office of the Western Union Telegraph Company; and, in a minor way, by railroad companies and other business houses. Not as yet has the building received its finishing touches for habitation purposes, though the railroad companies have already established quarters on the first floor.

The Fourth street front of the ground floor is taken up by the passenger ticket and freight contracting agencies of the Indianapolis, Lafayette and Chicinnati and Cincinnati, Hamilton and Dayton Railroads. These railroads have recently entered into a pooling arrangement as regards the profits on Western freight and passenger fares, and having done this, their agents are able to occupy a joint office in harmony together. Mr. E. L. Stark is passenger agent for the Indianapolis, Cincinnati and Lafayette Road, and Mr. A. F. Lindsey for the Cincinnati, Hamilton and Dayton Road. Mr. J. H. Lynch is freight agent for the Indianapolis, Cincinnati and Lafayette, and Mr. W. H. Allen for the Cincinnati, Hamilton and Dayton. The corner they now occupy is more convenient and convenient than the time honored one on Third street.

The rest of the first floor of the building will be taken up by the Western Union Telegraph Company, which will not be ready to take possession for a month or more. The batteries will be located in the basement, and will consist of fifteen hundred cups. The number of wires running into the office from points outside of the city will be fifty-one, and including the city "loops" will be seventy-five or eighty. In the way of battery capacity, the new office will be much enlarged, as in the old place there are only one hundred and eighty Grove cups and two hundred of the Callend description.

The front of the counter, on the street floor, will be the office of the manager and the receiving and delivery clerks, and the wall fronting on Vine street, will be situated the offices of the superintendent and his clerks.

The second and third floors will be for rent for offices. On the fourth floor will be the office of the Gold and Stock Company, and the telegraphic operators' reception room for those who call to see the operators, and a cloak and lunch room for lady operators. The book-keeper's room, on this floor, fronts on Vine and Fourth streets, and its dimensions are fifty-six feet by twenty-eight feet. The entire fifth story, of dimensions of one hundred and four feet by twenty-eight feet, will be taken up by the tables of the operators.

The employes of the company are U. T. Williams, Superintendent; Frank Armstrong, manager; R. H. Johnson, chief operator, and three assistants; A. F. Lindsey, night operator, and two assistants; and W. A. Fowler, chief book-keeper. There are sixty-one operators, night clerks and office boys, who perform clerical duty, and fifty-two night and day messengers. The business of the company is very extensive. For the month of August the number of messages passing through it was 112,256. The collective of press reports. For the press the number of words handled during the month was 2,917,008. The average is small, as during winter, when Congress and Legislatures are in session, and there is more general news, the number of words passing through the office is more than doubled. In summer the average of city messages is about 1,000 a day, and in winter, when business is brisk, from 1,200 to 1,500 city messages are handled.

The company will retain an office at the old headquarters, and will extend it in order to accommodate the bankers and other down town business men, who frequently require the transmission and reception of messages with a rush.—*Cincinnati Commercial.*

Excellent and Successful Telegraphic Management and the Result.

In the last number of THE TELEGRAPHER, in commenting upon the Annual Report of President Orton, we incidentally alluded to the management of the Montreal Telegraph Company and its satisfactory results to the stockholders and the public. It has occurred to us that the subject could be profitably treated more at length, and the contrast to the management and results of telegraphic enterprises in the United States generally is so striking, that it may serve a useful purpose to present the matter for the consideration of those who may be engaged in initiating or managing similar enterprises.

The Montreal Telegraph Company was organized in January, 1847, commencing business in July of that year, with a line between Toronto and Quebec, a distance of 340 miles. The amount of the original capital was $50,000, which it will be conceded was by no means excessive for the length of the line. The company appears to have been carefully and economically managed from the start, Sir HUGH ALLAN, its President now, and Mr. JAMES DARKER, its present Secretary, having been originally connected with its management. A definite policy, and, as it has proved, a very wise one, was adopted, which was to pay to the stockholders a reasonable dividend on their investment from the proceeds of the business, and devote the surplus, whatever it might be, to extending and strengthening the lines and furnishing additional facilities, as they were required. This policy has been steadfastly adhered to up to the present time, and under it the line has been exceedingly profitable to the fortunate holders of its stock; the public has been provided with adequate telegraphic facilities as they were needed, and the company has become one of the leading telegraph organizations of the Continent. A dividend of ten per cent. has been paid to the stockholders every year since 1851, with the exception of two years, in which the dividends were eight and nine per cent., respectively. The surplus expended in extending the lines has been returned to the stockholders as a stock bonus, from time to time. In this manner the capital of the company has been increased from $50,000 to $1,750,000, and its lines have been extended throughout the present Canadian Dominion—the great- est length of line ever worked by the company being 1,750 miles. The company now owns and operates 12,000 miles of wire, 10,000 miles of wire, and has 1,300 offices. It will be seen that the present capital of the company is by no means excessive, being only $140 per mile of poles owned by the company. The lines and equipment are kept in excellent condition, and ready for any demand which may be made upon them. The tariff was reduced, from time to time, until January 1, 1870, when the low rate at present existing was adopted, and the company has now a uniform tariff to all Canadian points of twenty-five cents (gold) for a ten word message—date, address and signature free, as on United States lines—and one cent for each additional word. To this there is but one exception. When the distance is less than 32 miles the rate is 25 and 1 (gold). The American currency rate of the company is 20 and 2. At the time this reduction was made it was regarded by telegraph managers and others on this side of the line as a hazardous one, but the result has proved that the management of the company entered intelligently, and the reduced rate has proved not only satisfactory, but profitable—the revenues having steadily increased.

In the management of this model company there is no expensive red tape; everything being simplified as much as possible, as we understand; and while the agents of the company are held to a rigid accountability, it is not considered necessary to expend a dollar to discover a possible discrepancy of ten cents.

The Montreal Telegraph Company has no debt, either bonded or floating, and it is hardly necessary for us to state that its stock is held in high estimation by investors. The shares, whose par value is $100, are held at $125, and are seldom to be obtained even at the latter figure.

It should be remembered in this connection that the territory covered by the company is much inferior, telegraphically, to that of the principal United States companies, being more sparsely settled, and embracing but few large cities or places, and none equalling many in our own country. It cannot be said either that the company has not had active competition to contend against. During its existence several rival telegraph companies have been organized, and the Dominion Telegraph Company, now in successful operation, is by no means a competitor to be despised, and is pursuing, under its present management, a policy similar to that of the Montreal Company, and with satisfactory results. The Dominion Company is yearly extending its lines, and the season now closing will have added 700 miles of line to that which it previously had. This company is also paying dividends regularly to its stockholders—that for last year, and we believe for the year previous, having been at the rate of 5 per cent. In fact, telegraphic enterprises that do not pay dividends are not much in favor with our Canadian friends.

We do not know of any existing telegraph enterprise in this country, with the exception of the Northwestern Telegraph Company, which can compare favorably with those of which we have been stating the simple facts. We do not desire or intend to make any invidious comparisons, but these facts and figures are certainly significant, and worthy of the earnest consideration of our telegraphic managers, and especially of those who are now in view the immediate future may now telegraphic enterprises. We have frequently pointed out what have appeared to us to be errors in telegraphic management, without the use of the less satisfactory pecuniary results. One of these is much too common, and cannot but be considered a very damaging one—that is starting companies with its inflated nominal capital, selling shares at a quarter to half their nominal price, and distributing large amounts of bonus stock to promoters and contractors for which it can receive no adequate return. If the nominal capital of a telegraph company represented the real actual investment at the start, and was increased only as the property of the company would warrant the expenditure of revenue or by additional investments, it will be seen that a heavy load which most of our telegraph companies have to carry would not encumber, and prevent its pecuniary success, and the money would be more carefully husbanded and economically expended. It is time that American investors should get over the fallacy which has received to pressure so much attraction, and been believed in quite generally, that dividing a dollar into two or more parts will make it go the further two or more dollars, as the case may be, while in fact the result is merely to impair or destroy its intrinsic value. Inflating the capital of a telegraph or any other corporation only decreases the ability to pay dividends on the nominal amount.

With a reasonable capital representing the actual value of the property, and economical management, there is no reason why telegraph companies in this country should not show results as handsome as that of the Montreal Telegraph Company. There must in each case be no "dogs" to absorb the profits, either in extravagant salaries or profitable pickings by the officials or contractors, in which the shareholders do not generally participate. The lines must be managed for and in the interest of the investors and of the public, for whose service they are supposed to be constructed and operated. While remunerative prices should be exacted for the service rendered, these should be as reasonable as is compatible with the proper and adequate compensation of the employés, the maintenance and extension of the facilities, as required, and a reasonable return for the investment will permit.

We should very much like to see a national telegraphic enterprise thus established and conducted in this country, and have no doubt but that its success would be assured, even with all the odds that might exist against it at the start. If the lines and companies now competing with the great telegraphic corporation of the country could be brought under one control and management, and consolidated on a fair and reasonable basis as regards capital, we have no doubt but that the additional capital required to extend and complete the system could be obtained without very little difficulty. The obstacles to such a consolidation, so far as the majority of their stockholders are concerned, are by no means so formidable or difficult to be overcome as is generally supposed, and we once more renew our oft repeated and urgent recommendation that they shall, in their own interest and for the general welfare, take such action as may be necessary to bring about the result which all concerned admit to be desirable and necessary, but which, up to the present time, very little effort has apparently been made to secure.

Correspondence.

We do not hold ourselves responsible for the opinions of our Correspondents. Our columns are open to free discussion on all Telegraphic subjects, without distinction of person or opinion.

No notice will be taken of anonymous communications

Congress and the Telegraph.

WASHINGTON, D. C., *June 3*.

TO THE EDITOR OF THE TELEGRAPHER.

Less than three weeks of the present session of Congress remains, and the Committees are working industriously to get through with the business which is absolutely necessary to be done before the adjournment.

As there is scarcely a probability that any action will be taken upon the matters during the brief time remaining, any information under the familiar head of "Telegraphic Intelligence" can scarcely be expected to prove of engrossing interest. Still it is necessary that the record should be as complete as possible for future reference, and that we may know hereafter where to pick up the threads of events.

The House Committee on Foreign Affairs have agreed to report a bill relating to telegraphic communications between the United States and foreign countries, general in its character, and under its provisions the Secretary of State is authorized to grant permission to lay cables to any citizen or association upon the conditions prescribed. Similar bills have been presented and reported heretofore, and one or two have passed either the House or Senate, but have ultimately failed to become laws. It is not likely that any definite action can be had on this new bill at this session. It will be reported and go over with the unfinished business.

There was no Wednesday of last week another session of the "War, Orton and Western Union Telegraphing Society," —this time before the House Committee on Appropriations. The Western Union Company was represented by their counsel, Messrs. Lawrence and Porter, of New York, and Mr. Geo. B. Prescott, of Boston. Objection was raised with the usual amount of statistical information. Mr. Hubbard was also present, but he had had his say previously, and therefore did not attempt to enlighten or bolge the Committee.

Mr. Lawrence addressed the Committee at some length, arguing in the first place that the evidence of Mr. Hubbard is inconsistent. This was rather a new point to the latter, and did not seem to strike him favorably. Mr. Lawrey proceeded to introduce statistics, prepared by Mr. Prescott, which may be of sufficient interest to be given in full. The first table was GRAPHIC, showing that the Western Union Company operates more miles of telegraph line than all Europe. Sweden, Norway, Switzerland, Spain, Hungary, Bohemia, Denmark, Norway, Austria, Prussia, Italy, Wurtemburg, and Egypt, previously examined, it operates more miles of telegraph, and annually transmits more messages than all Germany, Spain, Hungary and Australia, notwithstanding the fact that these countries contain nearly the same area of territory, and nearly four times the population of the United States. Europe has a population of 300,000,000, and sends annually 50,000,000 messages, being one message to six persons. The United States have 40,000,000 inhabitants, and the Western Union Company alone sends 15,000,000 messages, being one message to two and a half persons. In 1868 England had 80,656 miles of telegraph wire, and in 1873 had 103,492 miles, being an increase of 22,836, or 28 per cent. In 1866 the Western Union Company had 75,000 miles of telegraph wire, and in 1873 175,357, being an increase of 99,357, or 120 per cent. In 1866 England had 9,161 telegraph offices, and in 1873 5,471 do., being an increase of 3,325, or 154 per cent. In 1866 the Western Union Company had 2,250 offices, and in 1873 5,000, being an increase of 2,750, or 161 per cent. In 1867 England transmitted 7,500,000 messages, and in 1872 14,250,000, being an increase of 7,250,000, or 97 per cent. In 1866 the Western Union Company sent 5,891,284 messages, and in 1873 13,362,651, being an increase of 7,471,433 messages, or 123 per cent.

In 1866 the average toll upon the English lines was 38 cents per message. In 1874 the average toll is 23 cents, being a reduction of 15 cents per message, or 39 per cent. In 1866 the average toll upon the Western Union lines was $1.10 per message, and in 1874, 55 cents, being a reduction of 55 cents per message, or 50 per cent.

Another hearing was to have taken place on Friday, but the committee came to the conclusion that the pressure of business upon them was too great to admit of their devoting any more time to the subject at this session, and so notified the parties, but adding, that any letter that might be submitted would be carefully considered.

Judge Porter was to have addressed the committee on Friday on behalf of the Western Union Company; and three reasons to believe that it was fortunate for Mr. Hubbard that the matter went over, as he would have been likely to have some of his statements answered, and the Judge an opportunity to take him in hand.

This ends the farce for the present session, and it is to be regretted that it is to the poorer of any person to recuse and revive it another session. It is to be hoped all hands that neither Mr. Hubbard's assigned subject nor a Government Telegraph project, stands any chance; and it is under the circumstances unprofitable that the telegraph interests of the country should be put to contribute public and expensive time themselves against the actual attacks of any man or set of men.

In order that the public may have the evidence in Washington published, Mr. Hubbard is engaged in various lobby schemes, and the publishers of the several Bank Note Engraving Companies in their contract with the Treasury Department for the printing of the currency, which, under existing laws, has been transferred to the Department.

CAPITOL.

TELEGRAPH PROFITS.—The gross receipts of the Great Northern Telegraph Company last year were 158,031, and the net profits, after paying all expenses, were 64,586; as the latter result called for the payment for the year of 94,3551. *Eng June 26*

Long Words in Conference.—One of the results of a recent telegraphic conference at St. Petersburg, is that in messages sent from India to England, or any other country in Europe, and vice versa, any word containing more than ten letters is counted as two words, and charged for accordingly. *Eng May 1/76*

Australian Telegraphy.—The steamship Edinburgh, with the contract for the Telegraph Construction and Maintenance Company (Limited), recently brought out to Australia a new cable, which is to be laid from Port Darwin to Adelaide—about 1,200 miles. The Duke of Sutherland, we learn, is to connect a telegraph line between South America and Western Australia.

TELEGRAPHY IN SCOTLAND.—The sixth anniversary of the transfer of the telegraphs to Government was last week celebrated by the telegraph staff of the Glasgow General Post Office. Mr. HUNTER, superintendent of the Central Telegraph Office, who presided, said that there were now about 800 telegraph stations in Scotland, having the uniform charge of 1s. per message, and the whole staff employed numbered 1,200. Referring to the work of the Glasgow Central Office alone, he observed that they were in direct communication with 197 offices and various other offices by means of 2,000 miles of wire, annually passing through their hands (in addition to an enormous amount of express business) 2,000,000 public messages, and this vast number was steadily increasing. The work passing through the Glasgow Postal Telegraph Office gave employment to nearly 200 persons. This society held a meeting in Edinburgh last *Eng May 1/76*

Resumption of Dividends by the Western Union Telegraph Company.

A MEETING of the directors of the Western Union Telegraph Company was held at the Executive office of the company at noon on Wednesday, June 3, at which President Orton presided, and presented the following report, which was accepted and adopted, together with the annexed resolutions:

To the Directors.

The net profits of the company for the eight years commencing July 1st, 1866, and ending June 30th, 1874—three for the present month of June not yet audited—are $24,077,503.23.

Of this sum there has been distributed in dividends to stockholders, as follows:

Paid for the construction of lines, and the erection and the enlargement of additional wires	$4,537,722 76
Dividends paid in cash	14,028,953 23
Do. do. subject to an annual rental	200,000 00
Western Union stock (72,071 shares)	4,804,133 33
Quarterly Stock Telegraph Company stock (67,716 shares)	1,171,680 00
International Ocean Telegraph Company stock (20,000 shares)	1,000,000 00
Pacific & Atlantic Telegraph Company stock (26,666 shares)	266,660 00
Anglo-American Telegraph Company stock (21,000 shares)	10,000 00
Do. do. do. do. (500 shares)	20,000 00
Western Union bonds redeemed and cancelled	1,060,000 00
Premium on bonds purchased and not yet cancelled, including interest accrued	60,000 00
Real estate, exclusive of telegraph property	218,753 84
Cash in the Pneumatic Tube Telegraph	45,336 00
Cash in the Merchants' Union Telegraph	12,852 12
Western Union bonds not cancelled ($7,000)	6,750 00
Premium of stock, and loans, redeemed and cancelled	42 50
Total	$19,595,907 78
Leaving a balance of net profits	$4,481,595 45

Represented as follows:

Cash on hand and from agents	475,000 00
Advanced on account of the new building, fitting-up and lay-out, and for the purchase of mortgages loans	1,000,000 00
Real estate, materials, and other supplies on hand	3,006,595 45
	4,481,595 45

Of this sum, $1,000,000 is the net profit for the six months ending June 30th, being about $2,000,000 being the net profit of April, May and June. This is an increase of more than $250,000 over the net profits of the same three months last year (1873). In view of this favorable increase in rates throughout the South and West, which took effect on the 1st of July, 1873, and of the universal improvement in most kinds of business which followed the financial panic of September last, such a result is most encouraging, and seems to furnish grounds for the belief that, with the general business of the country improved, the receipts and profits of the company will continue to increase. The Executive Committee have had under consideration for some time past, the subject of a resumption of the suspended dividends upon the preferred stock. They were at first disposed to recommend a dividend equal to the net earnings of the current six months, which would be about 4 per cent on the capital outstanding. To do this, however, would necessitate either the funding of the amounts expended in the construction and on the new building, to take care of the loan made for that purpose, or the sale of a portion of the common stock now in the treasury. On mature deliberation it is deemed advisable to do neither, but to limit the dividend to the profits of the current quarter. This course they have unanimously advised in

the recommend to the Board, and, in pursuance, of which the following resolutions:

Whereas, The business and financial condition of the company justify the resumption of regular dividends by the stockholders, which, in the judgment of this Board, should be made quarterly; therefore,

Resolved, That a dividend of two per cent. from the net earnings of the three months ending June 30 be, and the same is hereby declared payable on the 15th day of July next.

Resolved, That for the purpose of such dividend the stock books be closed at the close of business on the 30th instant, and be opened on the morning of the 16th of July.

W. H. GARNER,

Unreasonable Rivalry in Australia.

THE Melbourne, Victoria, correspondent of the *Saturday Review*, in a communication to that newspaper, calls attention to the necessity which exists for a more rational system of management of the Telegraph Department of that colony. It seems that Mr. Longmore, who has been Postmaster-General for the last two years, in order to diminish the difference between the receipts and expenditures of the telegraph branch of the postal service, has cut down the maximum competition rates to a point which is unremunerative. The reduction in the rate between Melbourne and Sydney, from £250 to £100 per annum, and the consequences it has had in necessitating the department to engage in similar service in other colonies, Sydney, where there are now three liberally organized, much to the detriment of the service. He says:

Very recently three first class men have left the department to accept better positions in some of the other colonies. One of these received a salary of £180 per annum, the maximum pay for a first class man, in almost any other part of the world would be better rewarded. The Sydney Government give him £280 per annum as a minimum salary. Two other Victorian operators, one receiving £195, the other £168, go to the same country, each receiving there £60 per annum. In fact, the salary adopted towards the service here is killing it. There is no reward for any of the skill, one of the most skilled branches of the public service, and I apprehend that in a short time the Victorian telegraphic service will rank in every respect as the lowest in all the Australian colonies. The Telegraph Department, like railways, wants at the head of it a man of some standing in life, whose efforts will be directed to maintaining the revenue by increasing the efficiency of the service, rather than by cheese-paring the salaries of able men, and making it appear impolitic to increase the staff, and thereby to avoid having to fix proper rates for the value of securing its benefits, undertake the cost of its construction and maintenance. This is the smarter lesson taught by the history of southern the towns at Quarantipeque, Castlepeque, Cornwallis, Antigonish, Tatamagouche and Maccan.

"Guatemala stretches out her hand towards us, and we, in the exuberance of our feelings, cry, 'Come, enter, I am the *ensalig* season, to connect with ours. Next morning we find ourselves in a friendship and under the chain of fraternity between the two neighboring states, I helped some merchants to get a railway, and such are leads onward to ultimate perfection."

The people of Guatemala appreciate the need of the cost of maintenance and operation, though they are increased considerably. Associated with it, if therefore, is the necessity of increasing the revenue to meet the Government necessarily demanded—that is, if Guatemala is to pay a fair interest upon the capital invested.

On the 20th of December, 1873, the Supreme Government made a contract with Mr. Charles H. Billings, as an inducement for the commencement of the line of telegraph between the capital and the port of La Libertad. Having procured the necessary material Mr. Billings began the work on the first of March following, and completed the line, office in La Libertad on the 27th of April, 1870, and that of Santa Tecla on the 20th of May following. On the 24th of May the contract for the Western line was signed, on which the first instalment that proved to be due was received from Don Nejapa in this city on the 20th of October, and the second instalment was received at Quezaltenango on the 20th of February, and Santa Ana on the 20th of following December, and the last that of Jacapitio the 6th of February, 1871; the work having lasted nearly a year, in which interval a sufficient number of men were employed to construct the telegraphic system as to carry on the business of the rising stations.

Mr. Billings, the Territorial Government of Manuel Gonzales, penetrated with the importance and utility of the telegraphic system, appointed Mr. Stanley McMillor the eastern lines, with offices at Sonsonate, Chalchuenago, Tihlanco, Sensuntepeque, Cojutepeque, San Vincente, Zacatecoluca, Cuscluan, Chinameca, and San Miguel, the central office was opened on June 18th, 1872.

It being found very difficult to maintain this line, which followed the cart road from Zacate-Coluco, Guatemala, to Santa Ana, on account of the frequent encroachments of the bush, and the wires being interfered with the wires, the route being almost unpassable—a new contract was made, June 8, with Mr. McNider, for the building of a direct line between Chalchuapa and Santa Ana, which was completed on the first of July following, under the direction of Mr. Money. To avoid the dense forests and uninhabited districts it was proposed to construct this line through the open plains and valleys to the north of the volcano of Sigunteyepec, but on arriving at the margin of the Lempa, with the view on the 19th of that month, he was obliged to suspend operations on account of the opposition of the Governor of San Vincente. Finally, the Government not appreciating the advantages of the telegraphic system, refused to pay the rents, which were now in arrear, and, decided, against the opinion of the contractor, upon another route, which occasioned three months' delay in the construction of the line, and increased the cost and subjected it to the same difficulties and disadvantages before-mentioned.

The inhabitants of several towns and cities, eager to possess the advantages of telegraphic communication, offered to take upon themselves the expenses of construction and operation, which resulted in an extension of the lines of seventy-nine leagues, which brings all these places in instantaneous communication with the capital and the rest of the Republic. At the present time there are in operation 1,000 miles of wire in the three districts mentioned. Besides the principal lines of the system, there are upwards of 300 miles of wire constructed, the lines unstrung awaiting for the completion of the wires, which are much larger than (No. 4 Morse) ordinance is at four times) the private lines used.

The remainder of the report is occupied with details of accounts, orders of organization, and the necessary for more executive authority being vested in the Director or Superintendent of the system.

The Survey for the Pacific Cable.

THE U. S. steamer Tuscarora, engaged in soundings for the Pacific Cable, arrived at Yokohama, Japan, April 22d, after a passage of fifty-four days from Honolulu, Sandwich Islands, via Port Lloyd, Bonin Islands. The survey of the Southern route, from San Diego, California, to Yokohama, via the Sandwich Islands, is now complete. The result of the last portion of the survey, from San Diego to Honolulu, has already been published in THE TELEGRAPHER, together from the report of Commander Belknap to the Navy Department, dated May 25th, and bearing that date. Soundings were generally very close for the work, and over seventy-three casts were made, the deepest being 2,287 fathoms, at which depth the working of the patent reel of Mr. William Thomson and the plans were was so admirable and satisfactory as ever. At that great depth a person standing on the topgallant forecastle, and watching the running out of the wire from the reel in the paying-out, could tell the moment bottom was reached.

A glance at the profile charts shows that after the seven bad prayer is reached, near San Diego, the land descends in comparatively gentle curves and undulations to the vicinity of the Sandwich Islands, with depth of 2,554 fathoms is found; thence, westward, the depth increases until the two hundred and fifty-seventh fathoming is reached, after one of those extensive plateaus so common in the Bonin group.

The bottom of the Bonin group is volcanic, and the character of its soil nearly uniform between San Diego and Honolulu, a range of submarine mountains is found to exist between the Hawaiian and Bonin groups, with peaks of varying character, the valleys swelling by light yellow-brown ooze or mud in the specimen cups, and the sides and tops of the mountains coral, limestone and sand, with fragments of lava. In three or four instances, too, solid rock was struck, the cup coming up empty and the points freshly battered. In others the lead from the plateaus was found to be covered with specimens and fragments of lava; and, in one specimen brought up, sixty miles from the land, was found material submarine peaks, quite a heap of the same material having been found on the top. It is also found all the way from the Bonin group to the coast of Japan, and, indeed, the entire region west of the Hawaiian Islands would seem to have been subjected, at some remote period, to volcanic disturbances.

Six of these submarine mountains were discovered, ranging from 7,000 feet to 12,000 feet in height, and thence inland, which rises scarcely more than from thirty to sixty feet above the surface, lies directly in this range. A cone shaped mountain, the land appears a depth of 1,400 fathoms, coral and sand being found on the sides, with other occasionally broken with large, black, volcanic looking rocks. Between the mountains the deep appearance characterized the bottom of the shores of the Bonin archipelago of the Japanese are all composed of broken coral and sand, and are not impracticable to explore that Marcus Island forms the apex of a volcanic cone or island, perhaps, in ages past, much higher than now. A thick growth of trees covers the island, and myriads of birds were flying over and around it.

The ocean bed between the Bonin and the coast of Jeddo Bay is irregular, as might have been sup-

grown it, I remained where I was in the pelting rain all night, and it was now my turn. Things then becoming serious I fully determined to try it at all risks, so plunged in and got on my knee but had a good spell, and was desirous of regaining his mate, he swam splendidly and regained the other shore." I remained there that day just to recruit myself, and then tackled it again with both knees and equipment, crossed successfully, and remained at the creek for the night. Next morning commenced the last two days, where with the saddle and as few loads as possible, quite made the attempt to cross [illegible] level. I had, however, been too sanguine, for I had hardly got fifty yards into the water when I found myself in deep water, when here and myself were rolled over and over in the water, the saddle-pad for the time being the only thing to float me up and prevent my drowning. However, by great exertion I got myself clear of my horse, and shortly after went bump against the other side, and succeeded in landing myself safely up to the surface, and straddled across a branch. On reaching my eyes on stream I saw my horse caught against another tree, but with his legs uppermost, so I swam him out for last, and just managed to get him away when he gave a struggle, freed himself, and floated in my direction.

As he came past, I made a grab and caught him in the fore-top of the bridle, and succeeded in pulling him up, and held him till I was quite exhausted, and then let him go, when he struck out and reached the bank a quarter of a mile below where he went in. The blood was now running freely from my nose, and I felt a dizziness coming over me, so moved higher up the tree, and having got myself a rest, I was determined to have a stop holding a knife, pipe, pouch and tobacco with me. I stopped myself for about an hour, and then started for when I found myself quite the worse for the fatigue of the day, and must have been there several hours, having started at daylight. I felt very weak, and my back and legs were literally skinned with the rasp on the saddle-pad. However, I got on my horse again struggled myself on with my head and shoulders first, above the saddle. I was getting on slowly, but soon made me shift out of that, and I got up as high among the branches as possible, and made a cushion of my head with twigs and leaves. Feeling desirous of a smoke, I lighted my pipe, and after a few puffs, I was sound asleep in my whiskers to dry, which they soon did, and so managed to breathe in a comfortable way. Next evening I began to feel hungry, and to add to my unpleasantness, the creek, instead of falling, kept rising slowly. I determined to vacate my seat; so, getting on to a limb about ten feet from the water, I made a dive head first in. When I came to the surface I struck out for my life, and down, down I went, and seeming to get a lot nearer the bank, and I came to a turn in the creek, where I made a great effort and managed to reach the edge and made land-ways with my feet. In the meantime the native police had been sent out after me, and the *Gympie Gold Mining* had a report in its columns that I had been drowned. I returned to my station, started again next day, and reached at the creek. A man was sent with provisions for me and orders to return; this I declined to do, and before the men left me had another try, but my horse knew too much for me, so I tried the same here. He, however, only got into swimming water when he plunged on it, turning short round, and I was compelled to swim myself and me, I being in the stream a middle one station. I then sent back a message for the two black boys, who came down two days after; and, at the earnest request of the men, I made another attempt, finding some broken bridges and thirty-five inches very calmly swimming behind. This magnificent record of history and intrepidness is reserved for those who have reached the topmost branch of the tree in their own particular line."

The Telegraph in Central America.

NOTWITHSTANDING the many difficulties which have had to be overcome, the telegraph line made considerable progress, and on the 15th of September the first semi-circle of a belt of the States of Central America, the State of San Salvador has been the most prominent in this work, and the telegraph has already connect many of its principal places, and are being constantly further extended. The lines are also being continued to connect that State with the adjoining States, and when the line to Guatemala is finished mail will be completed; and the construction of a line connecting San Salvador with Conzagua, the capital of Honduras, will soon be commenced.

From a communication, or report, by Mr. A. Money, the Superintendent of the Salvadorian telegraphs, to the Government, made at the commencement of the present year, which has been translated for THE TELEGRAPHER, an interesting account of the telegraphs in that State, and the difficulties which have been encountered in their construction, and the progress which was effected. The Central and South American telegraphs are owned and operated by the governments of the several States and countries, and are more extensively used for Government purposes than for private correspondence, though they are all open to private use, and the earnings for commercial and social correspondence increasing as the country is settled and developed, and the public become accustomed to the use of telegraphic facilities.

The interesting report of Mr. Money alludes, in opening, to the completion of the line of the Republic of San Salvador took the lead of her sister States in the introduction of telegraph, and to the obstacles with which she had to struggle, arising from the elements, financial embarrassment, and the hostile opposition of the her rustic population, and says: "From the City of Santa Ana to the frontier of Honduras, a distance of seventy-one miles and spanning the wide-spread plains, the line was built in the most substantial manner, and the poles are of iron. Such is the admirable work that, almost from the commencement of the undertaking, public opinion, manifested in its organization as it exists to-day, I have had the honor, in conformity in all the difficulties of its construction as in all its intricate counter material obstacles, to see that over the malicious inducements of its credulous enemies, until I behold it almost perfect itself, and come to an indispensable power in the life of the people; and I feel a glow of satisfaction and pride in having, each day increasing enthusiasm and its general utility among all classes of our population."

After referring to the good faith of the employés, to whom are reasonably entrusted the most important secrets and confidences in regard to private and government affairs, he alludes to the favorable appreciation of the service on the part of the municipal authorities and the people of the towns, and of the readiness with which for the sake of securing its benefits, undertake the cost of its construction and maintenance. This is the smarter lesson taught by the history of southern the towns at Quarantipeque, Castlepeque, Cornwallis, Antigonish, Tatamagouche and Maccan.

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The Builder of the First Telegraph.

A few days ago a telegraphic despatch from Maine announced the decease in that State of Mr. O. E. Smith, who constructed for Professor Morse the forty miles of magnetic telegraph from Washington city to Baltimore, which constituted the original of the vast system of telegraphs now extended throughout the world. That line was completed for use in the last week in May, 1844, the first news despatch having been sent over the wire on the 25th of May. The quite recent death of the constructor of that line naturally carries the mind backward over the thirty years of its exist-

ence of the magnetic telegraph, and brings into bold view the feeble beginning of the marvelous progress of this peculiarly American work. After the patient but persistent efforts of Professor Morse for several years, Congress in 1843 made an appropriation of $30,000 for an experiment with the Morse telegraph between Washington and Baltimore, and it was this line that was completed in the spring of the following year. The money, grudgingly granted in the midst of scoffs and jeers and references to "animal magnetism," etc., has been frequently referred to as a munificent gift in the interest of Science and the diffusion of intelligence. Perhaps it was, but it may serve at once to illustrate the magnitude of the growth of the telegraph, and how greatly the government profited by its generosity, to say that quite recently, within a period of five years, the Western Union Telegraph Company alone paid to the Treasury in taxes $850,000, and in gold duties, on imports of telegraphic wire, $28,000 more. Thus the investment of that $30,000 repaid itself in taxes two times since, in these five years alone, and now one company alone, more than thirty-fold.

Going back to the forty miles of wire between Washington and Baltimore, which measured the whole dimensions of the magnetic telegraph this day thirty years ago, we are able to appreciate the two hundred thousand miles of wire which form the network of the telegraph over the United States to day. Of these two hundred thousand miles of American wires, which would encircle the globe more than eight times, about one hundred and seventy thousand belong to one company. In June, 1851, there were two operators at work; in June, 1874, there were nine thousand nine hundred and thirty persons employed by one American company, and about twelve thousand by all the American companies. In this exhibit of the growth of thirty years, we built the figures to the statistics of our own country, leaving the Old World out of view altogether.

In some other respects, the change wrought by the telegraph is less than the period of one generation is still more striking. It requires no strain upon the memories of even the junior partners of some of our old business houses and offices to recall the anxious times when they were more or less at the mercy of shrewd and active men who used carrier pigeons, relays of fast horses with their hardy express riders, semaphore signals from hill top to hill top and along the coast, and other similar expedients for getting advance views of important events, with all the resulting advantages. In those days fluctuations in the prices of commodities in the great markets of the world were frequently secretly known only to a few, who sold their knowledge to another few, and then a small knot of men in every commercial center were enabled to buy the property of their unfortunate neighbors for far less than its value, or sell their own for far more than its value. Now all business men get their information simultaneously, and, if they wish it, they can get it from all the markets and money centres of the world. The merchant at our Commercial Exchange is in immediate communication with corn, cattle, cotton, produce, shipping, and commercial exchanges everywhere in our own country and abroad. The banker on Third street has his wire extending from his office to New York, Chicago, San Francisco, New Orleans, London, Paris, Frankfort, Berlin, Amsterdam, Constantinople, Bombay, Calcutta, Rio Janeiro and Shanghai, and all cities and countries between. He sits there with instant knowledge of the financial, commercial, political, and other important current events of Europe, Asia, Africa, Australia, the East and West Indies, and South America, as well as of his own country. The telegraph, the Associated Press, and the newspapers within that organization concentrate this universal intelligence, and lay it before the whole public simultaneously at least twice every day; and all this

marvelous change and the vast and wonderful system that has brought it about is, as the dreams of the builder of the pioneer line sharply remind us, the growth of but thirty years.—*Public Ledger.*

Information for the "organ-grinders," Telegraphy.

MITCHELL, IOWA, *Sept* 23.

TO THE EDITOR OF THE TELEGRAPHER.

In response to the questions of the editor of the *Journal of the Telegraph*, in his home of August 15th, regarding my duplex, would say, like Mr. Farmer (I quote from the above Journal), "by adjusting the antagonistic forces of the spring so as to equal the attractive force of the magnet when acted upon by one battery," to the extent of my adjustment. I said in above issue, "outgoing current does not operate relay at that station," and not "does not affect it." I did not say "without adjustment," but did say "without any changing of adjustment above that required in the single working circuit."

I still claim a permanent adjustment or equation in batteries, *i.e.*, that sum which allows them both to relay and is never disconnected from main line, so that the battery connected with sending key at "A," is there is never opposed by battery, therefore both currents are subject to the same variations. The last assertion is totally incorrect, because none of the current from working battery flows through relay there, the principle of which he admits when he says "were the keys open or closed, how can it affect the polarity of the opposing currents or batteries?"

Truly, my "supposition is that when both batteries are connected to line no current will pass through the relays" from "M M," the *receiving* battery, "*for the reason* that any tendency in the battery connected to relay to set up a current "with" "M M," *is in short circuit*, the opposing current from the battery connected with the sending key "A A" *is closed*," is balanced by the resistance coil."

S. J. M. DEAN.

for the use and benefit of the Institution." On the communication of this generous response, preparations were at once made for the laborious undertaking, and the inauguration of the enterprise was fixed for the year 1868.

In January of that year, however, occurred the disastrous fire which so seriously embarrassed the labours of the Smithsonian Institution for several following years; it became necessary to indefinitely postpone this meteorological work, which, indeed had, through its whole history, been envied on with much limited financial means, and was quite dependent on the liberal co-operation of the different telegraph companies.

It will thus be seen," writes Prof. Abbe, "that without material aid from the Government, but through the enlightened policy of the telegraph companies, and with the assistance of the unsolicited bequest of James Smithson, "for the increase and diffusion of knowledge," the Smithsonian Institution, first in the world, organized a comprehensive system of telegraphic meteorology; and has thus given, first to Europe and Asia, and now to the United States, that most beneficent national application of modern science, the Storm Warning."

ON THE DISCHARGE OF ELECTRIFIED CONDUCTORS.

BY M. BICHEVA.

THE electrical equilibrium at the surface of a system of conducting bodies results, as has been shown by Poisson, from the following condition:—The resultant of the actions exercised by the several electric strata upon any point taken at the interior of the conductors should be nil. If we designate by σ an of those electric masses, affected by a sign according to its nature, by r its distance from a point situated at the interior of a conductor, the function—

$$V = \Sigma \frac{\sigma}{r}$$

should then have a constant value for all points situated at the interior of the same conductor. The function V, introduced by Laplace in his *analyse*, has been designated by Green under the name of the *potential function*.

If we designate by m and m' two electric masses of the same nature, situated at a distance r, each of the masses is repulsed by a force equal to $\frac{m\,m'}{r^2}$; if the distance of the electric masses becomes $r+dr$, the sum of the elementary works of the repulsive forces is—

$$\frac{m\,m'}{r^2}\,dr = -d\left(\frac{m\,m'}{r}\right).$$

The sum of the elementary works of all the repulsive forces is then equal to the increment of the function—

$$W = -\Sigma \frac{m\,m'}{r},$$

where the sum is extended to all electric masses, supposing each of them effected by a sign. The function W, is designated, according to Gauss's notation, under the term of *potential of electricity*.

The fathers of XIII. Heindhelm and Clausius have particularly called attention to this function, which plays an important part in the phenomena of electric discharge; the increment of potential represents, in effect, the work effected in the electric discharge. M. Clausius has shown that the potential can be easily expressed by means of the charges and of the potential functions relative to each conductor; if we call V the potential upon a conductor, Q its charge,

$$\Sigma\, V\, Q$$

If we call V_1, Q_1 the initial values, V_n, Q_n the final values relative to a conductor—

$$W_1 - W_n = \tfrac{1}{2}\,\Sigma\, V_1 Q_1 - \tfrac{1}{2}\,\Sigma\, V_n Q_n$$

measures the work effected in the partial discharge of the system of conductors, and, when the conductors are reduced to a neutral condition, the work of the complete discharge is—

$$\tfrac{1}{2}\,\Sigma\, V_n Q_n.$$

The mechanical equivalent of the discharge is independent of the manner in which the discharge is effected; it depends only upon the initial and final values of the potential, so that the first and the effects of the electric discharges remain the same, whatever the nature of the discharge.

M. Heindhelm has already evaluated the momentum gained by electricity in passing from the surface of a conductor to an infinite distance; but he has considered the potential of the electricity of a conductor as a constant quantity, whilst in reality the potential diminishes upon the conductor proportionally to the charge; this diminution has for its effect the re-diminution of the expression for the work which is produced in the discharge by air.

Let us consider an electric conducting body having a charge q, and suppose a quantity of electricity dq to escape from the electrified body and disappear in the air. When this electricity dq passes from a plane surface where the potential has a value V to a plane surface infinitely near where the value of the potential function is $V + dV$, designating by d the infinitely small normal portion comprised between the two surfaces at the point considered, the repulsive force exercised upon dq is $-\frac{dV}{d}\,dq$. The elementary work of repulsion,

in passing from a plane surface to a surface infinitely near, is $-d\,V\,dq$. Consequently, when the quantity of electricity dq is extended to infinity, the corresponding work has for its value Vdq, if we term V the potential function at the surface of the conductor, or, which is the same thing, at the interior of the conductor: this expression has already been given by M. Helmholtz.

The potential function V is proportional to the charge q of the conductor; we can put $V = \alpha q$, α being a constant particular to the conductor. The work necessary for the infinite repulsion of the quantity of electricity dq is $\alpha q\,dq$. Consequently, if we term q_1 the initial charge of the conductor, the work necessary for the infinite repulsion of all the electricity of the body has for its expression—

$$T = \alpha \int_{q_1}^{0} q\,dq = \tfrac{1}{2}\,\alpha q_1^2 = \tfrac{1}{2}\,V_0 q_1.$$

V_0 being the initial value of the potential function upon the conductor.

Also the work consumed in the infinite repulsion of all the electricity of the body is equal to the potential of the electricity, or, in other terms, the mechanical equivalent of the exterior discharges is equal to the potential of the electricity. The result is evidently the same for a system of electrified conductors.

32

C. H. C. suggests that telegraph companies plant trees on which to hang their wires. "In most sections of the country, the tree first planted would cost but little more than a pole, and after two or three years in growth would be a permanent pole which can rot at the bottom or need resetting, and would be seldom struck by lightning. Having many times seen from three to a dozen poles, in a row, shivered by a charge of electricity running along the wires, the above question arises in my mind."

Scientific American 3rd '75

New Style of Telegraph Poles.

There has lately been erected at the junction of Broadway and 23d street, in this city, an example of a new form of telegraph pole, of iron. It is said to be lighter than a wooden pole of the same hight, stronger, and capable of supporting a greater weight.

It is constructed of a number of wrought iron bars, rolled out the entire length of the pole, which bars are placed around light cast iron cores, arranged at proper intervals from each other. The cores have seats or notches to hold the bars in their places to prevent their moving sideways, and the bars also have notches, into which the cores fit to keep them from moving up or down. Around the outside, where each core is placed, a ring or band of wrought iron is tightly fitted, which holds the bars firmly in their places, and thus forms the whole into a light, open, and graceful column. Any number or any size of bars may be used, but it is found that six very light bars of angle iron arranged in this way afford a strength that fully meets that required for a telegraph pole of fifty feet in hight. The cores are large at the base and are made smaller as they approach the top, which gives the column a graceful taper, and the whole is surmounted by a suitable crosshead to hold the arms for the wires. Such a column is very simply constructed, and is without a rivet throughout its entire length. No machinery or shop labor is required to put it together, other than the making of the suitable rings or bands by an ordinary blacksmith, so that the pole may be ordered in pieces and put together at the point where it is to stand. The column is suitable not only for telegraph poles but for masts for iron ships, derrick masts and booms, stringers for bridges, lamp posts, and a variety of other purposes.

The Western Union Telegraph Company have begun the work of laying the telegraph wires in New York underground. Iron pipes are being placed in position under the Union Exchange, the Herald, pneumatic tubes for the transmission of telegraphic messages by the Ad Sheet are also being hooked on the line of the telegraph pipes. The pneumatic tubes are made of brass.

Jan 76

Anglo-French Telegraph Cables.

A memorial has been presented to the Postmaster-General by the Association of Chambers of Commerce with regard to a reduction in the present tariff on messages between England and France. The memorial states "that the existing tariff for telegraphic communication between France and England is incompetent with the principle of uniformity established by both countries in inland messages, inasmuch as the present charge of 1 fr. 25 c. (1s. 0½d.) for twenty words, including the telegram of twenty words to or from any point in the kingdom, rather than the metropolis, the memorialists have ascertained that a reduction in the Anglo-French tariff is favorably entertained by the French Government, and that it is prepared to bear its share of the reduction and to enter into negotiations with the English Government and the Submarine Company to that effect. The memorialists conclude by expressing a desire that the Postmaster-General would consent to a reduction of the Anglo-French telegraphic tariff to a uniform price of 1 fr. 00 c. (1s. 2d.), per message of twenty words, to apply equally to France and to England, to the provinces and to the metropolis; and that the Postmaster-General should enter into negotiations with the Submarine Cable Company and the French Government with a view to such reduction of the present tariff."

RAILWAY ACCIDENTS.—An annual number of railway accidents, chiefly collisions and derailments, must mark the most serious

The Annual Report of the President of the Western Union Telegraph Company is published in the *Telegrapher* of Oct. 14. Since the present Company was established, by the consolidation of the leading telegraph companies in the United States, the mileage of line has been increased 96 per cent., the mileage of wire 142 per cent., the number of offices 214 per cent., the number of messages annually transmitted 219 per cent., and the tolls reduced 52 per cent. The capital stock outstanding has been re-duced from 41 to 33 million dols., the difference (in the treasury), with other property acquired, re-presenting an aggregate value of nearly 12 milli n dollars. The average cost of transmitting te grams in Europe is 5-8ths of a cent more than the average cost of transmission by this Company.

Many of the officers of the late Electric and International Telegraph Company will be glad to learn that their old friend and colleague, Mr. H. Shütz Wilson, is continuing to gain laurels in the pleasant fields of literature for which, at the time for, he gave up the rougher paths of Telegraphy. His "Studies and Romances," published by King and Co., and "Philip Mannington," a novel published by Tinsley, are rapidly running through their first edition, and are much sought after at Mudie's, Smith's, and other libraries. Many will remember Mr. Wilson's early productions, published twenty years ago, in that pleasant and creditable but very scarce publication *Our Magazine*, produced entirely by officers of the Electric and International Telegraph Company. 7/6

Cavicornia, in being independent ossifications, situated on the suture between the frontal and parietal bones instead of simple outgrowths from the frontal only. A median excrescence on the forehead, in front of the above-mentioned processes, is the result of a protrusion upwards of the bones in the part.

The Pronghorn (*Antilocapra*) has well-developed horns. They are attached to ordinary bony cores, exactly similar to those of the Antelopes. They are, however, unique of their kind in that they are branched or bifurcate at their tips, a second smaller point springing from the anterior margin of the principal stem, and running forward with a gentle curve, convex upwards. In another respect these horns are even more peculiar. Mr. Bartlett, the Superintendent of the Society's Gardens, was the first to show, from a specimen living in the Gardens, that the Pronghorn is in the habit of annually shedding its horns from off their cores. This surprising discovery has since been fully confirmed; at the end of each season the cores being found covered with a skin from which the fresh horn is developed.

Respecting the geographical distribution of the Cavicornia, none are to be found in Australasia or South America. Very few inhabit North America; the Bighorn Sheep, one of the Bisons, the Musk Ox, the Mountain Goat, and the Pronghorn embracing them all. Africa is the head-quarters of the sub-order, and specially of the Antilopine family. In Europe the Ibex is a native of Poland, the Chamois and the Ibex of the Alps; while the peculiar Saïga reaches our side of the Caspian Sea. Among the best known Indian Antelopes are the Sasin or Antelope *par excellence*, and the Nilghau.

The Cheviotdale, or Tragulina, form a group of small, deer-like animals, without horns, which were formerly associated with the Musk Deer. The investigations of Prof. Flower have, more than any others, proved the independent nature of the group, which approach in their internal anatomy to the Pigs. The third stomach of other Ruminants—the Psalterium—is wanting. In the axis vertebræ, the odontoid process, instead of being scooped into a spout, as in the Deer and Antelopes, is pegs-like, as in the Swine. The second and third metacarpal bones are completely developed from end to end, and the lateral marginal intervals of the upper jaw between the canine and molar teeth are not cut away, as they are in other Ruminants. These and other peculiarities in the teeth, &c., are quite sufficient to divide off the sub-order as an independent one, ranking with the others previously described. The number of genera and species are very inconsiderable, there being two of the former (*Hyomoschus* and *Tragulus*), and not half a dozen of the latter. *Hyomoschus* aquaticus inhabits Western Africa, occupying much the same ground as does the Chinquotze. In it the metacarpal bones remain separate during the life of the animal, as in the Swine, and not in the other Ruminants. The fur is spotted like that of most young deer, throughout life. *Tragulus* is found, two species—*T. meminna* and *T. stanleyanus*—in India, the Napu (*T. javanicus*) and one or two others making Java and Sumatra their abode.

(To be continued.)

RARE ANIMAL AT THE MANCHESTER AQUARIUM

AMONG the numerous new accessions brought together to swell the list of special attractions for the thousands of Whit-week visitors at the Manchester Aquarium, one of the latest arrivals is especially deserving of notice in these columns. This is an example of the so-called "Congo Snake" (*Muræna phalo fridentici*), from the neighbourhood of New Orleans, a singular eel or snake-like animal, belonging, nevertheless, to neither of the classes represented by those two types, but rather to the true Amphibia. Judged from its shape, proportions, and colour, the uninitiated would certainly pass it as an ordinary eel, from which, on closer examination, it will be found to differ in possessing no fins, small beads-like eyes a mere puncture in the place of the ordinary gill-operculum, though more especially in having scattered at each extremity of the attenuated body a pair of feeble little legs, and each leg furnished with four slender toes. These legs may be described as almost rudimentary, but they are at the same time used by the animal, and with more marked effect than might be presupposed, when crawling over the ground at the bottom of its tank. Rising into the midst of the water, it can further swim with great rapidity, progressing then by rapid undulations of its body from side to side, after the manner of a true snake. The length of this specimen is about two feet six inches; greatest diameter, in the centre of the body, one inch and a half, tapering off from the posterior pair of legs into an attenuate and slightly compressed tail. The colour closely resembles that of an ordinary eel, being slate-grey on the dorsal surface and sides down to the lateral line, and below this, soft colour. Along the lateral line is a double row of minute punctures, the orifices, no doubt, of mucous glands similar to those existing in true fishes. The animal has to repair to the surface of the water to breathe, but this is at distant intervals, a large quantity of air being drawn through the nostrils into the lung-pouch by a singular inflation of the throat, repeated several times in succession. This specimen is exhibited in one of the octagon table tanks in the centre of the saloon, eighteen inches in depth, so that when taking in its supply of air it does not elongate leave the ground, but raises itself in a semi-erect position until the head touches the surface of the water. With the head just an inch or two below the surface, and standing, as it were, upon its posterior legs, with the anterior pair held out helplessly in the water, is a very favourite attitude with this creature, though at the same time an essentially gregarious one, reminding the observer of the somewhat similar attitude and general appearance, on a colossal scale, of the larva of *Salamandra atra* at the Geneva metamorphosis. In its native swamps the "Congo Snake" is reputed by the black population to be highly venomous, an injustice to the poor creature as great as when applied by our own benighted countrymen to the harmless Newt or Triton of English ponds and streams, and of which it is merely a highly interesting and most extraordinary zootic type.

We are indebted for this rare and, indeed, at present, we believe, in this country, unique example of this species to Capt. A. H. Mellor, of the Dunsinnie and Mantispe Steamship Company, to whose influential and friendly assistance we are also under further obligations for a fine young alligator some two feet long, the trophy of a preceding voyage.

W. SAVILLE-KENT

THE PROGRESS OF THE TELEGRAPH*

VI.

IT has already been observed that from the limited speed on the wire, the development of any extended system of electric communication between the centres of commerce in a country where great distances have to be reached, involves a vast outlay in the duplication of the circuits necessary to afford the requisite transmitting powers, and that by the application of the automatic process, in addition to the accuracy of its performance, the greater speed obtained upon long circuits enabled the telegraphic service to be conducted by a much smaller number of wires, thus relieving in a most important degree the outlay of capital expended on con-

* Continued from p. 50.

struction. It is not, however, only by the automatic process that the full transmitting capacity of a conducting wire can be attained. Metallic conductors under certain conditions are capable of transmitting more than one current at the same instant of time, both in the same and in opposite directions; and by a very ingenious system of adjustment of electric resistances and balance of currents, perfected by Messrs. Stearns, Edison, and Prescott, the American electricians, intelligence can be transmitted and recorded over a single wire in opposite directions at the same moment. This system of transmission is known as "Duplex" and "Quintuplex" Telegraphy, and is already extensively employed by the Western Union Telegraph Company in the United States, and over several of the more important circuits in Great Britain. The "Duplex" system is working in America between nearly all the principal cities, and has recently been introduced between Port Hastings, on the island of Cape Breton, where the land circuits are in connection with the submarine cables, and San-Francisco, a distance has been successfully introduced between New York and Boston, with a transmitting capacity upon a single wire equivalent to the transmitting power of four wires worked upon the ordinary Morse system. Thus, by employing arrangements such as the "Duplex" and "Quadruplex," a circuit may be worked either as one wire, or two, three, or four wires, according as the transmitting capacity of the circuit may require to be increased.

As is well known, several sounds may be conveyed at one and the same time by vibrations through a rod without interference, and it is difficult to realise the accuracy with which every vibration is separated by anyone who has not witnessed an illustration of the "transmission of sound" by solid conductors. So it is with "Duplex" and "Quadruplex" transmissions through the same wire in opposite directions at the same moment of time; it is equally difficult to realise how distinct signals can be received in either end without interfering with or destroying each other; and yet the principles involved are very simple and easy of explanation.

By the Duplex system, one of the most difficult problems incident to the successful development of telegraphic lines has been solved, namely, how to provide for the annual increase (averaging 10 per cent.) in the amount of business without the annual expenditure on capital account for the erection of additional wires. In the United States, over 150,000 miles of wire are in operation, the rate of increase being something like 20,000 miles per annum, and the Duplex system is capable of doubling the carrying capacity of these wires. The great value of the Duplex system consists in its capability to double the capacity of a wire at any moment, should injury by storm or configuration interrupt the circuits. By its means, the moment one wire is restored to continuity it becomes equivalent to two, and a second wire raises the carrying capacity of the circuits to four wires, and by skilful manipulation the system may be introduced and adjusted on a circuit in about a minute. From the earliest days of telegraphy it has been well known that two currents, either in the same or in opposite directions, could be passed simultaneously through a conducting wire; indeed, by this means, often has the frame of mind and temper of the operator at the distant station been clearly read at the receiving station, even though situated some hundred miles distant. When the direction of the currents from the two stations are passed into the wire in the same direction, the divecture force of the needle becomes more decided; but when the direction is contrary the motion of the needle will be comparatively neutralised and scarcely perceptible. The effect of a current transmitted along a wire from one station upon a galvanometer needle while currents are being transmitted from another station has therefore been long known. How this circumstance has been applied to the indication of distinct signals will now be explained.

Let us suppose two stations, A and B, are to be connected for signalling each other upon the Duplex system: the action of the coils in the instruments at the respective stations is so arranged that neither station's local or outgoing current shall affect its needle when passed into the line, its total being left free to indicate the effects produced by the incoming current from the distant station. For this purpose it is necessary to add to the coils of the instruments with two parallel wires after the manner of a differential galvanometer. Now, it is well understood in testing a line wire for resistance between two stations with a differential galvanometer, until the artificial resistance interposed has been made equal to that of the line to be tested, the battery current passed by the key into the galvanometer will move the needle in the one direction if the artificial resistance is too small, and in the other direction if the resistance is too great. It is only when an accurate balance is obtained—that is, when the two resistances have been made equal—that a current will not move the needle, because then the current is equally divided between the coil connected with the artificial resistance and that connected to the line, which two coils being wound in opposite directions counteract one another. Thus, so long as the artificial resistances (rheostats) at each end of the line are equal each to that of the circuit, each station will see the current sent by the other, while neither station will see upon its own instrument the current he is passing into the line; and for this reason, that the currents sent by each station divide equally between the line and the rheostat, passing through the coils in opposite directions, and have therefore no effect upon the needle of the sending instrument. When the distant station sends a current, it either increases or diminishes the effect of the home current; in the first case, it augments that portion which passes through the coil connected to the line, so that more flows into the line than exists in the rheostat, and the needle moves. In the second case, it reduces the current flowing to the line, and more will flow through the rheostat, moving the needle in an opposite direction. Thus if it be sent by the one operator "dot" it does not pass over another, but that when both stations send signals at the same time, the current sent by either of them acts upon the distant instrument by determining whether the currents sent by that station shall pass through the line or the rheostat. Thus we see that when station A signals separately, the current is equally divided in two, viz. through its instrument coil, and its effect is neutralised upon the needle, but it passes through both coils of the distant instrument in the *same* direction, and therefore produces a signal. If both A and B depress their contact keys at the same moment, the currents from the two batteries are united so far as the line wire is concerned, and this produces an effect upon the differential arrangements at each equivalent to a lessening of the resistance of the line, and therefore more current flows to the line than through the rheostat. It is thus seen that the Duplex system affords a means of increasing the transmitting capacity of a wire; and an invention which practically converts one wire into two, three, or four, as the necessities of business may require, is of great value.

A short historical summary of the introduction and progress of the electric telegraph, from its earliest application in a practical form to the establishment of its present world-wide reputation and utility, will following short sketch may convey in a succinct manner the steps by which progress that year by year has registered the index of improvement. It is not intended in any way to make the present sketch personal: some well-known names must of necessity be referred to, and the reader should also

be informed that the narrator in this instance has personally been more or less connected with the progress of the telegraph from 1841, the date at which this story commences, to 1875, the period under review. In the year first mentioned Charles Wheatstone, Professor of Natural Philosophy at King's College, London, was at the same time connected with a musical instrument and publishing house many of his important improvements and patents in connection with the electric telegraph were carried out, and many of the drawings connected with the filing of the specifications of these patents were, by permission of the directors of the firm, placed in Messrs. Cooke and Wheatstone were dispossed of for a sum of £20,000 to a Company called the Electric Telegraph Company, in which the late John Lewis Ricardo, M.P., for Stoke-upon-Trent, was at once the most prominent and vital element. Of this amount Cooke retained 90,000*l.*, and Wheatstone received 30,000*l.* This sum included the transfer to the Company, besides other matters, of the telegraph line between Paddington and Slough, on the Great Western Railway, already alluded to in the earlier pages of this summary. As already mentioned, this short line was a kind of Madame Tussaud—daily advertisements, and a profusion of visitors entertained, or, as they imagined, duped or humbugged, at one shilling a head, into the belief that standing before the little instruments in the Paddington station, it would *there and then* convey their thoughts, and in intelligible language return a response from a station some twenty miles distant. Inquiries as to the "time of day" "state of weather," or general health of the operator, served to test the accuracy of the new invention. Nevertheless, nine out of every ten persons who were attracted by the printed placards soon broadcast about the station, left the Paddington termini as little impressed with any belief that what they had seen represented the future germ of a great invention, as if they had viewed the automaton chess player. Necromancy, witchcraft, and delusion seemed to be the parting impression on their minds as they left, in return for their shilling charge. The announcement as issued in 1842, inviting the patronage of the public, is here reprinted; it affords an amusing souvenir of the early history of the telegraph :—

[*Facsimile of Announcement.*]

"Under the Special Patronage
OF ROYALTY.

INSTANTANEOUS COMMUNICATION
between Paddington and Slough, a distance of
nearly twenty miles, by means of the
ELECTRIC TELEGRAPH,

which may be seen in operation Daily, from nine in the morning till eight in the evening at the
GREAT WESTERN RAILWAY, Paddington Station,
and the TELEGRAPH COTTAGE, close to the Slough Station.
Admission—One Shilling, Children and Schools half-price.

Since this very interesting Exhibition has been opened to the Public, it has been honoured by the visits of His Royal Highness Prince Albert, the Emperor of Russia, the King, and Prince William of Prussia, the Duke de Montpensier, His Royal Highness the Duke of Cambridge, the Duke of Wellington, Sir Robert Peel, the Foreign Ambassadors, and most of the nobility, &c.

"In no way has the science of Electricity been made so subservient to the use of man, as in its application to the purposes of *Telegraphic Communication*, which is now brought to the *height of perfection*. The working of this beautiful apparatus can be seen in the best degree affected by the weather, intelligence can be sent by night equally well as by day; distance is no object; by the *Electromagnetic* agency communications can be transmitted to a *thousand miles* in the same space of time, and with the same ease and unerring certainty, as a signal can be sent from London to Slough, according to the best authorities, the electric fluid travels at the rate of 288,000 *miles in a second*.

"The Electric Telegraph has been adopted by Her Majesty's Government, and numerous have just completed a line of communication between London and Portsmouth, agreeably to directions received a short time ago from

THE RIGHT HONORABLE THE LORDS OF THE ADMIRALTY.

"In the late trial of John Tawell, at Aylesbury, for the murder at Salt Hill, near Slough, the Electric Telegraph is frequently mentioned in the evidence, and referred to by Mr. James Parke in his summing up. The *Times* newspaper very justly observes 'that it had it not been for the efficient aid of the Electric Telegraph, both at the Paddington and Slough stations, the greatest difficulties, as well as delay, would have been occasioned in the apprehension of the prisoner.' Although the train in which Tawell came to town was within a very short distance of the Paddington Station before any intelligence was given at the Slough Telegraph Office, nevertheless, before the train had actually arrived, not only had a full description of his person and dress been received, but also the particular carriage and compartment in which he rode were accurately described, and an officer was in readiness to watch his movements. His subsequent apprehension is so well known, that any further reference to the subject is unnecessary.

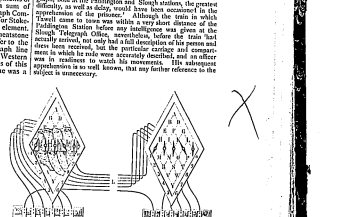

FIG. 16.—Cooke and Wheatstone's five needle telegraph.]

"The Telegraph Office at Paddington Station is at the end of the Up-train Platform, where a variety of interesting apparatus may be seen in constant operation."

The first office of the Electric Telegraph Company was at 325 Strand, a site now occupied by the Gaiety Theatre. In those days (1846) scientific men of renown crowded the instrument room to witness the progress of this great invention: George Stephenson, the Astronomer Royal, Brunel, Vignoles, G. P. Bidder, Samuda, Rennie, Fairbairn, and most of the leading engineers of the day. In

345, Strand, the magnetic disturbances and interference with transmitted signals from aurora and earth-currents were first observed and the observations tabulated, which have since proved useful, notwithstanding the then defective construction of the recording apparatus; here also the earliest lines of railway telegraph were inaugurated; the long five-inch astatic combination of the double needle and single needle instruments was employed, taking the place of less perfect apparatus. It must be remembered that, previous to the introduction of the double and single needle instruments, very cumbersome apparatus had been employed. There was the five-needle instrument, requiring five wires for the five needles, and a sixth wire for the return current (Cooke and Wheatstone's patent, 1837);

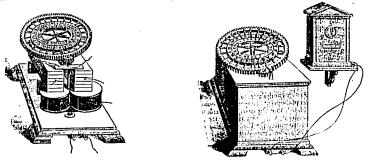

FIG. 27.—Wheatstone's letter-showing dial telegraph, 1840

the respective letter or signal being indicated by the concurrent deflection of two pointers. Obviously, this instrument became useless for extended circuits, the capital cost of outlay for the six wires restricting its use. The dial letter-showing apparatus of Cooke and Wheatstone (1840), in which the letters of the alphabet composing the word are severally presented to view at an opening in a dial-plate by means of an electro-magnet acting upon the pallets of an escapement, put in motion by independent clockwork. The communicator of the instrument is furnished with a dial-plate similar to that of the indicator, so that on the rotation of the dial of the communicator by the operator, the successive succession of make and break currents of electricity are sent through the wire and controlled so as to actuate the motion of the index-pointer of the indicator at the distant station.

(*To be continued.*)

THE INDIAN TRIGONOMETRICAL SURVEY*

ONE does not usually expect to find much of general interest in the Report of a Trigonometrical Survey. Col. Walker's admirably drawn-up Report, however, includes some matter of more than special value; indeed, many of the details connected with the immediate work of the Survey are calculated to interest the general reader, they are concerned to such a large extent with the peculiar difficulties to be overcome by the various parties, difficulties which make ordinary survey work look like mere child's play.

The Index Chart prefixed to the Report enables one to form a very full idea of the work which has already been done, and of how much there is yet to do. From Cape Comorin to Peshawur and all along the Himalayan frontier, and from Kurrachee on the west to Burmah on the east, the country is covered with an intricate net-work of triangulation, including, however, many gaps which will take many years to fill up. Shooting out from the northern border of the system of triangulation are numerous narrow-like lines indicating the secondary triangulation to fix the peaks of the Himalayan and Soolieman ranges. We cannot go into the details of the work of the Survey, and must content ourselves with a brief summary of the return of work during the year under review, and with a reference to a few of the more interesting side topics.

Of Principal Triangulation, with the great theodolites of the Survey, seventy triangles, embracing an area of 7,190 square miles, and disposed in chains which, if united, would extend over a direct distance of 302 miles, and in connection with which three astronomical azimuths of verification have been measured. Of Secondary Triangulation, with vernier theodolites of various sizes, an area of 5,212 square miles has been closely covered with points for the topographical operations, an area of 3,650 square miles has been operated in *part passu* with the principal triangulation last exterior thereto, and in an area of 12,000 square miles—in the ranges of mountains to the north of the Assam Valley which are inhabited by independent tribes—a large number of peaks have been fixed, many of which have already been found serviceable in the geographical operations now being carried on with the military expedition against the Duffles. Of Topographical Surveying, an area of 534 square miles has been completed in British portions of the Himalayas, on the scale of one inch to the mile, on area of 2,366 square miles in Kattywar on the two-inch scale, and areas of 690 and 63 square miles respectively, in Guzerat and in the Deccan 1/6th, on the scale of four inches to the mile. Of Geographical Exploration much valuable work has been done in Kashghuria and on the Pamir Steppes, in connection with Sir Douglas Forsyth's mission to the Court of the Atalik Ghazi, and several additions to the geography of portions of Great Thibet and of Nepaul have been obtained through the agency of native explorers.

In the course of the operations of the year under review the northern section of the Brahmaputra Meridional Series has been completed, whereby two important circuits of triangulation formed by it with the Assam and East Calcutta Longitudinal Series to the north and south, the Calcutta Meridional and the Eastern Frontier Series to

* General Report of the Operations of the Great Trigonometrical Survey of India, during the year 1873-74. By Col. J. T. Walker, R.E., F.R.S., Superintendent of the Survey. (Dehra Dun: Office of the Superintendent, G. T. Survey, &c. 3, O'Connor, 1874.)

5. A thermo-pile of 25 pairs, each of bismuth and antimony, was connected to the instrument. The heat from the hand placed at 5 c.m. distance caused a deflection of 3°.

6. Two cubes of boiling water acted differentially on the pile. At the distance of 5 c.m. the deflection was 20°; moving 1 to 10 c.m., the deflection was reduced to 5°.

Vallisneria Current.—7. A drop of water was placed on a zinc plate. While one of the connecting copper wires touched the zinc, the other was made to touch the water. The deflection was 16°.

The claim which is here made for the instrument, however, is rather for the general principle of its construction than for the advantages possessed by the individual galvanometer above described, which was constructed at short notice to meet an emergency. The comparatively small cost for which it may be fitted to the vertical line of the pile, the quickness with which it may be brought into use, the brilliantly illuminated circle of light which it gives upon the screen, the subdivided circle and needle, the great range of delicacy which may be given to the instrument by varying the coil and needle, and all experimental readjustments may be executed, and, finally, the satisfactory character of its performances as a demonstration galvanometer,—all combine to justify the record which is here made of it.

MECHANICAL AND ELECTRICAL TESTS OF IRON WIRE.

In a recent number of the Journal* the results of a series of tests of different samples of iron wire were given. Since that time a number of additional samples have been tested in the same manner, and the results are given in the subjoined table. For convenience of comparison, the results given in the former table have also been included in this table. In one or two slight typographical errors corrected. In addition to the column under the head of "Relative Breaking Strain," has been introduced, which has been calculated from the actual breaking strain as given in the fifth column, and the weight per knot as given in the second column, and shows the number of feet of its own length that each sample would be capable of sustaining. The arrangement of the table, it will be noticed, affords an opportunity of comparing in adjacent columns the relative breaking strain and relative conductivity of each sample. The tests are arranged in the order of their relative breaking strain.—*New York Journal of the Telegraph.*

Sample Mark and Gauge.	Weight per Nautical Mile (lbs.).	Mechanical. Per cent of Elongation.	Mechanical. No. of Twists (6 ins.).	Mechanical. Actual Breaking Strain (lbs.).	Mechanical. Relative Breaking Strain.	Electrical. Per cent Conductivity Pure Copper = 100.	Electrical. Resistance per mile in Ohms at 60° F.
EBB. Galv. No. 12	190·83	11·3	14 | 15·0 16	4391 4663	417·5	14·4	30·50
EBB. Galv. No. 8	381·66	17·7	21 | 26·5 29	9151 9301	937·5	17·3	12·67
EBB. Galv. No. 11	222·64	17·3	21 | 21·5 22	5251 5801	537·5	13·4	21·20
151. No. 93	282·80	10·0	25 | 26·5 28	7601 7891	770·0	11·9	16·10
EBB. Galv. No. 10	254·01	17·7	28 | 28·5 29	6251 7201	697·5	12·8	13·42
146. No. 93	283·50	16·0	27 | 29·0 31	8251 8751	832·5	11·9	16·10
EBB. Galv. No. 6	502·88	11·4	21 | 21·5 22	15851 15961	1587·5	12·7	9·21
EBB. Galv. No. 9	318·05	19·3	17 | 17·5 18	10051 10151	1007·5	16·9	15·54
Nashua ,, No. 8	381·65	15·1	25 | 26·5 28	15391 15401	1533·0	14·7	15·00
NS. Plain. No. 6	508·00	10·4	18 | 19·5 21	21101 21651	2137·5	13·5	11·78
443. No. 8	378·10	10·0	29 | 31·0 33	16301 16401	1635·0	12·3014	16·3
AH. No. 93	293·50	16·0	27 | 27·5 28	12351 12661	1257·5	21·53·0	15·1	22·70

NOTES.

THE iron telegraph poles in Persia are put to a novel use. A friend who has lately returned from that country informs us that between Teheran and Shiraz it is the common custom of the inhabitants to use the poles as targets for rifle shooting. Standing at one post and shooting at another, the people find the telegraph poles most convenient institutions for gun practice, and no doubt many believe that is their proper and legitimate use. The poles are made of sheet iron, and the natives test their guns by trying whether the bullet will pierce the post. Some posts are thus riddled with holes, and soon give way altogether. The reason why telegraph posts in Persia require frequent renewal is no longer a mystery.

The report of the Meteorological Committee of the Royal Society for 1872, issued on the 17th inst., contains the following information respecting weather telegraphy:—The office receives, or would receive, were the Continental telegraphic communication and that with the Shetlands perfect, fifty-one reports every morning, and nine every afternoon, except on Sundays. The observations are taken on Sundays as on other days, but are not received at the Meteorological Office until Monday morning, when the report for Sunday is made out. The stations are situate along the entire coast of the Continent, from Christiansund, in lat. 63 deg. N., to Corunna, in lat. 43 deg. N., with four stations on the coast of the Baltic

crease δ till the condition $a' d = b (L+\delta)$ is again fulfilled, when perfect signals will be again received.

23. The adjustment in the δ branch is not made by the comparatively slow method of withdrawing or inserting plugs, but by means of a contact sliding over equal increments of resistance fixed in a circular box. Moving the slide in one direction increases δ, and moving it in the contrary direction decreases it, and this adjustment is quite as simple as turning the micrometer screw of an ordinary polarised relay.

Batteries.

28. For duplex working about four times the battery power employed for single working is required, for the current—from Station I. for instance—side divides at the point x, and subsequently divides again at the point z. The key equations—

$$x+\delta = x'$$

should be controlled once or twice a week by accurately measuring the internal resistance of the battery and then unplugging in W that amount of shunting necessary to fulfil the key equation. The cells should be very carefully prepared, the same amount of amalgam by weight should be placed in each one, the rims of the jars should be paraffined, and the battery stands should be carefully insulated from the ground.

Control of the Duplex Instrument.

29. Tests of the several resistances for constancy, and of the condensers for insulation and capacity, should be made and recorded periodically.

Station of Work.

30. On commencing the day's work, and after both stations have received the line for "*permanent and transient current*," by means of the Morse instrument, Station I. for instance, signals to Station II., the word "*balance*;" Station II. then sends *intelligible*, and Station I. answers *relay*, by means of the micrometer screw for ordinary single signals, and then sends alternate signals O, U, to enable it also to adjust relay for single signalling. When this is done, adjustment by means of the micrometer screw ceases entirely, and both stations send signals simultaneously, and increase of decrease—as may be found necessary—the resistance in the δ branch, till perfect duplex signals are received. During the transmission of messages any adjustment that becomes necessary on account of variations in the line is confined solely to the δ branch. Corrections and questions are obtained as follows:—The receiving signaller, on finishing a message, makes a cross or underlines the words that he wants repeated, and places the message by the side of the sending signaller, who, after finishing what may be in course of transmission, calls for the required repetitions. In like manner the receiving signaller, who must have the sent messages near him, marks with a cross those words repetition of which is called for, and hands the message to the sending signaller, who goes on the repetitions; consequently there is no interruption to traffic—messages and calls for repetition follow one another contiguously.

Abbreviations to be used when calling for Corrections, Repetitions, &c.

FULL SENTENCES.		ABBREVIATIONS.	
In L.D.Q repeat Class		In L.D.Q	
" Number	"	"	Class
" No. of words	"	"	No.
" Date	"	"	Date
" Time	"	"	Time
" Station To	"	"	Sta. To
" Station From	"	"	Sta. Fr.
" Service	"	"	Ser.
" Name From	"	"	Fr.
" Address To	"	"	A.
" Signature	"	"	Address to Signature
" Repetition of word after not	"	"	RPT.
" Word, words, or sentence	"	"	W., P. R., RPT. Q. (Mean letters to present the numbers of words.)
" Alphabetical	"	"	Alter (figures)
" From allegory to beauty	"	"	Allegory to be-

Figures.

Instead of repeating *both* figures, as is the rule at present, they are to be sent *once again* after the end of the message.

THE TELEGRAPHIC CONFERENCE AT ST. PETERSBURG.

THE Paris correspondent of the *Times*, writing on the 16th inst., gives an outline of the principal discussions at the recent International Telegraphic Conference.

One of the first questions raised was that of Sunday labour. Mr. H. C. Fischer, of the English Post Office Telegraphs, claimed the right of a limited day service on Sundays for those offices which have a complete day service. This, he said, was necessary on account of the suspension of nearly all labour on Sundays.

On the proposal of M. Vincent (Belgium), who objected to exceptions in favour of particular States, it was agreed that any country may limit the hours of Sunday service, reducing this measure to the International Bureau, which will apprise the other States.

The question of responsibility for the correct transmission and delivery of messages was brought up by the French delegates, who proposed that, as in exchange for which an extra sum is paid for insurance, there should be some fixed limit of responsibility. To this it was objected that words difficult to transmit or copy might be used on purpose to set up a claim to compensation, and the Committee to which the proposal was referred reported by five to three against it.

M. Allibaud (France) urged on its behalf that registered letters had never produced lawsuits or inconvenience, but he was willing to exclude cypher messages and to limit compensation to cases where the telegram had manifestly not fulfilled its object. As to the fact that in France secret service messages is no more cumbrous, rather the number of collated despatches would not increase, and the responsibility proposed would be very slight, or it would augment, thus showing, that a public want had been satisfied. Several other private companies, he mentioned, since this law altogether was in force, the maximum compensation being ten times the cost of the message.

Herr Stephan (Germany) took the same view, thinking it unfair that the Government should be capable of miscarriage, and should be absolved from responsibility. The principle of compensation would operate as a limit to negligence and reduce greater cases. Inquiry, moreover, would always show whether the sender had been guilty of bad faith, or whether injury had been sustained.

On the other hand, Signor D'Amelio (Italy) urged that the telegraph was more liable to error than the Post Office, that faulty operators were already punished, that the best operators, owing to the nervousness consequent on their employment, oftenest committed mistakes, and that the system should first be tried in France or some other country.

Herr Stephan, in reply, said nervous operators ought to be dismissed.

M. Faber (Denmark), contended that the compensation should be divided among all the States sharing in the profits made for the telegram, but it was explained that the extra payment would be shared among all the States concerned, while the compensation would fall on the one guilty of the irregularity.

M. Nielsen (Russia) suggested that the indemnity should be limited to five times the cost of the message.

Eventually it was agreed, at a special committee of seven members should consider the question. This committee, by five to three, agreed that the cost of a registered message should be entitled to the return of his money and a fixed sum of 50 francs, the latter, however, not applying to irregularities caused by *force majeure* or

over

An iron telegraph pole has lately been erected in New York. It is said to be lighter than a wooden pole of the same height, stronger, and capable of supporting a greater weight. It is constructed of a number of wrought-iron bars, rolled out the entire length of the pole, which bars are placed around light cast-iron cores, arranged at proper intervals from each other. The cores have seats or notches to hold the bars in their places to prevent their moving sideways, and the bars also have notches, into which the cores fit to keep them from moving up or down. Around the outside, where each core is placed, a ring or band of wrought-iron is tightly fitted, which holds the bars firmly in their places. Any number or any size of bars may be used, but it is found that six very light bars of angle iron arranged in this way afford a strength that fully meets that required for a telegraph pole of 50 feet in height. The cores are large at the base and are made smaller as they approach the top, which gives the column a graceful taper, and the whole is surmounted by a suitable crosshead to hold the arms for the wires.

ELECTRICAL NEWS, August 1, 1879.

The Western Union Telegraph Co. is completing a tower of 50 feet in height on the crest of the lofty highlands of Newcastle. The operators, who are to have the most powerful glasses, will be able to distinguish steamers and other vessels 20 miles out.

At Simla a house belonging to the Government, and inhabited by one of the leading officials, was recently struck by lightning. A native subordinate of the Public Works Department was deputed to erect a conductor. In course of time, says the *Times of India*, the workmen placed four metallic rods in position on the roof, and connected them about half way down the building itself, which, material failing him, he deemed his job

CAUSES OF DESTRUCTION TO WOODEN POSTS.

By M. BOURSEUL,
Sub-Inspector of French Telegraphs.
(Concluded from page 90.)

I have often observed on rasped trees upon which the bark has been left that the *Aubier*, or inner bark, has withered; consequently the fibres of the wood tend to close up on each other, whilst the drier or harder core preserves its volume; the fibre splits, and the wood cracks. From the surface the germs of decay are installed away by rain, or carried off by wind; but in these trees they are very plentifully, and in a short time produce the fungus. The same thing naturally takes place when two pieces of wood are brought together.* In duplex poles are placed naturally on upon the other; if they remain too long in the same position, *even when they do not lie immediately upon the ground*,—if they are exposed to rain, or, being covered, if they are in the shade in a damp, badly-aired spot, the fungus asserting itself soon develops at all the points of contact existed between the poles. Should care not be taken, and the poles be plunged in that condition, it will not be long before the decay (rot) crown-burns should threaten to be mistrusted in telegraph poles, &c.

When, under exceptional circumstances, poles are obliged to be left stored in a depôt, they should be turned from time to time, so as to change their points of contact and successively expose their different parts to the light; and when the fungus has begun to develop itself, it is indispensable that the affected part be cauterised, either by fire or by sulphuric acid.

When once the *Mérulius* attacks planted poles it is very difficult to preserve them. The moment the authorities charged with the surveillance of the lines observe at the foot of a pole the existence of those filaments which denote white decay, they should lay bare its foot until they meet with no further trace of mycelium in the soil; the part of the detached earth should be thrown to a distance, and only bit of contaminated wood should be taken away by the hatchet or by cutting tool.† Then two shavings or branches, tied together around the pole earth as cramped, clipped, and free from it as possible. Afterwards leave a day mixed with water, of cement, or fat masses, will compact the whole together, and form a kind of natural concrete, often sufficient in itself to completely preserve the wood.

Because the fungus, in order to vegetate, requires access to the atmosphere, it is not developed below a certain depth, varying from 30 to 50 c.m., according to the nature of the soil. In grounds where the wood is usually attacked we must—without waiting till the "rot" has commenced—renew the earth at intervals, and well ram it down. The best instrument will evidently be the least weighty one, and one which, without burying itself in the soil, possesses the most possible surface.

By turning over and renewing the earth at intervals all

* In double poles the cross-bars are fixed with each of the poles, and therefore the same results may be expected.

† The cutting tools, straight, but rounded a little towards the end, are well adapted to this purpose.

‡ The conclusions of the experience last been observed unfavourable as far as to a depth of 3 metres. But this instance of gradual must be considered as thoroughly exceptional.

Electrician: May 28, 1881.

OVERHEAD *v.* UNDERGROUND WIRES.—The Chicago Common Council has passed the following resolution:—"No person shall hereafter erect, construct, or put up, any telegraph pole, telegraph line, or wire, electric conductor, in any street, avenue, or alley, within the corporate limits of the city of Chicago, under the penalty of 100 dollars for each and every offence. And each and every day any such telegraph pole, line or wire, or electric conductor shall be continued and maintained after the first conviction shall constitute a new and separate offence." This law rather discomforted the telephone companies.

injurious repetitions are destroyed; and for the same reason brambles must be removed, as also shrubs, since these not only produce an injurious effect by their roots, but they hide the foot of the post from the light, hinder circulation of the air, and maintain a constant dampness.

These operations will considerably retard the destruction of timbers, and will very often preserve them from "rot." It must not, however, be denied that it is very difficult to combat the fungus when once the rot, in attacker; and to make sure of guarding against it, the surface of the wood must be entirely isolated from the water and air which surrounds it. To this end a hole is made around the pole, in the form of a covered cone, to a depth of about 50 cm. This hole is filled with concrete or cement, and the black is carried from the level of the soil by an inclined surface, open and from which the rain water glides. The joints near the timber should be attended to with exceptional care.

Iron should be used for the same purpose are dear; moreover, for reasons to be hereafter detailed, their use is not recommended. Stone is the best material for the following reasons by first-rating, with sculptured ornaments, all these portions to be preserved, and afterwards covering; then with a sheet of zinc, soldered to the joint, and finely fastened above and below.

The line entrances have often assured me that the raising posts always rot in a greater proportion than ordinary supports. All but this seems impossible, but it admits of easy explanation. These posts are most often placed close to cultivate which lead to precisely on the banks of a river. The lime and sand used in their construction mix with the surrounding soil in quantities sufficient to cause wood-rotting,—an action which is also facilitated by an abundant dryness and moisture, resulting from the close neighbourhood of the trench. We should therefore be careful not to plant wooden supports too near cultivate or arched drains.

We ought equally to abstain from the fashion of planting a new pole in a hole from which a rotten one has been taken. The germs of destruction being close at hand, the second pole will perish yet more rapidly than the first.

The practice of heating all rotten poles level with the ground is very bad. They should be pulled out entire; the diseased parts should be burnt, carried away; the old hole should be filled up, and another hole made, the new pole should be placed at least a yard from the locality of the old one. If rotten sleepers or cross-beams and the ends of posts are left about, the filaments of the mycelium —in light or cracked soil—force their way through the ground in a manner and to a distance one would have deemed impossible, and will soon invade unaffected localities.

It may be remarked that when once a pole has been injured by wet-rot, if it be carefully taken up and all the rotted portions sawed away, and if it be replanted at a sufficient distance from its former position, it will not, in a usual way, be long serviceable: it will soon recommence to perish, as it is almost impossible to prevent some destructive germs remaining in the fissures of the wood. The soil is greater still if, instead of replanting the wood at once, it be left exposed for a certain time to the air. In such a case it is not worth the carriage. Once replanted, it almost always perishes with very great rapidity.

If I have succeeded in laying bare the nature of the evil so he fought against it, I understand how much easier it is to be prevented than to be cured, when once it has made its appearance. It seems to me almost certain that among the numerous coatings known as preservative compounds, one can be found capable of preserving buried woods; and supposing, which is very probable, that this

* These observations show that the position of the cavities of telegraph supports becomes more and more difficult; as we have seen, the quantity of matter in decomposition which may accumulate on the surface of ground in close proximity to railways, as much from the cinders of locomotives as from the support the rails as from the rot of the feet of poles planted.

exciting would require to be renewed at longer or shorter intervals, its use would still effects a considerable saving.

Century has not been successful. I have reason to believe that it has not generally been well applied. The tar ought to be used hot, though it should not be allowed to boil too long, lest it lose the essential oils which alone assist in to enter into the wood, and lest it become reduced to a substance in all points resembling bitumen. The wood should be well heated. By this means moisture is dispersed, the pores are opened, and the material by penetrating freely, altering and retaining layer. A single thick layer has a very bad effect; repeated and light layers should be given, though it is a difficult operation. For want of following out these precautions we simply lay on the wood a coating which is repulsed from it by resistance, and is of a brittle, cracking, and splitting character. Under these circumstances all the destructive agencies penetrate by the splits, and the wood is attacked as though it had been not at all treated. The best method consists of three distinct parts: a metallic mirror with linear facets; a blackened boiler the axis of which coincides with this focus; and an envelope of glass, allowing the sun's rays to reach the boiler, but preventing their escape after they are transformed into obscure rays. He has convinced himself (he says) that the proportion of the heat utilised to the extent of the surface of normal insolation increases with this extent, or in other words, the productive power of a large generator is better than that of a small.

He describes the large generator which has been in work at Paris for some time past. The mirror has the form of a truncated cone with parallel bases. The generating surface of this cone makes with the axis an angle of 7°; this, he (Depuis) showed best century, is the best form for that kind of mirror because the incident rays, parallel to the axis are reflected normally to the axis, and give a form of the maximum intensity for the same aperture of mirror. The reflecting surface is composed of twelve sections of silver plate, supported by a framework of iron, in which they can slide. This arrangement allows of removing each sector in order to clean it, or to substitute for the silver plate polished brass, which produces the same effect. The diameter of the aperture of the mirror is 250m.; that of the bottom is 1 metre; whence it follows that the surface of normal insolation of the apparatus is about four square metres.

The bottom of the mirror is a disc of cast iron, added to diminish the force of the wind. At the centre of this disc rises the boiler, the height of which is that of the mirror. It is of copper, blackened externally with lamp black. It consists of two envelopes of bell-form, connected at their base by an annular ring. The outer envelope is 80 centimetres in height, the smaller 70 cm.; their respective diameters are 28 and 22 cm. The water is inclosed between these two envelopes, forming an annular cylinder 3 cm. in thickness. The volume of liquid should not exceed 20 litres, so as to leave about 10 litres for the steam chamber. The boiler, when empty, is terminated by a copper tube which opens on the one hand into the steam chamber, and communicates on the other by a flexible tube with the boiler of the motor or with the fire-place of an alembic. A second flexible tube, connected with the bottom of the boiler, serves to convey the water to it.

Lastly, on the steam pipe are fixed safety valves.

As for the envelope of glass, it is a bell 85 centimetres high, 40cm. diameter, and 5mm. thickness. It allows, then, a constant interval of 5mm. between its walls and those of the boiler, and is adherent only by its foot to the bottom of the mirror. Thus arranged, the generator should turn about 50° in the hour, about an arbour parallel to the axis of the earth, and incline gradually

The English Mechanic
AND
WORLD OF SCIENCE AND ART.
FRIDAY, OCTOBER 22, 1875.

ARTICLES.

ON INDUSTRIAL APPLICATION OF SOLAR HEAT.

IN a recent paper to the French Academy (October 4) M. Mouchot gives an interesting account of some attempts he has made to utilise solar heat industrially. The solar generator, as he now has it made, consists of three distinct parts: a metallic mirror with linear facets; a blackened boiler the axis of which coincides with this focus; and an envelope of glass, allowing the sun's rays to reach the boiler, but preventing their escape after they are transformed into obscure rays. He has convinced himself (he says) that the proportion of the heat utilised to the extent of the surface of normal insolation increases with this extent, or in other words, the productive power of a large generator is better than that of a small.

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Lastly, on the steam pipe are fixed safety valves.

As for the envelope of glass, it is a bell 85 centimetres high, 40cm. diameter, and 5mm. thickness. It allows, then, a constant interval of 5mm. between its walls and those of the boiler, and is adherent only by its foot to the bottom of the mirror. Thus arranged, the generator should turn about 50° in the hour, about an arbour parallel to the axis of the earth, and incline gradually to this arbour, regard being had to the declination of the sun. M. Mouchot describes how this is provided for.

The apparatus acts, of course, only in the sun. The following are some of the results obtained with it:—On 8th May, in ordinary good weather, 20 litres of water at 20°, introduced into the boiler at 8.30 a.m., took, after completion of air, 40 minutes to produce steam of 2 atmospheres—that is to say, at 121° C. This steam was then raised rapidly to the pressures of 5 atmospheres, which it reached in 5 minutes. It would have been dangerous to exceed, notwithstanding the regularity of the heating, the sides of the boiler being only 5mm. in thickness, and the total steam generated by these sides being then about 10,000 kilogrammes. Towards mid-day, with 25 litres of water in the boiler, the steam at 100° rose in less than 15 minutes to the pressure of 5 atmospheres, or, in other words, to the temperature of 152°. On the 23rd July, about 1 p.m., when there was unusual heat, the apparatus supplied 5 litres of water in the hour, corresponding to a production of 150 litres of steam per minute.

In default of a motor adapted to the apparatus, M. Mouchot used at first a large experimental engine, without expansion or condenser, the capacity of the pump being one-third of a litre. This machine made, in good weather, 80 strokes in the minute, under constant pressure of one effective atmosphere; it also work when the sun was slightly clouded. Quite recently M. Mouchot has substituted a Berlin's small steam engine; this has worked wonderfully, especially as it is directly a small centrifugal pump, which has proved too weak for the generator, and is disheated.

Lastly, M. Mouchot has brought the steam from the apparatus into contact with wine; he has thus distilled 5 litres of wine in a quarter of an hour. The steam could also be made to rapidly cook vegetables, food for cattle, &c.

From the results he concludes that the apparatus utilises, on an average, in that region, about 8 to 10 calories per minute and per square metre. This is, however, only an approximation, because the intensity of the reflected heat constantly increasing from the base to the summit of the boiler, the temperature of the latter is not uniform. The glass of the reflector being only a quarter of a millimetre in thickness, he considered to not to be therefore too small a portion of the incident heat.

DRY-ROT IN TIMBER.*

CONTINUING our notice of Mr. Britton's work we have to deal first with the important process known as seasoning. The methods employed for seasoning timber divide broadly into the natural and the artificial—the former being undoubtedly the best as far as the quality of the material is concerned, while the latter are those of great value in a commercial point of view, and are consequently the subjects of numerous patents. All wood that is used in the arts of construction, and intended to be durable both in substance and shape, should be thoroughly seasoned—that is to say, it should be thoroughly drained of sap, and have been so treated that the albuminous matter it may contain have lost their liability to ferment. When a tree is felled it contains, even if it has been barked for some time previously, a considerable quantity of sap, which consists of water holding gummy, saccharine, saline, and albuminous matters more or less in solution, and if these are not reduced to the dry and solid state, they are liable to ferment and cause the premature decay of the wood. If the drying is carried on by natural means the process is slow—two years being required for timber intended for carpentry, and double that time, and more too, for wood used in joinery. Timber in the log is liable to attack by the action of the weather, and loses by the very same process a large part of its value. It consequently soon as soon as possible, when the seasoning process is carried on with care, the actual loss is small, and with considerable increase in the value of that which does not split or warp. The most trifling great care is taken in piling the planks, and the stacks should be well-pegged and thrawed three times round; for it is found that timber which becomes bent during seasoning, or during the early stages of that process, will retain the bend when dry. With different kinds of timber different methods of treatment are adopted in the seasoning. Trees that contain little sap may remain for years in the log, and most kinds may have the splitting tendency reduced by squaring them, which will remove much of the sap wood. Where possible, timber to be seasoned should be set upright, protected from the sun and the rain, and so stacked that a free current of air may constantly circulate without the timber being exposed to strong currents of wind. But when the greatest precautions are taken there are some kinds of timber which will always warp, and others, notably white Petersburg deals, which are naturally hygrometric, swelling in a damp atmosphere, and contracting again in a dry one. It may, however, be taken as a general rule for all kinds of timber that, whatever expedient may have to be beat as regards the preliminary seasoning, some time before it is used the wood should be reduced to something near the size it is intended to remain, by the ordinary process of boat. It, however dry a piece of timber may be, it will absorb more or less when cut to a smaller seantling, in consequence of the coating being less dry than the exterior, and it should be noticed in favour of this process that a well-seasoned wood that the more rapidly the drying has been carried on the greater will be the subsequent shrinking. *ceteris paribus* in dimensions, which is largely used for curved work and the finer fittings of buildings, requires very careful seasoning, for it is easy to conceive the destruction caused by shrinking in panelling. Mr. Marshall advises that oak for this purpose should be barked as it stands—in the spring, we presume, and cut down in winter, when the sap is then partly dried out by the most natural means, and when acquires a rich brown colour. As soon as the tree is felled it is to be sawn into the required lengths and thicknesses, viz. 3in. 1in. thick, taking the first cut through the centre of the tree, so as to remove all heart-shakes. With regard to the drying, he recommends stacking in a shed with a good draught through it, laying the planks with their ends between, so as to prevent warping. If this plan is pursued it is said that the wood will not require ovens to the weather. On the other hand, Mr. Phillips, while recommending that the tree should be cut as soon as felled, would have the pieces 12in. or 6in. thick, and would stack them on end in the open, keeping them wet by artificial means if necessary, during the first three months. After being exposed for about six months it is put into a dry place for some little time, and then cut up to the sizes required by the joiner, allowing for a shrinkage of 1in. to the foot, when it is stacked in a covered shed, weighted to prevent warping, and occasionally turned and shifted. Mr. Phillips advises that oak should be cut in fortnight-old moons, or in mild moons from the centre of the tree. It is a waste of material, he says, to leave the bounty of the wood and its freedom from warping.

The two methods above given are a fair

* A Treatise on the Origin, Progress, Prevention, and Cure of Dry-Rot in Timber. By T. A. Britton, Architect. E. and F. N. Spon.

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A NEW TELEGRAPH SYSTEM.—A new telegraphic system invented by Paul la Cour, vice-president of the Royal Meteorological Institute at Copenhagen, obtained considerable attention lately at the International Telegraphic Congress at St. Petersburg, where the inventor exhibited it. The invention is thus described by the inventor:—The system does not consist in a new form of receiving and transmitting apparatus, which by the talented combination of Hughes, Wheatstone, Siemens and others have attained such a state of perfection that great improvements seem improbable. La Cour's system, however, opens up a new scope for telegraphy in that he has constructed some simple instrument, whereby the electric current, by being passed through different instruments obtains different qualities, whereby it can act upon corresponding instruments at the receiving station. Supposing twenty conducting wires be led from one of the poles of a battery through twenty such instruments, then by connecting each or some of these with a single telegraphic wire the following result is obtained, viz., that an electric local current is produced in the twenty corresponding conducting wires on the receiving station, exactly as if the twenty conducting wires on the transmitting station were connected with the twenty conducting wires on the receiving station, by means of twenty separate telegraphic wires, while there is in reality one single telegraphic wire only. La Cour's instruments consequently accomplish the same as if the number of telegraphic wires were the same as the number of instruments; they are very simple, and their construction is as follows:—Each of these little instruments contains a tuning fork which is so connected with an electro-magnet and two wire coils, that the electric current by traversing the instrument becomes isochronously vibrating in the "measures" which corresponds with the note of the tuning fork, and when a thus vibrating current then traverses similar instruments on the receiving station, then those tuning forks in them which have the same note as those in the transmitting instruments will be set vibrating, and thus a current is caused in their local wires. It is evident that such a multiplication of a telegraph line can be very advantageously applied in many ways. As each pair of instruments applied at the two termini of the telegraph line represent the application of a new line, a new pair of telegraphic clerks can be applied to correspond with one another without disturbing the correspondence going on along the same line, and the correspondence can thus be considerably multiplied. Instruments at intermediate places can also be applied, and thus many different telegrams can be sent simultaneously to different stations. This system is also suitable for transmission of handwritings or drawings—pantelegraphy. Heretofore this has been done by the synchronous movement many times over the paper of a single line on the transmitting and receiving station, but in La Cour's system a great number of lines may be moved over the paper side by side, and the handwriting is produced by one passage over the paper. The vibrating currents in this system have also the advantage that they do not affect other ordinary relays or receiving instruments through their pass, so that they can pass through a line without disturbing the correspondence going on, neither do the ordinary currents from the other end affect La Cour's receiving instruments. These vibrating currents thus neither disturb the ordinary telegraphing through the line nor are they disturbed by it.

Engineer Sept '75

THE directors of the Clay-street-hill Railroad, San Francisco, recently removed the old wire rope which has been in use for some two years, and substituted a new one. The road runs up Clay-street-hill, and the cars are propelled by an endless wire rope passing up one side of the street and down the other, underground. The engine furnishing the power is at the upper end of the line. The old rope was 7000ft. long, three inches in circumference, and made of 114 steel wires of No. 16 gauge. It was put in use August 22nd, 1873, and was in use two years three months and twenty days when removed. It was made to work seventeen hours a day while running. During this time it carried 3,300,000 passengers. A few deductions, says the *San Francisco Scientific Press*, showing the amount of work obtained from this rope will be of interest. The 3,300,000 at an average of 150 lb. apiece would give 495,000,000 lb. Eight cars go up twenty-five times a day for 840 days, giving 705,600,000 lb. Adding the weight of the cars to passengers it gives 1,200,600,000 lb., or 600,300 tons, raised 307ft. vertically in a distance of 3300ft. in 840 days, working seventeen hours a day. The result is, we get 1,200,600,000 lb. raised 307ft. in 856,800 minutes. This rope travelled 64,260 miles, or more than equal to two and a-half times the distance around the globe.

The Decay and Conservation of Wood.

MB June '76

I.

IT is well known that wood of different kinds, under various circumstances, is subject to certain changes, which are of a chemical character, called decay or rot, and which causes the wood to become, for certain technical purposes, of less value, or even totally worthless.

Careful investigations into the nature of this, in a practical point of view, so important a phenomenon, have shown that there are five different kinds of changes of this nature which wood may undergo; there is, 1st, the suffocation of the wood; 2d, fermentation; 3d, decay; 4th, humification, (humus forming); and, 5th, dry rot. The most important of these are the moist rot and the dry rot, as they are the commonest and ruin the wood most of all for technical purposes; for these reasons we will give them special attention.

Fermentation is a comparatively rare change in the wood ... der extraordinary circumstances to which wood is rarely exposed, while the often observed suffocation changes more the appearance of the wood, but not so much its practical value—at least not to any considerable degree. In a general way it may be stated that the dry rot of wood only takes place in the presence of oxygen and comparatively little moisture, being a kind of slow combustion, by Liebig called "eremacausis," while the moist rotting and humification do not need the presence of oxygen, and usually take place in water or in the ground. If by the exclusion of atmospheric air and the presence of moisture, either moist rot or humification takes place, depends on the temperature by which the chemical decomposition of the wood is effected. Humification takes place at a lower temperature, rotting at a higher; but in the latter case the presence of nitrogenized compounds, and the presence of more or less water, can also determine the result.

Fermentation of wood is nothing but the alcoholic fermentation of the contents of the cells, while suffocation is a process as yet not well understood, which consists chiefly in a chemical change which affects principally the color of the wood.

Some investigators add to these five kinds of destructive agencies a peculiar decay of the wood which must be distinguished from the moist and dry rot; next a molding of the wood, and finally the formation of parasitic fungi. If we must add all destructive agencies, we ought to mention the damage done to it by various insects and other animals, and finally the utterly destructive agency of fire.

Nature of Dry Rot.—What is called dry rot consists of a process which is mostly seen in trees which have died at the place of their growth, or parts of trees which from some cause have lost the vitality of the trunk; it is less common in lumber which has been felled when in good, sound condition. The consequence of the dry rot is that the wood takes a light, sometimes even a white color, and is easily pulverized, so that the use of such wood for the purposes of resisting strains in buildings is out of the question. Even as a fuel, such wood has lost most of its value, as some of the combustible elements in the same, (the carbon and hydrogen,) being already partially slowly oxidized and carried off as carbonic acid and watery vapor, can no longer contribute to the heat evolved by combustion, which is all due to the rapid oxidation of their elements.

If this process of dry rot takes place in warm weather, and is hastened by heat and sunlight, a peculiar result is sometimes obtained, namely, the white bleached wood becomes phosphorescent—an interesting phenomenon which an observing person can often see when walking about in the country during summer evenings. The slow but active oxidation which is always connected with every form of decay, shows in this case a similar action to that seen by the slow combustion of phosphorus. In both cases the latent energy, which is set free in consequence of the oxidation process, effects not only, as usual, the mode of molecular motion called heat, but also in some of the molecules or atoms so intense a motion, that they show self-luminosity, a phenomenon which, as is well known, has many analogies in nature.

Such is the ordinary view in regard to this phenomenon; but we ought to add that F. Ludwig published in 1872 the result of his researches, which appear to show that this capacity of decaying wood to become luminous, depends on the growth of peculiar fungi, of which the cilia produce the self-luminosity, a function very common in the organic kingdom, and which is possessed by some insects, and especially by many species of small animalculæ inhabiting the ocean.

The difference between the molecular motion producing heat and that producing light is only a difference of velocity; when the motion is less than 40,000,000,000,000 vibrations per second, the eye is unable to

ENGINEERING '76

Telegraphy. By W. H. PREECE, C.E., Divisional Engineer Post Office Telegraphs, and J. SIVEWRIGHT, M.A., Superintendent (Engineering Department) Post Office Telegraphs. London: Longmans, Green, and Co., 1876. [Price 3s. 6d.]

THIS is one of the "Text-books of Science" series, and seems an excellent little work, although, according to the very modest preface of the authors, it contains nothing, and everything is to be found in some other author's work on electricity or telegraphy. It is not so large a work as Mr. Culley's, and does not touch on some subjects, such as submarine cable testing, so fully as Mr. Culley's work, but, on the other hand, there is a good deal about the construction of land lines that is not to be found elsewhere. The book commences with a brief sketch of electrical terms, then passes on to the various batteries employed, the Daniel in its numerous forms, such as Siemens and Halske and Meidingen's, Muirhead's, Minotti, &c., the Leclanche, which if very fully described, and others. We looked in vain for some description here of Fuller's new battery. Passing on through a systematic description of the various signalling instruments—including the wonderful Hughes type printing instrument—which well deserves, however, more than a perspective view to illustrate it, we come to a chapter on Special Telegraphy, under which head are included Wheatstone's automatic system, the use of condensers in submarine lines, and the duplex system so ably carried into practical form by Stearn. Duplex telegraphy—the sending of messages in opposite directions on the same wire—is one of the great wonders and puzzles to those unacquainted with telegraphy, and we advise any engineer who, not finding it possible by any means to carry traffic in two opposite directions between any two points on a single line of rails at one and the same time, and thus wonders at duplex telegraphy, to read Messrs. Preece and Sivewright's book.

The construction of overground lines, including the various processes of *Burnetising*, *Kyanising*, and *Boucherising*, and creosoting the timber poles, the various iron poles used abroad and the means of placing them in the ground, are given. By one process—Mr. Oppenheim's—the cast-iron base, which is a fish-shaped casting with centre feathers, is driv into the ground by a kind of "monkey" supported on a tripod and the pole is shipped into a socket in this casting. These are used in Australia.

Siemens' and Hamilton's iron poles, which have flat iron bases—Siemens' square, Hamilton's round—are described. To place these in the ground the bottom of the hole must be sufficiently large to admit of the flat base, which seems to us a disadvantage. Several modes of boring holes in the ground by a species of large augur are described. The setting, staying, and strutting of poles are discussed. Perhaps the most meagre part of the book is that on insulators, a very important subject. It only occupies five pages, and merely describes the insulator at present used, and indeed the principles on which the perfection of insulation in an insulator depends are scarcely well defined. Nor are the different insulators that have, at different times, been employed and abandoned to be replaced, at enormous cost, by others which have again been improved on, been sufficiently dealt with.

Underground wires are also treated of, as well as faults in instruments and lines, and many practical questions as regards the quick restoration of communication when a wire fails, are dealt with.

Taking the book altogether it supplies a great want. It is systematic in its arrangement, is well and clearly written, and profusely illustrated with very good cuts, and entirely deserving of encouragement from those whose duty or inclination lead them to study telegraphy.

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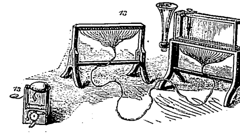
THE FIRST ELECTRIC TELEGRAPHS.

Electricity, magnetism, and electro-magnetism have demanded instruments of great variety. Bishop Watson, in 1747, transmitted the electrical contents of a Leyden jar through 10,600 feet of wire, suspended on wooden poles, at Shooter's Hill, near London. A plan for an alphabetical telegraph is described in the Scots' Magazine for 1753: this was not experimentally realized. At Geneva, were tried, in 1774, wires, each connected with a pith-ball electroscope, every pith ball a letter. Frictional electricity was here tested, but was found too difficult to manage. Volta's discoveries, the galvanic electricity being more continuous, paved the way for the subsequent unfolding of electric-telegraph history.

No. 13 is the original apparatus of Th. Sömmering, made by him in Munich in 1809. It was the first electric telegraph worked by galvanism, with a Volta pile, silver and zinc plates; about 9 inches high.

Modern magnetism dates from the year 1600. It was then for the first time clearly shown by William Gilbert, physician, of Colchester, that the earth possesses magnetic properties.

The polarity of the needle, the variation of the compass, the magnetic dip, were, indeed, displayed by George Hartman, Vicar of St. Sebald's, Nuremberg, before Duke Albert of Prussia, in 1544. These discoveries were intrinsically of fundamental importance, but they went no further. On the other hand, the unbroken line of descent dates only from the publication of Gilbert's work, which has never been lost sight of, and ever since recognized as the starting-point of accurate magnetic science.



Nov 76

A correspondent of the *Eastern Province Herald* (Algoa Bay) suggests a plan by which the South African Colonies may be brought telegraphically a week nearer to England than at present. What is wanted for the moment to fill the hiatus due to the failure of Hooper's contract, is merely a loop-line of cable between St. Vincent and Goree or or Dakar, close to Cape Verd. A light line with heavy ends, about 600 miles total length, would span the space to the main land, at the parts indicated, which all mail-vessels closely pass, and could manage to "call off" with very little delay for telegraphic dispatches generally. The Cable Company would probably execute the job straightway after preliminaries, and doubtless the French and British Governments and the Colonies would be willing to contribute to meet the trifling expense of this enterprise, which would bring South Africa within twelve days of Europe, and be of immense value, should energetic action be required in the Transvaal imbroglio.

THE TELEGRAPH DEPARTMENT.

IN a pamphlet just issued Mr. Herring again charges the Telegraphic Department of the day since with exhibiting rare perfection in the art "how not to do it." His case, on his own showing, appears hard, but it is, unfortunately for him, an old grievance, a class of subject [illegible] it is almost impossible to interest the public. The discussion has now exceeded [illegible] years, and has recently been enlightened by Mr. Herring's reflections on the result in which the arbitrators between him and the Post Office have performed their duty. Mr. Herring not only accuses the arbitrators, Sir William Thomson and Mr. Fleeming Jenkin, of being rather the servants of the Government than impartial judges, but falls foul of Mr. Gisechen and Lord John Manners for the apathy they have exhibited concerning his real or illusory claims. So far as the pamphlet before us explains the matter at issue, Mr. Richard Herring is the inventor of a new method of printing telegraphic messages—claimed by him to be a great improvement on the Morse system of printing. The chief difference between the two methods appears to be in reversing the position of the dashes and dots of the Morse alphabet. In the latter well-known system a strip of paper moving forward by clockwork receives from a style or pointer, influenced by an electrical current, a mark broken or interrupted into long or short dashes and dots. In Mr. Herring's system the dashes and dots are made by separate styles or pointers, and they are perpendicular instead of horizontal. A great saving in space is thereby secured, and it is also claimed that greater clearness is obtained. Mr. Herring considers that he has made a distinct improvement, and continues to ask that his system may be afforded a full and impartial trial, inasmuch as if his improvement be real its commercial value is unquestionable.

So long ago as 1870 Mr. Herring brought his system under the notice of Mr. Scudamore, and a discussion ensued which, with sundry intervals, has lasted to the present time. Mr. Scudamore appears to have been at first well disposed towards the inventor, but the experts of the Post Office showed less appreciation of Mr. Herring's "method of making the dots and dashes in uniform time by using a positive current for the one and a negative current for the other." To them it appeared to offer insuperable objections, on the ground of its interference with the duplex system of telegraphy; yet he was willing that it should have a final trial, "to be carried on before one or more scientific persons acting on behalf of the Department, but not connected with it," and on behalf. It would seem, then, that the Department, although not hopeful of the success of the new system, was disposed to afford it an impartial trial, and the upshot was that Sir William Thomson and Mr. Fleeming Jenkin acted in its behalf. Mr. Herring at this juncture would have had the best of the position, supposing his improvement to be really valid, had he not taken unnecessary pains to examine the Government Telegraph officials by perpetually writing letters concerning the conditions of the trial. Some difficulties arose respecting the use of an automatic sender, which Herring declining to accept the report of the arbitrators appointed by the department as "final" and it is on the finality and completeness of this trial and report that the case now turns. Proper facilities were undoubtedly offered to Mr. Herring but, although he was treated with every imaginable courtesy, he has perhaps a right to consider that the "final trial" of his instrument, automatic sender and all, never came off. In his opinion the hostility of Mr. Culley, Engineer-in-Chief of Post Office Telegraphs, is the main cause of the rejection of his invention by the Department. To the inventor Mr. Culley appears to have been from first to last opposed to his improvement, but "willing to maintain an appearance of fairness by pretending to try an instrument which he had resolved beforehand to condemn." This is strong language, but various remarks of Mr. Culley give it a semblance of justice. He had evidently made up his mind on the subject when he wrote, in April, 1871, that "we might allow Mr. Herring to try his instrument on a line where it would no doubt die a natural death;" but, in justice to Mr. Culley, it is only fair to cite that his opinion is substantially backed by the report of Sir William Thomson and Mr. Fleeming Jenkin, who, admitting that the instrument possessed certain minor advantages, pronounced it inferior to the Morse on two points—firstly, as not being adapted to work on the double current method, by which two currents are used for each symbol; and, secondly, as being more complicated. On the other hand, the opinion of Mr. Latimer Clark and that of Messrs. Charles Hockin and Herbert Tayler, of the house of Clark, Forde and Co., is highly favourable to the instrument. Thus, the story of the Herring instrument is the old one of the disagreement of doctors, aggravated by the very natural desire of the inventor to get fair play for his invention and the equally natural determination of the Department not to have a distasteful attention forced upon them "in spite of their teeth."

Perhaps the Post Office Department has, to Mr. Herring, seemed indifferent to his invention simply because they did not quite see its commercial value as applied to an established system of telegraphy. Had the whole telegraphic lines of this country to be laid down *de novo*, probably Mr. Herring's scheme would have come in for closer attention than it was fortunate enough to receive, but it is possible that the official staff did not see sufficient merit in the alteration to justify the suppression of the Morse system. This is one of the greatest stumbling blocks of the inventor, and yet one that he must be prepared to meet with good humour. The merit of an improvement may be unquestionable, but there always remains a lingering doubt whether it is quite "worth while" to revolutionise an expensive plant to take advantage of it.

While telegraphy is before the public it may perhaps be well to call attention to the defects of aerial lines. Within the last few days communication has been interrupted between important cities—a result which could hardly have arrived had the lines been laid in pipes underground instead of being carried far above the surface on posts. There is, of course, the disadvantages of extra first outlay, but perhaps this would be covered by the reduced cost of maintenance. The improvement has also the merit of being applicable by degrees to existing lines, which, when brought down below the surface of the earth, would at least be comparatively safe, instead of at the mercy of every gale.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

On Tuesday, the 21st ult., Mr. LATIMER CLARK, President of the Society of Telegraph Engineers, held the Annual Soirée at Willis's Rooms, St. James's Street, where he received a numerous and distinguished company.

There was a numerous assemblage, both of gentlemen interested in electrical and mechanical science, and those who confine themselves to the less ambitious sphere of practical telegraphy. Among others we noticed Sir. Gladstone, F.R.S., Professor Fleeting Jenkin, Dr. C. W. and Mr. Carl Siemens, Mr. Bramwell, C.E., Dr. Warren de la Rue, Mr. Willoughby Smith, Colonel Stotherd, and Majors Webber and Frank Bolton, R.E.; Sir James Anderson, Mr. H. Weaver, and Messrs. Wilmer Patey, Graves, Preece, Fischer, &c., of the Postal Telegraphs Departments. There was, as usual, an exceedingly interesting display of electrical and telegraphic apparatus, and of historical objects illustrating the progress and development of telegraphy. Foremost amongst these must be mentioned the

THE TELEGRA

January 1, 1876.]

Wheatstone collection, exhibited by Mr. Robert Sabine, C.E., and Mr. B. S. Culley, C.E. This collection is invested with peculiar interest at the present moment, in view of the recent death of the celebrated electrician. The Wheatstone collection begins with the five-needle telegraph, patented by Messrs. Cooke and Wheatstone in 1837, and ends with the capillary mercurial receiver for signalling on submarine cables. A five-needle telegraph was shown, which was in use at one time on the Paddington and Drayton line, and is said to have been the instrument which transmitted the message leading to the apprehension of Tawell, the murderer. Tawell, as will perhaps be remembered, was dressed in the garb of a Quaker in his attempted flight from justice; and as this ancient telegraph, despite its five needles, could not make the letter "Q," the writer is said to have resorted to the expedient of spelling the word "Quaker" The gap in the Wheatstone collection between the earliest and latest efforts of the inventor was filled up by specimens of his well-known A B C telegraph, the automatic telegraph, the Wheatstone bridge, and the instrument originally devised by him for measuring the velocity of light.

General Eckert, who visited Europe two years ago with Mr. Prescott, has suddenly resigned the General Superintendentship of the Western Union Company's lines. E. Atherly. He is about to manage, as President, the Atlantic and Pacific Telegraph Company's business, the chief competitors of the Western Union Company; and it is reported that a great and bitter telegraphic contest is about to commence in that country between these rivals.

CENTRAL AMERICAN TELEGRAPH.

THE adjourned general meeting was held on February 23, at the City Terminus Hotel; Mr. J. Hough presiding.

The report reminded the shareholders that at the last annual meeting in December, 1874, the chairman stated that probably before another year had elapsed the company would have transferred its cables to the West India and Panama Telegraph Company Limited—in accordance with the terms of the agreement with that company, which had been submitted to and approved by the shareholders of this company—and this company practically be wound up. The Trinidad-Porto Rico section of the cable had been completed and handed over to the West India and Panama Company, but the directors regretted to state that that company had refused to accept the Para-Demerara section. Legal proceedings were pending between this company and the contractors in reference to this section.

The Chairman briefly moved the adoption of the report, stating that the affairs of the company being in litigation, and the contractors with the company for the cable being shareholders of the company, he did not think it would be desirable to discuss the company's affairs any further.

Mr. A. Seymour seconded the motion.

The Chairman, in reply to Mr. S. Lawis (of Hooper's Telegraph Works Company), said the company had had no reserve, and had received nothing from traffic. The cables were in such a state that they had not been able to carry enough to pay expenses. He believed [illegible] had passed through, but the companies working the cables—the West India and Panama and the Western and Brazilian—had the receipts to cover expenses. The gross revenue would, he believed, be under £100.

The reports and accounts were then adopted.

whilst the department cannot claim to have been infallible in its management, the deficiency is mainly due to the exorbitant price paid for many of the telegraph undertakings, and to the heavy quantity of unremunerative labour, which it is compelled by statute to perform. I would, at the same time, remind your lordships that although up to the 31st of December, 1874, the deficiency of telegraph revenue to meet the interest on the stock issued under the authority of the Telegraph Acts, 1869, 1870, and 1873, amounted to the sum of £473,153 3s. 2d., yet, that if from this sum is deducted £40,136, the amount of the payments chargeable to capital, the deficiency of the telegraph revenue, after allowing interest upon the £ from deducted, to meet the interest due, is under £370,000, or less than £54,000 per annum for each of the five years since the transfer."

With reference to the number of non-paying offices, it is stated these have entirely disappeared in London, and diminished altogether in the extent of one-half since the return was taken in 1874. In the face of such facts, his lordship hesitates to recommend the withdrawal of accommodation already enjoyed by the public.

The recommendation to amalgamate the duties of the Post-office Surveyor with those of the Divisional Engineer is regarded as likely, if carried into effect, to be attended with injury to both branches of the service; whilst as regards the proposal to extend the employment of the Royal Engineers, the review continues:—

"The employment of the Royal Engineers, to which the committee next advert, is a political deal with it here in regard only to its financial bearing. The engineering staff admits of reductions; but this can only be accomplished as opportunities occur.

* * * *

The Royal Engineers can at any time return to the War Office; and, as all that would be required to replace them would be a few additional line men, nearly two-thirds of their allowances, or so, I am compelled to advocate their withdrawal. Committee, on financial grounds, to recommend a festly wrong to expose a large sum annually on an object altogether foreign to that for which the taken. In the event, however, of its being considered desirable, upon grounds of Imperial policy, that the postal telegraph service should be used as a school of instruction in telegraphy for the Royal Engineers, it will be but just that the pay of the officers and men thus instructed should fall, not on telegraphs, but on War Office funds."

His lordship does not think any attempt by legislation or otherwise to induce railway companies to undertake the maintenance of the lines of the railways would be successful, and doubts whether the Committee could be in earnest in making such a proposition. His demur to the assertion that the working expenses have increased in a greater ratio than the increase of messages; so far from this the net revenue now exhibits an increase considerably larger than the increase of messages, a fact which induces a hope that the undertaking will ere long exhibit a profitable result, provided that the capital account is charged with the expenditure which properly belongs to it, instead of being a charge against revenue.

Touching the question of tariff, his lordship remarks, that in acquiring the telegraphs, the intention of the legislature was to consult public convenience, and not to transform the transaction into a mere commercial speculation, and he adds, "it would in my opinion, be inexpedient and hardly fair, to go back entirely from what parliament granted when the Telegraph Bill was passed." The existing press rates will therefore continue except as regards the "copy" charge of 2d. which it is proposed shall apply only in cases where such copies can be delivered by hand. If this has effect, it is estimated to produce a net gain of revenue of not less than £30,000 a year. Modifications in the charges for messages handed in at railway stations, the commission on which are now paid by the department varies from 3d. to 9d. on the message, are also advocated, and valued at £12,000. A late and Sunday fee of 6d. except on press messages, to which it is not to apply, is also calculated to produce a like sum of £12,000 per annum, and it is lastly proposed to purchase up the rights possessed by certain railway companies to send free messages over the wires of the Department: the main object of which is to free the wires for other and more profitable work, and relieve the department of much correspondence.

His lordship concludes:—

"The charge is that the telegraphs in the hands of the Post Office have not turned out a paying concern. Had the increase in the number of telegraph offices from 2,488 to 5,600, and the increase in the number of messages from 8,000,000 to 20,000,000 been accompanied by a corresponding increase of net revenue, it would have been highly satisfactory; but there is nothing in the Act of 1868 to show that this was expected, nor indeed would it have been reasonable to expect it. What the legislature did intend was that the public should be better accommodated, and during all the discussions which have taken place in Parliament, or elsewhere, no complaint that this intention has not been carried out, so far as I am aware, ever has been heard. Undoubtedly, and mainly to those which are acknowledged by the committee, the financial result of the measure is not, up to the present, satisfactory. 'There are, however, signs of improvement; the service is yet but in its infancy; the business of the department is steadily increasing, and the necessity for economical management will be steadily kept in view. If the alterations which I have proposed be adopted, and due allowance be made for the charge upon revenue of expenditure fairly chargeable to capital in ordinary commercial undertakings, I shall be much disappointed if, at the expiration of the ensuing financial year, telegraph receipts, as compared with working expenses, do not show a result which would make it impossible to ask parliament to adopt the retrograde policy which the committee have felt it their duty to advocate."

The receipts of the Western and Brazilian Telegraph Company for four weeks ending 25th inst. show £2,591 increase over same period of 1875.

THE TELEGRAPHIC JOURNAL.
VOL. IV.—No. 90.

NEW ZEALAND TELEGRAPH.

THE Government of this enterprising colony has just issued its twelfth Report. It is an exceedingly interesting and well-compiled document. It not only narrates the history of the telegraphic progress of the islands for the past year, but it furnishes very complete plans of the telegraph system connecting together the three islands which are called New Zealand. It appears that the revenue for the year 1875-76, which was estimated at £62,000, has exceeded that amount by more than £1,300.

The number of telegrams transmitted during the year was 1,051,080, being an increase over the previous year of 133,958. Including the value of General Government telegrams, the gross earnings of the department for the year amounted to £79,537 7s. 11d. The expenditure exceeded the receipts by £2,803 12s.: the expenditure incurred in the repairs of the Cook Strait Cable amounting to £3,363 15s. 5d., having been debited against the vote of the department, has placed the balance on the wrong side. Owing to the increased number of stations and the additional lines, the expenditure is greater than in any previous year. Several amounts have also been charged against the vote of the department, which, it is said, might with justice have been charged upon construction, and taken out of the telegraph portion of the loan.

The number of telegrams transmitted during the year, as compared with the number of letters posted during the same period, shows that 22·21 telegrams were sent for every 100 letters posted. This proportion is rather less than last year, when the comparative number was 22·50. It must, however, be remembered that there is an increase in the number of letters of almost 700,000, so that the proportion of telegrams is very satisfactory.

Since the date of the last Report, direct communication has been established with Australia. The cable was opened for business on the 21st February last, and has been largely used. The Wakapuaka Station has, since the date mentioned, forwarded to New Zealand stations, 3,689 telegrams. Of this number, 3,395 messages were received through the cable, from Sydney and places beyond, the average of words per message being 19·3. The number forwarded from New Zealand through the cable, to Sydney and places beyond, during the same period, was 3,268, the average of words per message being, in this case also, 19·3.

The number of Money Order telegrams sent during the year was 10,712, representing a value of £40,988 17s. 3d., or an increase of 1,062 messages, and of £2,409 17s. 5d., as compared with the previous year. The commission collected by the Post Office was £1,355 19s. 4d.; and after deducting £335 12s., due to the Telegraph Department as fees on the telegrams, there remained to the credit of the Post Office, as commission on exchange, £1016 9s. 4d., almost £3 per cent. on the amount transmitted. The largest number of orders was issued in Wellington, Dunedin coming next, and Christchurch next.

During the year, 118 miles of line carrying double wire, and 90 miles carrying single wire, have been erected; and 335 miles of wire have been added to the original lines, making a total addition of 621 miles of wire.

There are now opened to the public throughout the colony 142 stations, 15 of which have been opened during the past year, 9 in the South Island, and 6 in the North Island.

The length of line maintained during the year was 2,930 miles, the average cost for maintenance being £5 18s. 10d. per mile. This is exclusive of the amount expended in the repair of the Cook Strait Cable, which is referred to above.

At the close of the year, 3,154 miles of line, carrying 7,247 miles of wire, were in circuit, showing an increased mileage upon the previous year, in line 168 and wire 620.

The nominal strength of the department, including Linemen and Inspectors, on the 30th June, 1876, was 567, against 509 of the previous year.

The duplex system of telegraphy has been further introduced on the circuits between Blenheim and Christchurch, and between Wellington and Napier. It has been in daily operation upon the circuits mentioned for some months past, and on the cable since the 18th June, 1874, and has proved the greatest success. With all these facilities, the wire accommodation is not more than the increasing work of the department requires. It must, therefore, be obvious that the perfecting and introducing of the system has proved a very great advantage and saving to the department.

The sea has been found a great enemy to overground wires. Wherever it has been practicable the wires have been carried inland to avoid the influences of the salt spray upon the insulators. When the precipitous nature of the country would not admit of such deviation, every precaution has

DIRECT SPANISH TELEGRAPH.

THE fifth ordinary general meeting of the shareholders of the Direct Spanish Telegraph Company was held at the London Tavern, Bishopsgate-street, on the 21st March, Mr. Noel Bannatyne in the chair.

The Secretary having read the notice calling the meeting, the report was taken as read. It stated that during the last six months the number of telegrams which had passed over the cables of the company was 26,625, against 37,419 in the corresponding six months of 1874. Out of the balance of £3,382 at the credit of profit and loss, £2,679 would be required for the payment of the half yearly dividend on the 10 per cent. preference shares, leaving the sum of £4,423, out of which the directors proposed paying a dividend at the rate of 5 per cent. per annum upon the ordinary shares, absorbing £4,000, and leaving £1,604 to be carried to the reserve fund.

The Chairman said, in moving the adoption of the report, the directors were in hopes up to a recent period of being able to meet the shareholders with a higher dividend on the ordinary shares, but unfortunately the Lizard-Santander cable broke on the 3rd of last month; it was, however, efficiently repaired on the 29th of the same month, and that cable was now, as well as the one from Barcelona to Marseilles, in excellent condition. The cessation of the war in Spain had rendered it of the greatest importance that they should see to the early establishment of direct communication with Bilbao, so as to get back the valuable traffic they previously had on that line, and which they had for some time been without, owing to the state of matters in the north of Spain.

Mr. Abraham Scott briefly seconded the motion, which was agreed to unanimously, and the dividend at the rate of 5 per cent. per annum on the ordinary shares declared.

La ligne de Sibérie a été de nouveau interrompue le 26 Août par de fortes inondations, au-delà d'Alabazine. Les travaux de réparation ont commencé immédiatement et on rétablit la communication jusqu'à Bingowetschensky, mais, ce-delà, la ligne est encore interrompue dans la section de Blagowetschensk à Chabarowka. Sur le parcours interrompu les télégrammes sont transportés par vapeurs; les départs n'ont pas lieu à des dates et heures fixes, mais toutes les précautions sont prises pour une aussi prompte expédition que possible.

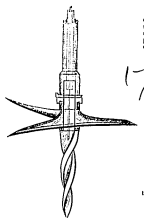
Le câble de Bahia à Rio de Janeiro interrompu depuis le 20 Juillet a été rétabli le 30 Août; mais celui de Rio Grande do Sul à Montevideo est interrompu depuis le 5 Septembre. Les télégrammes profitent de toutes les occasions que donnent les nombreux vapeurs qui circulent entre ces deux ports.

MARSHALL'S

PATENT EARTH-BORING APPARATUS.

(IN USE IN THE POSTAL TELEGRAPH DEPARTMENTS.)

The most practical and useful implement in the erection of Telegraph Lines, Signal Posts, Scaffold Poles, Flagstaffs, Mangnels, Bootls, putting up Fencing, Planting, &c., &c.



Effects an economy of Labour equal to 60 per cent. and ensures a greater firmness and stability to the fence than can possibly be obtained by any other method.

175

This apparatus has been extensively used during the last few years in England and abroad with the most satisfactory results.

Testimonials, with full particulars and price list, free.

W. A. MARSHALL, TELEGRAPH ENGINEER, BRIDGWATER.

THE FIRST OVERLAND TELEGRAPH IN CHINA.

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The Pall Mall Gazette says: The construction of the first overland telegraph in China has been attended with considerable difficulties. It was when the Foochow affair became threatening that the Viceroy of Pekkin made arrangements with the Great Northern Telegraph Company for the construction of a line from Amoy to his Yamun at Pakchow. But no sooner was the first portion completed than the natives discovered that the erection of the poles interfered with the benign influences of the Fung-shin of the district. They therefore turned out "in their thousands" and uprooted the poles. Upon this the company appealed to the native authorities for protection, and ultimately the matter was referred to Prince Kung and the foreign Ministers at Peking. The result of this diplomatic interference has been that a new contract has been made with the Great Northern Telegraph Company, under the terms of which the Viceroy agrees to pay the company $151,500, or upwards of £30,000, for the construction of the line between Amoy and Pakchow, a distance of about 160 miles, and a further annual sum of £20,000 for its maintenance. We imagine that the natives will have nothing to complain of in these terms. The Mandarins further bind themselves to give full protection to the company's staff and material, and to be responsible for any theft that may be committed on the property of the company, or for any delay that may be occasioned by unlawful interference on the part of the natives. The company, on their part, agree to make and to keep in repair the line, and to instruct Chinese pupils appointed by the Government in the art of telegraphy.

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un courant positif d'une force 1; dans le second, par un courant négatif de force 1; dans le troisième, aucun courant ne se produit sur la ligne, et dans le quatrième, elle est traversée par un courant positif de force 2. Donc si les quatre manipulateurs des deux stations sont au repos, il y a sur la ligne un courant continu double de force de ceux qui agissent sur les appareils quand on travaille. Cette double transmission dans le même sens peut facilement être transformée en quadruple transmission, par l'introduction des relais de chaque station dans la diagonale d'un pont de Wheatstone. M. Winter donne encore une seconde solution du même problème qui, sans différer beaucoup de la première, est un peu plus simple et plus économique en ce qui concerne l'usure des piles.

9. Quelques observations sur la combinaison de la transmission simultanée dans le même sens avec celle en sens contraire, par le Dr. K. E. Zetzsche. (Dinglers polyt. Journal, vol. 217, page 29).

Cet article traite principalement de deux systèmes, l'un de Prescott et Edison, travaillant entre New-York et Chicago et entre Chicago et Cincinnati, l'autre de Dr. H. C. Nicholson. L'auteur revendique une partie de ces inventions pour Maron.

(Nous rappelons ici notre article « de quelques nouveaux systèmes de double transmission », Journal télégraphique, vol. III, page 208).

5. Les lignes sérieuses.

1. Sur la construction des lignes télégraphiques, par Joh. Gavey. (Telegraphic Journal, vol. III, pages 139, 150, 174, 195, 219, 236, 245, 293).

Pour le choix du tracé d'une ligne télégraphique, il faut surtout prendre en considération si la route fait des courbes, si elle est bordée d'arbres et traverse souvent des villages, et s'il y a ou non des terrains non cultivés le long de la route, qui permettent une libre application de jambes d'appui et de haubans. Il faut autant que possible éviter les routes longeant les bords de la mer ou passant près d'usines avec évaporations nuisibles. Si la ligne doit suivre une voie ferrée, les tranchées, les tunnels, les grandes stations et les ponts sont toujours autant de causes de renchérissement de la construction. Les distances entre les poteaux et la longueur de la ligne en général doivent se déterminer avec une chaîne de géomètre. Le long des voies ferrées, la distance entre les poteaux doit varier entre 60 et 100 mètres. Il faut autant que possible placer les poteaux à une distance des rails telle que si les poteaux viennent à tomber du côté de la voie, ils ne puissent atteindre les rails. Il convient de poser les fils de façon qu'ils puissent facilement être inspectés d'un train en

THE TELEGRAPH IN SENEGAL.

The Senegal service comprises three lines: the first going from St. Louis to Dakar, the second from St. Louis to Dagana, and the third from St. Louis to the Bar (Mouth of the Senegal).

Dakar Line.—This line is the most important; it is 126 miles in length; its direction is from N. to S. W.; it is constructed with a single wire of 3 m.m. It connects six offices—St. Louis, Gandiole, Batele, Mbidjem, Rufisque and Dakar. The region it traverses is for the most part uncultivated, without any road, intersected by large and deep recesses, slightly undulating, with impenetrable thickets of palms and bushes of different kinds scattered over it. From Gandiole to Mbidjem the country is no longer under the dominion of the French; it was given back in 1870 to a native chief, on the sole condition that he would respect the telegraph line and the station of Batele, placed in the heart of his territory. The staff employed at each of these stations is as follows: At St. Louis, the director of the service, an employé of the 6th class on the metropolitan list, a native assistant, a superintendent, a superintending chief, and two native superintendents; at Gandiole, a military employé and two superintendents; at Batele, a military employé and two superintendents; at Mbidjem, a military employé and two superintendents; at Rufisque, a military employé and one superintendent; at Dakar, an employé of the fourth class on the metropolitan list, a head of the office, a military employé, a superintendent, and two superintendents, total, 23 employés.

Dagana Line.—This unites with St. Louis by an inscribed station in a commercial point of view, placed on the River Senegal. Its length is 77 miles, and its direction from W. to S. E. This line serves four offices: St. Louis, Lampsar, Richard-Toll, and Dagana. The office at Lampsar is closed for the time being. The country traversed by this line is under French rule, it is often inundated during the winter season by the swelling of the river. At Lampsar resides a superintendent; at Richard-Toll, a civil employé and a superintendent; at Dagana, a civil employé and two superintendents, total, 6 employés.

The Bar Line.—The length is nearly seven miles. It traverses a region intersected by morasses, and by the tributaries of the river; its direction is from N. to S. It unites to St. Louis the pilot station placed at the mouth of the Senegal. A civil employé has charge of the office.

Staff.—These nine offices are supplied with the following staff. A head clerk from the Metropolitan Administration, director of the service (M. de Clauvillebrain); two employés from the Metropolitan Administration, one of whom is at St. Louis (M. Sabbe-Marie-Pidoll, and the other at Dakar (M. Fleuiot); four employés of the 6th class, military; seven military employés; a chief superintendent and fifteen native superintendents. The native employés are recruited by means of examinations. The military employés are not, by the native infantry, at the disposal of the telegraphic service; they receive instructions at St. Louis and Dakar, and they are then sent to the inferior stations. The native superintendents form a very good staff, many of them having been in the service since its organization, twelve years ago; they are well up in their duties, thoroughly disciplined, and capable of bearing the fatigues and privations of a journey on foot in this unhealthy climate.

Interior Service.—The offices are open every day from 7 to 10 o'clock in the morning, and from 2 to 6 o'clock in the evening. The offices at Lampsar and Richard-Toll were closed in 1872.

Tariffs.—Between any two stations 2 francs for twenty words; 0,50 fr. more for each fraction of five words. Between St. Louis and La Barre, 0,50 fr. for ten words; 0,05 fr. for each additional word.

	Francs.
The amount received for private dispatches transmitted.....	9,923.85
The transmission of official dispatches corresponds to a sum of.....	18,629.00
Total.....	28,117.85

The total number of messages transmitted during 1873 was 8,231.

The stations Gandiole, Batele and Mbidjem, being distant from any centre inhabited by Europeans, have only very few messages.

Superintendence of the Line.—This service is very trying, especially during the winter season; the hot-sands of rain and the violent tempests overthrow the poles and break the insulators. Notwithstanding these difficulties, only three days' interruption have taken place during the year. The materials, including the poles, are carried on the backs of mules. Nearly all the disarrangements are caused by the fall of the poles, which the sandy soil will not retain firmly; there is no stone in the interior of the country to consolidate them, and the wooden traverses are soon rotted or exhibited by Termites; fortunately, however, they do not attack the injected poles. Many poles are also destroyed by the fire which the natives set to the bush grass to clear their fields. The thunderstorms, notwithstanding their great electrical intensity, lead to no durable perturbation over the lines and in the apparatus. As to the disarrangements caused by malevolence, these are exceedingly rare. The blacks, very superstitious, fear to break the lines; they believe generally that it serves only to indicate to Europeans the road to follow in going from Dakar to St. Louis.

THE TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.

At the half yearly meeting of the Telegraph Construction and Maintenance Company, held on Tuesday, July 29th at the Cannon Street Hotel, London, Sir Daniel Gooch said that the work that they had had in hand during the present year had been very small. In the course of a few days, however, he hoped that the company would conclude a contract for a cable, 1,200 miles long, from Sidney, New South Wales, to New Zealand, and he trusted that for the rest of the year they would be well employed. They knew of no other work like the one he had mentioned coming forward, but they were quite prepared to take work should it present itself. He did not think it was unfortunate, even for them, that there should be a cessation for some time in the construction of these long cables. He thought this work had gone on now for some time, and with a little rest he hoped the existing cables would remunerate their shareholders better than they had in the past.

LITERATURE.

Telegraphy—By W. H. Preece, C. E., Divisional Engineer Post Office Telegraphs, and J. Sivewright, M. A., Superintendent (Engineering Department) Post Office Telegraphs. Second Edition. London: Longmans, Green & Co., 1876.

This work is evidently intended as a manual or text book for the information and guidance of the ordinary employés, such as operators, linemen, etc., of the English telegraphs. It professes to be in some sense an introduction to Culley's well-known hand book, but if the average British telegrapher is anything like the average American telegrapher, which we presume he is, the little volume before us will be of far more practical use to him than Culley's, or indeed any other work with which we are acquainted. The authors of this treatise evidently possess a thorough knowledge, not merely of the subject they are writing about, for their names are a sufficient guarantee, but what is of at least equal importance, a knowledge of the mental peculiarities of the class of persons for whose benefit it is designed. One of these peculiarities is exemplified, for instance, in the mingled sentiments of aversion and terror which are incited in the mind of the ordinary telegrapher by the sight of even the most harmless and inoffensive algebraic symbols, and which is comparable to nothing in the world except perhaps the feelings of a party of plantation negroes suddenly confronted by a group of armed "ku-klux," arrayed in the disbelief contained of the "klan." With the exception of a very few equations, which have been skillfully concealed in the latter part of the book, where the reader will not be likely to dip at them till he has read the greater part of its contents, the authors have conscientiously abstained throughout from the employment of mathematics. In fact, the simple, clear and concise language by which the ideas an l information sought to be communicated to the reader have been conveyed, is worthy of the highest praise. Commencing with a brief explanation and definition of the electrical terms in modern use, the first subject taken up is that of batteries. The varieties in actual use in England are well described and illustrated, and the methods of setting them up and managing them which experience has shown to be preferable, are detailed at length. This is followed by a description of the various instruments in use, including the needle, Morse recorder and sounder, alphabetical dial, etc., at the close of which we note an interesting discussion of the relative practical utility of the various systems. The average number of words per message in England, including service signals, is stated to be 24 words, averaging 4.5 letters each. On this basis a table is given, which is stated to be a fair average, not of what the instrument can do, but what they do do in actual every-day work in that country.

Messages per hour.	Per day.
Sounder,	60 250
Ink-writer,	40 175
Needle,	30 125
Dial (A. B. C.)	15 60

For news and commercial purposes, where the amount of business is sufficient to justify the employment of skilled labor, the conclusion arrived at is that the sounder is unquestionably superior to the record-er, and will ultimately supersede it. In the chapter on circuits, we find also a discussion on the vexed question of the relative advantages of the open and closed-circuit system, which affords an explanation of the reasons why the former system has been so obstinately adhered to by the English in the face of what has seemed to Americans the incontestable advantages of the latter. We quote:—"There can be no doubt that where many intermediate stations are fixed on one wire worked on the Morse principle, the closed-circuit system offers considerable advantages over the open-circuit system. . . . But in England we never do use the Morse on such circuits. The needle is far preferable, and in that system no adjustment whatever is needed. It is an exceedingly rare thing to fix more than four stations on one Morse circuit, for the simple reason that it is almost impossible to group four Morse stations together without filling the wire—that is, without producing a sufficient number of messages to occupy the wire during the whole of the day. If there is not enough work to fill the wire, the needle instrument, from its simplicity, economy and certainty, is used in preference; so that the necessity for employing the closed-circuit in England has not been experienced, while its extra cost, as compared with the open-circuit, and injurious action upon gutta-percha-covered wires have proved it to be really objectionable. . . . Every country has developed its own system, and the conditions which have rendered the closed-circuit necessary in America do not exist in England."

A considerable portion of the book is occupied by matters relating to the laying out, construction and maintenance of pole lines, housetop lines, and underground lines, most of which is of much practical value, although it is to some extent specially applicable only to the English system of construction, which is in many respects radically different from ours. The various faults and interruptions to which lines, instruments and cables are subject, are classified, and the process of detecting, locating and removing them explained with great clearness and precision.

We know of no work which gives such an accurate and intelligible idea of the English telegraphic system and its every day working as this one, and we regard it as a fortunate circumstance that one of its authors, Mr. Preece, should have been selected by the Post Office authorities to examine and report upon the practical working of the American telegraphic system, a duty which, as many of our readers know, he is at the present time engaged upon. Mr. Preece has been a frequent contributor to English telegraphic literature for the last fifteen or twenty years. His productions have been characterized not only by their marked ability and originality, but by a candor in respect to the treatment of controverted subjects which is far less common, at least among writers upon telegraphy and kindred subjects, than could be desired, and we shall therefore look forward with unusual interest to his statement of the results of his observations in America.

Before dismissing the book under discussion, we wish to speak with special praise of the illustrations, which are all new and appropriate, and have been drawn and engraved with great care and skill, by some artist who we risk little in venturing to say is a telegrapher as well. Most of the figures of apparatus are to scale, and are so well done that they would in many cases serve for actual working drawings. The book is so attractive in appearance and contents, so handy in size and so cheap in price, that we are not surprised that a second edition has been called for within so short a time of its original publication.

JOURNAL OF THE TELEGRAPH.

VOL. X., NO. 24. NEW YORK, DECEMBER 16, 1877. WHOLE NO. 243

Original Articles.

EXPERIENCE WITH PLAIN AND GALVANIZED WIRES IN EUROPE.

In reply to a communication from Mr. George B. Prescott, electrician of the Western Union Telegraph Company, to telegraph administrations in Europe, asking information in regard to their experience in the use of plain and galvanized iron wires for telegraphic purposes, the following communications have been received:

IMPERIAL GERMAN GENERAL TELEGRAPH } OFFICE, BERLIN *October 29th, 1877.*

Mr. E. Prescott, Esq., Electrician Western Union Telegraph Co.:

The General Telegraph Office begs to inform you, in reply, in your favor of 6th inst., with regard to the experience gained by us in the use of galvanized and plain iron telegraph wire, as follows:

1. In 1851 the first iron wires were erected in Prussia. Plain iron wire was then used.

2. From 1852 till 1856 inclusive, a majority of the lines were constructed of plain iron wire. Some of the longer lines were constructed with galvanized wire.

3. From 1856 till 1871 inclusive, all the lines were constructed with plain iron wire, owing to the greater expense of galvanizing the wire, and the small amount of the appropriations which were granted at that time to the Administration of Telegraphs for the purpose of meeting the increased requirements.

4. From 1872 up to the present time, galvanized wire has been used exclusively.

A single line of galvanized wire of 3 millimeters thickness (No. 11, B. W. G.), has been used as far back as 1857 together with the stouter wire of 5 and 4 millimeters (No. 7 and 8, B. W. G.). The former is used mostly when it is required to remove the weight of stout wire from the poles.

It will thus be seen that we have had an experience of almost twenty-six years with galvanized and plain iron wire for telegraphic purposes. This experience has shown that the old lines constructed of 5 and 4 plain wire, after having been in use for twenty-five years, have suffered so considerably from rust as to necessitate their replacement by new wires at an early date. Up to the present time the replacement of these old plain wires has been limited only to comparatively short distances, and mostly those where the wires were exposed to the action of the vapor from chemical factories, or near railroad depots to the smoke from locomotives, which has caused a more rapid destruction.

As for, however, as the lines constructed with galvanized wire of the same size is concerned, it is a fact that even the oldest ones which have been in use from 1852 to the present time (25 years) are yet in a perfect state of preservation, and nowhere is any destruction of the zinc coating visible. It is evident that galvanized wire is by far preferable to non-galvanized or plain wire, provided that the zinc coating be properly performed.

In connection with the latter, we make here the following requirements:

(a.) The zinc coating should have a smooth surface, cover the wire everywhere continuously, and stick so fast to the wire, that

A wire of 5 millimeters thick (No. 6.) shall take 5 spiral turns;

A wire of 4 millimeters thick (No. 8.) shall take 6 spiral turns;

A wire of 3 millimeters thick (No. 11.) shall take 8 spiral turns around a wire of the same thickness for a length of six inches of the covered wire, without the zinc coating sustaining any flaw, or even exfoliating.

(b.) The zinc coating should be so thick that:

The 5 millimeters wire endures 8 immersions, each lasting one minute;

The four millimeters wire endures 7 immersions, each lasting one minute.

The 3.5 millimeters wire endures 6 immersions, each lasting one minute, in a solution of one part of sulphate of copper in five parts of water, without covering itself with a continuous copper coating.

The costs of zinc coating amount to (according to the price of iron) about fifteen to twenty per cent. of the price for non-galvanized wire, but by expending this additional amount, as is shown by the information given hereinbefore, we obtain a not yet fully ascertained longer duration of the wire, which bears such a favorable proportion to the additional expense of galvanizing, that the undersize use of galvanized wire for telegraphic purposes undoubtedly is decidedly a great saving for telegraph companies.

BUDDE.

SWISS CONFEDERATION, } BERN, *October 30th*, 1877.

We are in receipt of your honored letter of the 6th instant, and hasten to give you the following information on the use of plain and galvanized wires in Switzerland.

From 1852 to 1857 we used non-galvanized wire only, of 3 millimeters diameter (No. 11, B. W. G.).

From 1857 we have used galvanized iron, usually of 3 millimeters diameter (No. 11, B. W. G.). For some direct lines wires of 4 millimeters diameter (No. 8, B. W. G.) have been used, and for international wires 5 millimeters diameter (No. 6, B. W. G.). Non-galvanized wire lasts from eighteen to twenty years, and while the galvanized wire will certainly out-last the former, we cannot give you any exact comparative results, as the oldest of our galvanized wires have been in use only ten years.

All we can say about the latter is that they still look very well. The outside has become darker, and a few have become black, but the surface is still smooth, and does not show any rust.

The Director of the Swiss Telegraphs,
HERTLEIN.

ROYAL TELEGRAPH OF NORWAY, } CHRISTIANIA, *October 30th*, 1877.

In reply to your esteemed letter of the 6th instant, I have the honor to state, that in Norway we have used galvanized wire only, and have, had therefore, no experience as to the durability of plain iron wire.

As galvanized wire, in any case must be more durable than the unprotected iron, and as our lines, for the greater part, go over mountains where there are no roads, and transportation is consequently very costly, we are obliged to use the material that will last the longest.

NEILSON.

MINISTRY OF FINANCES, } DEPARTMENT OF TELEGRAPHS. THE HAGUE, *Nov. 2*, 1877.

In answer to your honored letter of October 6th ult., I beg to inform you, that the first government telegraphic office in the Netherlands was opened in the latter part of 1852, and that in the course of this years a wire put up in 1846 for the use of a railroad company, was transferred to my administration. This was a plain iron wire of No. 6, B. W. G., and the only plain wire which has been in use here, all the other wires being galvanized.

This plain iron wire was replaced in 1872, when its diameter had been reduced to half its original size, and its electric resistance greatly impeded telegraphic transmission.

With regard to our galvanized wires put up in 1852, lasting now been in use for twenty-five years, not a single one has been replaced up to the present time, and the results of repeated tests show that the resistance of these wires has changed very little, so that the time when they have to be replaced may be considered to be pretty far off.

It is my opinion that galvanizing well does considerably increase the time of duration of iron wire, and that it is fully worth the increased cost.

The Director General of Telegraphs in the Netherlands.

STARING.

ST. PETERSBURG, RUSSIA, Oct. 27, 1877.

Concerning the question mentioned in your letter of the 6th ultimo, the Russian Telegraph Department has the honor to inform you, that in consideration of the high prices for zinc-coated wire, there is employed iron wire from 6 to 4 millimetres diameter for the construction of Government lines in Russia and for city lines iron wire with a diameter of 3 millimeter. Such a wire ought to fulfill every demand contained in the technical conditions for delivery of the wire in question, annexed to the present communication. Zinc-coated wire (3½ millimeters) is however employed, only for fixing the wire upon the insulators.

Director General,
LITKENSKY

such as it is. Few galvanometers are seen in the offices, the faculty of a break being estimated by receiving the return shock on the finger! There is no official called a repairer, who "knows a little about our "Sosman" and our "Whitehouse," who does the rounds, and who is paid from £150 to £200 per annum.

Closed circuits have been and still are the favourite system of working, although they are gradually giving place to open circuits, especially for long distances. They have the advantage of the battery being all in one place; but the substitution of the relay being all in one place; but the substitution of the relay being all in effects a saving in battery power.

As regards instruments, the number is most generally used. Wheatstone established a few such systems, and spoke very highly in favour of the combined use of which he has advocated for some years past. All the apparatus required to rig up an American office are a key, a relay, and a small sounder. As long as circuits requiring are used, the principle of "relay" sitations have not yet been studied with several of them. The weather sense of these can be cut out, but in find a remarkable fact, that no apparent loss of speed resulted from their cessation. This is, of course, a direct variance with our experience here.

Compound or multiple telegraphy is largely adopted in the States, the duplex, quadruplex, and various other "plexes" of Stearns, Gilliss, Prescott, Gray, and others all coming in for a share of attention. In telegraphic systems as established on the London-Liverpool circuit by the country for that purpose, who recently visited Wheatstone, I may be mentioned here that the quadruplex of Messrs. Smith and Hamilton, who recently visited gives highly satisfactory results.

Type-printers are employed, to some extent, principally on the lines established by Mr. Hughes, on the basis of that invented many years since by Professor Hughes. They have, however, chiefly confined to private wires.

Edison's automatic system is used by the Atlantic and Pacific Company, and very flattering accounts of its performance are given. The maximum rate has been witnessed is 72. Proctor did not exceed 200 words per minute.

On the Chicago and Dubuque circuit there is a certain is carried on without, manifestly through erroneous working. The telephone, however, does not seem to play any great part as yet, in commercial telegraphy.

In concluding his remarks upon the telegraph companies, Mr. Preece remarks upon the telegraph companies, the workshops, and says surprised that he visited some of mechanics are employed. Much of the work done by England principally, especially for large distances. In America is done by machinery, operation, who, as before, Sosman, are very skilful.

Some curious and characteristic terms are current in America, and Mr. Preece highly amused his audience by hearing a few of them. The "sounder" is called a "click;" a step is to "break;" a "relay" is "taking it;" contact is "closing;" calling a disinterested system, and, strikes in America is the important system, and, strikes in America is the "sounding." A country where so much sound is used in business. In every town a most complete and perfect system of fire signals has been established. When a fire or an something the alarmist has only to pull a handle at the station and equally simple; this rings a bell at the office, and indicates the locality in which the fire is to be found. The effect of this system is that they can get engines for the slightest carpet in a few minutes, and incomprehensible to us. Mr. Preece states that he and Mr. Fischer, when inspecting the working of the system, timed the operation of getting an engine on and away. A gong was sounded, the engine-house in which gas the signal serving to release the horses, who, at the engine, were harnessed in two minutes and a half. The sound of three observations gave 8 minutes as the time elapsed from the sounding of the alarm to the starting of the engine. Mr. Preece also testified to a still more perfect state of things existing at Chicago. There the high-current not only sounds the gong and switches the horses, but it also draws the bolts from a series of traps-doors; and, that nothing may be left to chance, it supplies the current of the men whose beds are placed with regard to the trap-doors that they are (It was not stated whether the men turn in with their uniform on, or whether the current puts this on for them).

But even this close approach to automatism is not left unsurpassed; for many buildings are provided with automatic alarms which sound any abnormal increase of temperature above a certain point, and "sound an alarm."

Domestic comfort is studied and ministered to in a variety of ways. Compact, and not unsightly, little boxes are fixed up in a convenient place in the house. This box has a dial divided into compartments headed, respectively, messenger, butcher, salt, beef, and a pointer simply pressing a lever in the person's wants are at once made known at the nearest call-station, as also the house from which the call proceeded, and in the briefest possible time the required person or article puts in an appearance.

With regard to the general question of the organisation of the staff, the American telegraph system is characterised by far greater elasticity than ours, more being left to the discretion and energy of the officials than is the case with us. The result cannot fail to be beneficial to the service; and has shown administrative capacity displayed by their superiors. The spirit of emulation is fostered, and a wholesome consequently, far less of that half-heartedness, and frequently characterises the English employé.

Financially considered, the American telegraphs are a greater success than the English, as they "pay" better. It must be remembered, however, that they are still in the process of joint stock companies, and that, early being places which are "paying" as a fair amount of traffic being served. In England the system has been commercially developed, since its acquisition by the Post Office, upon principles of national utility rather than with an eye to large revenues.

In view of these and other considerations, Mr. Preece would not attempt any close comparison between the two systems; such is admirable in its own way, and America the natural to be in advance of the other in increased by the requirements of multiplex working, in England the same end has been sought, and to a great extent attained, by the perfecting of fast speed instruments, such as that of Wheatstone automatic, &c.

In the matter of invention there are some notable points of difference between the two countries, and the comparison is apparently unfavourable to us. Here, it has to rely principally upon his own private resources, in America, invention is subsidised—in fact, men are practically of the day, one of the most eminent Union Co., and furnished with a magnificent, well-

RUSSIAN TELEGRAPHS.

An interesting résumé of the Russian telegraphic service has recently appeared in the *Moniteur des Chemins de Fer*, giving the details up to the end of 1876, the latest that have been made up by the Department. At the commencement of that year, the length of the telegraphic lines worked by the State was 61,287 versts (1 verst equals about ⅔ furlongs), with 138,209 versts of wire, while there were 778 telegraph offices. In the course of the year 32 new lines were opened for service, of the length of 2,973 versts, with 6,697 versts of wire, and 46 offices, of which 48 were in Russia in Europe, 8 in the Caucasus, and 11 in Russia in Asia. Twenty-one of these offices were on account of the war necessities. The lines worked by the railway companies in 1876 were increased by 622 versts, with 1,304 versts of wire and 130 new offices. The line of telegraphs to private companies have only undergone extension to the amount of 93 versts, comprised in the of Ahovel, an undertaking which was carried out by the Northern Telegraph Company. On the 1st January last year, the total of Russian telegraphs were as follow:—

	Versts of line.	Wire.	Stations.
State network (recent)	68,620	124,627	864
Railways	16,009	30,000	1,198
Anglo-Indian line	3,407	7,200	53
Submarine cable (Aboard Islands)	36	72	2
Private lines	22	22	1
Military and police of the capitals	350	378	23
		350	1
Total	85,030	169,577	2,163

At the close of 1876, the Administration employed 7,253 persons, viz.:—Central Administration, 291; mechanicians, 143; superintendents, 686; telegraph operators, 4,057 (2,020 women); messengers, porters, &c., 2,126. During the year 3,858,228 paid messages, 258,842 free messages, were sent in the Inland Department; 327,451 paid and 9,169 free were sent in the Foreign Department, which also received 324,880 paid and 12,009 free messages; while in the Imperial service there were 74,412 messages in hand—making a grand total of 4,220,261 messages for the year, an increase of about 10 per cent. over the year before. The following is a table of the proportion of messages from each country to Russia:—

	1876.	1875.		1876.	1875.
Germany	816,051	660,754	Denmark	16,126	15,021
Great Britain	117,891	113,097	Roumania	9,622	6,652
France	76,481	74,677	Switzerland	9,622	6,593
Austria	74,198	72,553	Servia	3,212	2,404
Sweden	36,793	27,005	Greece	2,891	2,366
Turkey	25,702	25,707	Spain	2,197	1,217
Italy	22,832	20,849	Malta	971	1,233
Belgium	16,017	16,749	Portugal	182	1,233
Turkey	16,126	15,021	Montenegro	47	55
Norway	10,710	10,059			

As regards the Eastern nations, the particulars were :—

Persia	4,497	3,013	Cuba	438	457
Turkey in Asia	3,497	3,610	India	151	177
Armenia	1,195	1,018	Japan	111	94
Egypt	646	621	Australia	7	11
Japan	470	640	Arabia	7	1

There are only some 37 towns in Russia which do any foreign business by telegraph, and these do about 90 per cent. of the whole. For instance, St. Petersburg received 107,859 foreign messages; Moscow, 32,974; Odessa, 29,881; Riga, 24,561. Warsaw, 21,326. The gross receipts, which in 1875 were 4,802,386 roubles, rose in 1876 to 5,506,111—an increase of about 15 per cent. The expenditure in 1875 was 4,604,670 roubles, and in 1876, 4,940,000—an increase of 7 per cent. The average total of the telegrams was 1 rouble 43 copecks (1 rouble equals about 2s. 2d., 3 copecks equals nearly 5d.), and as the cost of the telegram was about 1 rouble 15 copecks, the Treasury gained 28 copecks by each message.

SCHOOL OF TELEGRAPHY.—The French Government has established a school specially devoted to the study of telegraphy.

QUEENSLAND.—In Queensland, telegraph extension is in progress between Dalrymple and Junction Creek, 170 miles; Gympie and Kilkivan, 50 miles; and Burdekin and Cape Bowling Green, 50 miles; making an addition of 270 miles to the existing telegraph system.

GREAT NORTHERN TELEGRAPH.—It is announced that the Hong Kong Amoy cable has been provisionally restored. The further repairs required have been postponed until the Singapore route has been re-established. Messages are received for all China and Japan stations.

THE TELEGRAPHIC SYSTEM OF AMERICA comprises about 300,000 miles of wire, of which the Western Union Company has about 195,000, the Atlantic and Pacific Company (now consolidated with the former), 36,000, the Montreal Company 20,000, the Dominion Company 7,000, and smaller companies and railroads 40,000.

CHRONIQUE

Voici une bonne nouvelle que nous donnons avec joie à nos lecteurs :

Le câble transatlantique français se construit en ce moment dans les ateliers de la maison Siemens, à Woolwich.

Il serait à désirer que cette ligne nationale pût servir à relever le goût des études télégraphiques en France et que des opérateurs français fussent chargés de la transmission des dépêches.

Mais un pareil résultat ne peut être obtenu sans une éducation préalable, car la manœuvre des télégraphes sous-marins demande une instruction spéciale, que tous les opérateurs ne possèdent pas.

Nous croyons donc faire plaisir à nos lecteurs en leur annonçant que nous avons visité l'école de télégraphie de Londres dans le but de nous assurer que nos jeunes camarades qui voudraient être initiés aux mystères de la télégraphie sous-marine, y trouveraient les mêmes facilités que les étudiants anglais, et que l'enseignement, s'ils se connaissent plusieurs, leur serait donné en langue française.

Le *Journal des Postes* du l'Empire d'Allemagne nous apprend que le gouvernement japonais vient de concéder une ligne allant de Yokohama à San Francisco. Espérons que ce n'est point à une compagnie allemande.

La compagnie concessionnaire, quelle que soit sa nationalité, est en instance auprès du gouvernement chinois pour obtenir le droit d'attirer à Tien-Tsin et de conduire la ligne atlantique jusqu'à Pékin. S'il en est ainsi, l'électricité pourra bientôt faire le tour de la terre.

THE ELECTRICIAN.

TO CORRESPONDENTS.

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All letters intended for insertion in THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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We shall be happy to exchange with the Editors of Scientific journals who receive the first numbers of THE ELECTRICIAN.

Nous serons heureux de faire l'échange avec Messieurs les Rédacteurs des Journaux scientifiques qui recevront les premiers numéros de L'ELECTRICIEN.

Es wird uns ein Vergnügen sein mit den löblichen Redactionen der Journalen und anderen wissenschaftlichen Zeitschrifte, deren die ersten Nos. des ELECTRICIAN *zu Händen kommen möchten auszutauschen.*

I Signori Editori di giornali scientifici che ricevranno i primi numeri dell' ELETTRICISTA *possono con profitto scambiarlo il cambio che loro offriremo.*

SOUTH AFRICAN TELEGRAPHY.

The question of telegraphic communication with our South African possessions is rapidly assuming definite shape. Of the several alternative routes that have been proposed for effecting this much desirable object, and which offer a veritable *embarras de richesses*, none present so many points in their favour as that along the East Coast from Aden, *viâ* Zanzibar and Mozambique either to Delagoa Bay or Port Natal, with a branch line from Zanzibar to Mauritius, lapping Madagascar at its northern extremity. Its marked superiority over any of the western lines *viâ* the Atlantic, either by deep sea cables from the Cape Verd Islands to Ascension, St. Helena and the Cape, or by coast lines by Senegal, Upper and Lower Guinea, Walfish Bay, we had recently occasion to dwell upon. Lately, however, it has found a rival in an overland route across the eastern side of the Dark Continent in the entire length north and south. As this scheme has been highly spoken of, and, indeed, warmly recommended, by no less an authority than Mr. J. Sivewright, at present in charge of the Telegraph Department, Cape Colony, we are likely to hear a good deal about it for some time to come; hence it may be useful to examine its merits, and once for all dispose of its pretensions to serious consideration.

It proposes to carry a line from Natal and Transvaal through Matebeleland northwards to Tete, Sena, or some other point on the Lower Zambesi, thence *viâ* Lake Nyassa or the Unyamuesi, and across Lake Victoria Nianza to Uganda, and down the Victoria Nile to Gondokoro, or rather Lado, on the White Nile, where it would form a junction with a line connecting Egypt with its recently-acquired equatorial provinces. But, notwithstanding the eloquence with which it has been advocated in some quarters, this project will scarcely bear serious discussion. The line, however judiciously chosen, would necessarily have to traverse no less than four-and-twenty parallels of latitude, or some 1,650 miles of country from the Limpopo River on the northern frontier of Transvaal to Magungo on the southern frontier of Egyptian Soudan a country either totally unknown or but partially explored with a dangerous climate, infested in many places by the tsetse fly, and inhabited mainly by fierce and unfriendly tribes.

No doubt, an apparently similar *line de force* was successfully performed in 1872 in Australia, where the wire has been laid down for a distance of 1,972 miles right across the Continent, from Adelaide on the Southern to Port Darwin on the Indian Ocean. But the circumstances are so entirely different that the astonishing success of this magnificent undertaking cannot be appealed to as a precedent. Before the attempt was made, the unknown country between South Australia and the northern territory was roughly explored by J. McDonall Stuart, and was found to present far less serious physical obstacles than had been anticipated. The country was especially free from troublesome native tribes, except near the McDonnell Range, and at one or two other points, where the judicious application of a few electric shocks was sufficient to inspire the aborigines with a permanent and wholesome respect for "the whitefellow's devil." But the warlike, powerful and intelligent Mazitu, Wamasai, Wanyaturu, Wasipan, Lenywé, and other East African Bantu nations, are not to be so easily disposed of. Nor would it be possible to subsidise them, so numerous are the independent chiefs, especially in the region east and north of Lake Nyassa, all of whom would have to be dealt with separately. These districts may be said to be in a chronic state of petty warfare, and are from time to time laid wast, especially by the fierce Mazitu and Wamasai predatory hordes under such formidable leaders as Mirambo, who generally make a clean sweep of everything, and would not be at all likely to spare the telegraph poles. These objects, if "fetish," and therefore sacred in the eyes of one tribe, would in all probability be regarded with all the greater aversion by their neighbours. In any case, if we have not yet acquired influence enough to put down the detestable slave trade still openly carried on in these regions, or to induce the natives to allow free passage to an occasional explorer or missionary without subjecting them to oppressive exactions, the time must be still more remote when we shall be in a position to keep open an overland line along the proposed route, except at an utterly ruinous expense. When it is added that such a line could under no circumstances develope any local traffic, except at Zanzibar, and at its extreme ends north and south, that its repair would be always a difficult and costly matter, and that the scheme itself is for the present at least *in nubibus*, it seems scarcely deserving of a moment's consideration when compared with that already carefully thought out and matured by the practical and experienced minds connected with the Eastern Telegraph Company. This powerful and influential corporation has applied itself to the solution of the problem, and has pronounced emphatically in favour of the route along the eastern seaboard, which thus promises soon to pass from the regions of fancy and theory to the world of realities.

Including the contemplated branch from Zanzibar to the Mauritius, not by any means the least desirable part of the project, the length of cable required by this route to connect the Cape and Natal with Aden and the rest of the world would be either 5,520 or 5,600 miles, according as it might be landed at Natal or the Portuguese station of Lourenzo Marques, Delagoa Bay. At the rate of £250 per mile, the price for which the Telegraph Construction and Maintenance Company have actually undertaken to construct and lay such a line, there would be needed a capital of about 1,380,000l., which might be raised under an Imperial guarantee at 3½ per cent. The interest on this sum (48,850l.), together with the general charges for working expenses, stations, repairing ship, &c., would involve a yearly outlay of, perhaps, 60,000l., and as the line is not calculated to yield for the present more than 40,000l. of revenue on traffic, there would be a clear deficit of something like 20,000l. It should, however, be remarked that, whereas some of the proposed alternative routes could possibly be commercially remunerative at first, if at all, the deficit in this case would be amply covered by the subsidies already either promised or anticipated from the several Colonies or States directly interested in the undertaking. In this way, 5,000l. might be reasonably expected from the Sultan of Zanzibar, 5,000l. from Réunion, 10,000l. from Mauritius, the same from the Cape, 5,000l. from Natal and Portugal, altogether about 40,000l., leaving for shareholders a net profit of 14,000l. at once, with a fair, not to say a certain prospect of a steady increase of traffic in such places as Transvaal, Mauritius, Madagascar, and Zanzibar.

But, even should some of these promises prove delusory, we understand that the Eastern Telegraph Company is still prepared to make such liberal arrangements with the British Government and the Colonies for the working of the new line as would amount practically to an annual subsidy of about 10,000l., thus securing, under the most adverse circumstances, a surplus income of at least 20,000l., from the commencement.

There can be little doubt that, should this route be adopted, a cable would eventually have to be laid down between Mauritius and Ceylon—a distance of not more than 1,700 geographical miles. The South African Colonies would by this means be brought into direct telegraphic connection with India, China, Japan, Australia, and New Zealand, whereas by the West Coast line their communication with these important regions would have to be made by a most circuitous route, *viâ* Cape Verd Islands, Lisbon, and the Mediterranean, involving a practically prohibitive tariff and the constant risk of interruption between the Cape Verd Islands and Lisbon, where there is only a single deep-sea cable. This point alone ought to outweigh all other considerations with our enlightened brethren, who, when they come to study the matter in all its bearings, will scarcely fail to recognise the overwhelming advantage presented by the East Coast route over all the alternative projects hitherto proposed.

THE *London Telegraphic Journal*, in a recent article upon the admitted pre-eminence of telegraphic improvements and advances in the United States over all other nations, expresses the opinion that this superiority of the Americans is due to the excellence of our patent laws, which encourage inventors to obtain patents, and place no restrictions upon them after they are obtained.

TELEGRAPHS.—Owing to a typhoon, the Great Northern Telegraph Company's cables between Nagasaki and Shanghai, and between Shanghai and Amoy, are interrupted. The repairing steamer is on the spot, and a speedy restoration is expected. Meanwhile messages for Hong Kong and Amoy cannot be accepted, and messages for Shanghai will be forwarded from Nagasaki by steamer. The company's lines to all Japanese stations work well.

ACCIDENT TO A TELEGRAPH STEAMER.—Lloyd's agent at Singapore, in a telegram dated September 24, 6.5 p.m., reports that the British steamer *Edinburgh* had gone ashore there, but would probably be got off without damage. The steamer referred to in this telegram belongs to the Eastern Extension, Australasian, and China Telegraph Company, Limited. She is an iron A 1 steamer, built at Glasgow in 1855, and her dimensions are:—1,317 tons net, 2,315 gross, and 229·2 under deck. The steamer is stated to have been on her way to Penang to repair the telegraph cable when she met with the mishap.

Imperial Chinese Telegraphs.

THAT such a line of telegraphs really exists and is in daily work is now an established fact, the first line of telegraphs ever erected by the Chinese Government having just been completed by Mr. J. A. Bate, M.S.T.E., Director of the Imperial Telegraph College, Tientsin, and the students of the college. Although the line is but a short one, connecting the offices of the Arsenal with the Yamen of Li Hung-Chang, some six miles distant, its erection marks a new era in the policy of the Chinese authorities. With all the pressure that was put upon the Chinese at Foochow, the Great Northern Telegraph Company failed to get the line through from that port to Amoy, and after two years of hard fighting the erection of the line was finally abandoned by the company. The line at Tientsin has been put up under very different conditions, being ultimately erected by the Government with native labour. No the slightest opposition was offered by the people; permission was readily given to erect the poles of the lowest in Tientsin, or places in their vicinity when necessary—not an angry word was heard, and the line was got through with considerably less difficulty than is frequently experienced in England. The River Pei ho is crossed by a piece of submarine cable, with two large placed in the terminal poles on each side. The instruments used are Morse inkers, worked by Leclanché batteries. *The Li Hung Chang* has since got interest in the work, and spends many hours in the office, which is one of the private rooms of his Yamen.

The success of this line at once proves the ability of the Chinese youth to learn the technicality of foreign science, and the absurdity that "Pung-Shin" has anything to do with the opposition which telegraphs and railways have hitherto experienced in China. Mr. Bate has been requested to proceed to Formosa with some of his students to construct a line along the Western Coast of the Island from Kee Lung to Ai-an-tan, and a line from Tientsin to the provincial capital, "Tsan-ling-fou," is also contemplated.—*The Telegraphic Journal.*

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IRON TELEGRAPH POLES.

Passing from cables to aerial lines, there is at the entrance to the French annex a fine exhibit of iron telegraph poles, shown by the French Telegraph Administration, MM. Vuilleumier et Fils and M. Dargoffe. In some countries wooden poles cannot be used. Either want of wooded tracts from where to obtain poles, chemical conditions, or ravages of insects, or some or all of these combined, serve to prevent the use of wood. The iron poles shown are of varied design, from light poles to carry one wire to heavy poles to stand on the banks of rivers, nearly 50 ft. high, constructed to carry from 40 to 50 wires. The lighter poles are constructed of T and U angle iron, or of iron strips wound spirally inside three uprights. The heavier poles are of angle iron of different kinds. Some of these poles are fitted with boxes, which will hold tools, etc., necessary for the repair of the line, or instruments for testing purposes. The arrangements in use in one or two cases are so made that the leaves contain curved grooves for the junction of aerial and subterranean wires. It has been suggested that lighter and stronger poles of iron and might be made by using steel. It is true that as yet steel is not so widely used as it will be in future, and it may be found that the suggestion is of practical value. We should be glad to have statistics relating to the question of lightning upon lines constructed with iron poles. Is it found that less damage is done, or more?—*The Engineer.*

August 1, 1878.] THE TELEGRAPHIC JOURNAL. 171

THE VOLTAIC BATTERY.

A COURSE OF SIX LECTURES,

By DR. JOHN HALL GLADSTONE, F.R.S.,

Fullerian Professor of Chemistry, Royal Institution,

DELIVERED AT THE ROYAL INSTITUTION OF GREAT BRITAIN.—CHRISTMAS, 1874-5.

(Continued from page 137.)

LECTURE VI.—THE ELECTRIC TELEGRAPH.

IT was in 1820, little more than half a century ago, that Oersted first noticed the action of the voltaic current upon a magnetic needle. I have had occasion to show you this action two or three times already, but I must show it to you again. We will take this needle, pointing at present to the north with a wire passing over it. By just making contact between the wire and a battery, we shall find that the needle will turn round. There you see the needle turning away at right angles. Now, of course, we can make and break as we please, and by sending the current the other way, the needle will turn over to the other side. So we can make it go either to the right or to the left. Now this has led to the invention of what are called galvanometers. This is the simplest form of galvanometer, but if, instead of taking a straight wire we made it coil round many times, and especially if we take what is called an astatic needle, that is, two needles which are fastened together with their poles reversed, so that the north pole of one is over the south of the other with the wire passing between, we should be able to produce movements of the needle by exceedingly feeble currents. You are aware that this has been fully carried out in Thomson's galvanometer which we have here. I explained that to you on a previous occasion, and mirror responded on the needle, and how we were able to throw a light from that moving mirror upon the screen.

Now what may be done with an ordinary galvanometer. I can move the needle which way I please, or reverse it as often as I like, by the power that comes from the battery. Now, we can attach marriage to these movements of the needle. We can read one as "A" and another as "B," and so on. We might then carry the instrument to that table. I have only to make the wire longer for that purpose, or I might take the instrument up into the gallery, and do just the same as I have been doing here. But I need not be content with that, for I could take this instrument out into Albemarle-street or Piccadilly; or I might carry it to Hounslow or Bayswater, and still, if there was a sufficiently long wire, the voltaic force would flow through and reach the instrument, and our needle would act in response to what took place here. Now, you see by giving certain meanings to these swingings of the needle; we can make communications at a distance to those places. I have spoken of, for instance, as to Birmingham or Edinburgh, or anywhere else; and hence, we have the invention of the electric telegraph.

In the same year that Oersted noticed this movement of the needle, another great electrician, Ampère, suggested it as a means of indication at a distance. Communication by means of electricity had been suggested before that, but I believe that there was no actual electric telegraph made and used till Gauss and Weber, who were making certain observations in 1833, carried a wire from their physical cabinet to their observatory and back again—a distance of a mile—and made a needle swing, and were then able to communicate from one place to the other. There were partially successful attempts by Ritchie and others, I believe, in this building, but we may go on to the year 1837, when Cooke and Wheatstone took out their patent for the use of the electric telegraph. They employed five different needles moved by five different wires, and they were able to speak at a distance. This was employed upon the Great Western Railway, and this was the commencement of that long series of electric telegraphs which now send their metallic threads all over England and over all the civilized nations of the world. Of course, it is necessary that these wires should not touch one another, and that they should be separated from other conductors of electricity, and, therefore, they are insulated, as it is called; they are covered with thread or with something else which keeps them from other bodies. Gauss and Weber hung their wires up in the air. Cooke and Wheatstone first of all employed insulated wires, and carried them underground, but you know now very well that along our lines of railway we see the electric telegraph wires hanging in their various curves as we go along, and we cannot see, but we may imagine, if we please, the messages that are passing along these lines.

But this was only the commencement—the very infancy of telegraphy. It has since had an immense amount of attention paid to it, and an immense amount of success has attended it. Mr. Steinheil, in 1838, stretched wires in the air by insulated supports, just as we see them now arranged on poles. I do not know whether he employed the porcelain which is employed now, but there are various ways in which the wires may be suspended on the poles, so as to keep them from the damp earth. But Steinheil made another important discovery, that is to say, that it was not necessary to have two wires. It is necessary merely that you should have one wire—one wire going from your battery to your instrument, right along where you want to send the message. All that you have to do is to bring your battery in connection with the earth, and your instrument at the other end of the wire, in connection with the earth there also. Large plates are sent down into the ground to some place which is permanently damp, so that the plate may continue in connection with the earth.

Perhaps it may be difficult to explain how the earth acts; but we know that the result is a very satisfactory one. We actually got less resistance than if we employed return wires.

I must say a word about this resistance. You recollect I have spoken of different substances having very different powers of stopping the galvanic current, or, in other words, of conducting the current, and I have said that silver is that which conducts it most readily. Platinum conducts it by no means so well. Now, if we take wires of the same size throughout we find that the amount

Home-Made Electric Telegraph.

At the request of several correspondents, we will explain the fundamental principles on which the electric telegraph is based, and will attempt to make it so clear that any one of ordinary intelligence and in the possession of some iron and copper wire, sheet copper, zinc, and a few small pieces of rod-iron, will be able to construct a telegraph by bringing his material into proper shape at the vise, with the help of a few files. The possession of a little is convenient in this respect for turning the iron core, winding the coils, etc., but is not absolutely necessary.

The Battery is the motive power by which the electric wave is sent over the wire; two cups of the same are seen at the left side of our figure. The battery here represented on a small scale is a so-called gravity battery, at present quite popular among the telegraphic profession, but undoubtedly soon to be superseded by a totally different apparatus. This gravity battery has a piece of sheet copper at the bottom of the cup, with crystals of sulphate of copper laying around it, a disc of zinc is suspended at the top, while the cup is filled with water as high as to entirely submerge the zinc. After awhile the sulphate of copper commences to dissolve in the water, the zinc in top is attacked and

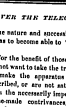
HOW A MESSAGE IS SENT OVER THE TELEGRAPH WIRE.

changed, first into oxid and then into sulphate of zinc, while metallic copper is precipitated on the copper disk at the bottom. The solution of sulphate of copper being heavy, will remain below, and only slowly rise in a very diluted condition until it reaches the zinc, where its sulphuric acid combines with the zinc, which is first oxidized at the expense of the water. The hydrogen which escapes in a fierce battery, that is, one containing free sulphuric acid and no sulphate of copper; see beginning of page 229, Vol. IV.,) combines in this battery with the oxygen of the oxid of copper, and instead of hydrogen escaping copper is precipitated. This battery is called a Daniel battery, but is modified so as to do without the objectionable porous cup, (see the end of page 228, Vol. IV.) Other forms of batteries also used for the same purpose may be found more extensively illustrated and described on page 229, Vol. IV., and page 155 of this volume.

If the place with which we wish to communicate is distant, so that the wire is necessarily long, two or more cups must be combined in the manner shown in our cut, or of the seven cups represented on page 229, Vol. IV. The wires proceeding from the first and last cups are called the electrodes, and one of them is soldered to a copper plate buried in the moist ground, so as to use the earth for the return current, while the other electrode is connected with

The Key.—This instrument, with which the messages are sent, is represented at the extreme left of our figure. It may have different forms; according to the most common form it is simply a metallic lever turning on a pivot, and by means of a spring kept at a very short distance above the end connection of one of the electrodes of the battery. The lever carries at its extreme end a flat ivory or rubber knob to receive the finger point of the telegraph operator. When he depresses it, the lower surface, which is provided with a platinum point, touches the platinum end connection of the battery electrodes, and thus "closes the current," as it is termed. This current is then at once sent over the wire which is stretched through the air, and supported from distance to distance on poles, by means of the insulators made of glass, porcelain, or rubber, as the wire must not touch the wood of the poles or the walls of houses.

At the other end of the line is the receiving instrument. This consists simply of an electro-magnet, as represented in the adjoined small figure, or better, as represented in the large cut; it consists of two round cores of iron screwed to a cross piece below, and each surrounded by a coil. When the current passes through the coil, the iron becomes magnetic and attracts the armature suspended by a spring, each attraction makes a click, and these clicks differ in their nature when the contact made with the key is of short duration, or if it is continued for some time. The first corresponds with the dot or point, the second with the line or dash; and after some practice the operator becomes able to distinguish the nature and succession of the clicks to such a degree as to become able to "read by sound," as it is called.



For the benefit of those who do not want to take the trouble to make the apparatus here described, or are not satisfied with the necessarily imperfect home-made contrivances, we give here an estimate of the minimum expense of a small private telegraph office between two stations, one mile distant:

Eight cells battery, at $5,	$40
Two keys, No. 2, at $3,	6
Two sounders, No. 2, at $2 50,	5
Two miles wire, No. 16,	25
Twenty insulators, glass and bracket, at 25c.,	5
Office wire and sundries,	9
	$100

The total expense of two offices, one mile apart, is thus $100, of which more than one half is for the line and its supporting posts. The expense of the line increases in a direct ratio to the distance, while the other expenses remain the same, except the battery, which also requires some increase for increased distance; but in any case the line is, if the distance is a mile or more, the most expensive part of the whole arrangement; any contrivance therefore able to make a single wire do a multiple duty, is of great importance in an economical point of view, and for this reason the method of transmitting two messages simultaneously over the same wire in opposite directions, as described on page 229 of our former number, is important in all cases where the business of the line is so active as to require a continual dispatch and reception of messages, which with the usual appliances would require two lines, and therefore almost double the expense.

The Eastern Telegraph Company have sent out [illegible] cable with core sheathed in [illegible] it will withstand the [illegible]

...IES ET INDUSTRIELS

...ques et les animaux.

...Tandis qu'en Europe, les fils télégraphiques aériens sont ...respectés des hommes, des animaux et même des éléments, ...il n'en est pas de même dans certaines contrées tropicales.

Les Hollandais ont établi des lignes télégraphiques dans ...leurs possessions de Java et de Sumatra. Un rapport officiel qui vient d'être publié constate que l'entretien et le fonctionnement de ces lignes présentent d'assez grandes difficultés, par suite des dégâts dûs à des animaux sauvages, principalement aux éléphants. A Sumatra, pendant les trois dernières années, on n'a pas compté moins de soixante interruptions sérieuses.

Le 23 mai 1870, la ligne télégraphique de Mihara-Iwarahat a été complétement abattue sur une longueur de trois lieues; tous les travaux de réparations exécutés pendant le jour étaient régulièrement détruits la nuit; c'est seulement au bout de trois jours que le service a pu recommencer.

...voici quelques-uns des éléphants, les tigres, ...n danger permanent pour les ...ter le télégraphe dans la jungle. ...ils paraissent aussi regarder les ...raphiques comme étant destinés ...ercer leur gymnastique; ils se pen...souvent, et emportent les isola...

...graphic Communication from Algeria across ...Pontic possessions in Senegal, is said to be ...Lesseps and others. The French lines already ex...nd to Tripoli, while the Egyptian lines reach to ...e confidently expected that the extension of the ...rench lines will be very long de...

TELEGRAPHY IN BRAZIL.

According to the last published report the extent of the lines has increased to 6,000 kilometres (about 4,000 miles). The small number of stations (97) over this length is represented as adding to the many other drawbacks in the matter of maintenance. The maximum number is limited to 101 over this distance, the only use of one-half of which is to facilitate and aid the service, seeing that the revenue is actually nothing, without even a reasonably remote prospect of the point being arrived at for the adjustment of deficits. As examples:

20	stations	produce	less	than	315	monthly.
10	"	"	"	"	25	"
12	"	"	"	"	40	"
8	"	"	"	"	50	"

The annual expenditure in maintenance and facilitation of these lines is stated at $125,000. The receipts from the State telegraph lines in 1.76 were about $ 46,000; the relative expenditure was about $740,000.

Telegraphy in Japan.

Mr. E. Gilbert, who for more than four years past has had charge of the Government Telegraph department of Japan, as Superintendent-in-Chief, but whose engagement is about to terminate, was entertained by the Acting Minister of Public Works, Yamao Yoso, at a banquet at Shiba Palace. The Minister for the Home Department and about thirty other gentlemen were present. A very cordial and pleasant evening was spent, and all united in expressions of good will and good wishes for Mr. Gilbert's future happiness. We believe that Mr. Gilbert has given the government ample satisfaction, from the way in which he has conducted the important department under his charge, and leaves the lines of telegraph in as excellent a condition as the best lines in any part of the world.—*Japan Daily Herald.*

Management of Government Telegraph Lines.

An order has been recently issued from the War Department relative to the control and management of United States Telegraph Lines, which have been placed in charge of acting Signal officers. Interference with the duties of the latter is prohibited, and all commanding officers are directed to render them, upon application, such proper assistance as may be necessary for the maintenance of the lines.

Electrician May 28, 1881.

Telegraph Wires in New York.—A Bill just presented to the Senate at Albany enacts that all wires going in a northern or southern direction, on that part of the town comprised between the Battery and Forty-two-street, shall be placed underground, or be carried on most metal supports; that the companies shall begin to effect this change after the 1st July, 1881, and that it shall be completed by the 1st May, 1882; that after this latter date it shall be illegal to use wooden poles as supports for wires; and lastly, that the laying of wires shall be done under the direction of the Commissioner of Public Works.

delegates from the Physical Society, the Society of Telegraph Engineers, and the Royal Institution of British Architects, had accepted an invitation from the Council of the Meteorological Society, and would shortly assemble to settle all doubtful points.

The lecturer resumed his next month's warm applause.

On the motion of the chairman, a hearty vote of thanks was passed to

Mr. SYMONS, who, in returning thanks, cordially invited those present to attend the ordinary meetings of the Society.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).

The Extraordinary General Meeting of the Members of this Company, adjourned from the 6th ult., was held on Wednesday, the 4th inst., at the City Terminus Hotel, Cannon-street, "for the purpose of approving an Agreement made with the Governments of the Australian Colonies or some of them, for the duplication of the Australian Cable, and passing Resolutions authorising the Directors to execute all contracts and to do all acts requisite for carrying such Agreement into effect, with such modifications, if any, as the Directors may determine; and further authorising the Directors to raise the capital required for this purpose and for the general purposes of the Company, by the issue of Debentures or otherwise upon such terms and in such manner as the directors may think fit."

The CHAIRMAN, in opening the proceedings, said: Gentlemen, the secretary will read the notice calling this meeting.

Mr. HAYES (the Secretary) read the notice, as above.

The CHAIRMAN then said: Gentlemen, a month ago, when the extraordinary meeting was adjourned until to-day, I stated that I thought—in fact, that I felt confident—that I should be able to-day to announce to you that the agreement with the Australian colonies had been signed. You will have had a good deal of telegraphing during the month, and I am happy to say that this morning I received the following telegram from Colonel Glover:—"Perry, in London, will have all signed the agreement, and will deliver complete. Hope this will be in time for general meeting. Documents left here to-day by Francis Dove." Now, before making my remarks upon the importance of this contract (which has been made with the Australian colonies, I think it is better that I should read out the cablegram to read the agreement, and after you have heard it I shall make a few remarks, and then I shall be glad to hear from any shareholder his views on the agreement. I may state that Mr. Berry is the Prime Minister of Victoria, and Mr. Burns is the Treasurer of New South Wales, and I may say that they both have been authorised by their respective governments to sign the agreement. The agreement is, of course, not perfected, though it is signed, and is virtually perfected. It must, however, be perfected by the Board, and is virtually perfected. It is best, I believe that the colonial representatives are still in London. Mr. Hayes has the original contract.

Mr. HAYES, the solicitor, accordingly read the Agreement as follows:—

1. That the Company shall, subject to the approval of the shareholders, contract with the Governments for the construction of a second line of cables, Singapore direct to Hanjoman, thence direct, to Port Darwin, for an annual subsidy of £6,000; and, thereupon, the Company shall sign the Contract and accept the conditions on or before 1st July, 1879.

2. That the subsidy shall be payable for a period of Twenty years, subject to the provisions hereinafter contained.

3. That the Company shall, throughout the whole of the period during which the subsidy shall be payable, maintain in full working order the whole of the present lines of cables between Singapore and Batavia and Singapore and Port Darwin.

4. That the Company shall, before such subsidy shall become payable, construct a second cable between Singapore and Penang, and thereafter in like manner, and to the same (the not of Set) as the Queen's enemies accepted, the first lines of cable between Singapore and Penang, Penang and Madras, and Penang and Malacca, in full working order.

5. That the Company shall, in consideration of the subsidy hereby agreed to be paid, and whilst the same shall be duly payable, allow a rebate for Government messages, hereinafter defined, on messages passed between England and Port Darwin, reducing their own proportion of the charge for the transit of 20 words, at the present rates, and on Press messages exchanged between Singapore and Port Darwin, as hereinafter defined, one-third of their own proportion of the charge for the transit of 75 per cent. upon their own rates, provided that such reduction shall not be extended to any cables other than such as may contribute to the payment of the subsidy.

6. That the Company shall construct and open for communication the second cable above mentioned between Singapore and Port Darwin, and thereafter in like manner, within eight months from the date of the signing of the contract, provided always that the Company shall not be held liable for any loss or damage which the Colonies may sustain in consequence of delay in completing the said cables in the event of such delay occurring by war, inevitable accident, or other contingency over which the Company can have no control.

7. That in the event of the Company completing and having the duplicate cables hereinbefore mentioned open for communication within the period herein contracted for, the subsidy payable by the Governments shall commence and accrue from the date of the completion of the contract, but the Company shall not be entitled to any payment under this clause until the cables shall have been actually completed and are open for communication, as aforesaid.

8. That the said subsidy shall be payable quarterly in London to the Company in sterling money, free of all deductions.

THE TELEGRAPHIC JOURNAL. JANUARY 15, 1879

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CONTRACTS ENTERED INTO for the SUPPLY, CONSTRUCTION, and MAINTENANCE of TELEGRAPH LINES.

LONDON: PRINTED FOR THE PROPRIETOR BY H. BLACKLOCK & CO., ALLEN STREET, COSWELL ROAD, E.C.—JANUARY 15, 1879.

TELEGRAPH EXTENSION IN AFRICA.

The electric telegraph is being rapidly extended over the dark Continent. The active energies of M. Lesseps are being directed towards the establishment of a line across the Great Desert, from Algeria to the French settlement of Senegal, and the French have already extended their Algerian lines eastward to Tripoli. The Egyptian lines reach to the Equator, and those of South Africa will probably before long be in communication with them; and, by and by, we may expect to see an overland line from Cape Town to Cairo and Alexandria. The extension of communication in the same direction will aid in protecting the wires; and it is stated as regards the northern lines that the Arabs, finding their camels travel much faster when following lines, most scrupulously respect the wires and poles.

Ledr 1869

A NEW MODE OF PLANTING TELEGRAPH POLES.—The following method has recently been tried in Tuscany, and is described in the *American Manufacturer*, has been tried with success in Titusville, Pa. The ground being sodded off at distances of about 300 ft. apart, a small charge is fired off with a percussion cap, which, by means of a connecting wire, explodes another charge placed in the bottom of a hole about 5 ft. deep. The explosion of the second charge forms a hole about 3 ft. in diameter at the bottom, and 2 ft. at the surface. The pole is then placed in the hole, and the earth and stones thrown in, when a hole about 2 ft. in diameter is formed above the charge. The pole is then rammed down, and the hole filled in with gravel and earth, and the job is complete. It takes about one minute, and three persons can put up from 100 to 150 poles a day, or ten poles per hour. The cost, therefore, of this new and improved process is about two thirds less than the ordinary method of planting telegraph poles, as now practised. *March 17.*

A TELEGRAPH TO THE CAPE.

Feb 17

The recent disaster to our arms inflicted by the Zulus renders it imperative that telegraphic communication should be speedily established with the Cape Colonies. The subject was brought to the notice of Sir Michael Hicks-Beach on February 12 by a deputation, headed by Sir J. Lubbock and Sir H. Barkly. These gentlemen advocated the construction of an overland line from Egypt to Pretoria via Zanzibar, the pet scheme of the colonists, and requested a Government subsidy to aid in the work, which they estimated to cost £180,000. The Colonial Secretary replied that the Government was prepared, with the Colonial Parliament, to subsidize any company undertaking the work; and that he believed at present a cable more feasible than a landline, though the latter might be more advantageous when once established. Before deciding in the matter he should, however, require a definite estimate of the time and money required for the land-line. It is to be hoped that this will speedily be furnished, and that, whether the line be overland or submarine, and the latter indeed seems to us the most feasible at this time, it will now be realised.

from the provinces as well as from London—the additional charges for provincial messages being abolished. In like manner messages from Germany and Holland addressed to provincial towns in the United Kingdom will be charged the same rates as messages addressed to London. For a prepaid reply to a message, the charge will not be less than for ten words, whether the number of words desired to prepay the charge for a reply of more than ten words, be more or less than the number of words, but no prepaid reply may consist of more than thirty words. For the acknowledgment of the receipt of a message the charge will be the same as for a message of ten words.

The Railway News, of London, in its financial summary for 1878, has the following in regard to telegraph companies: The shares of the Telegraph Construction and Maintenance Company, the Globe Telegraph and Trust Company, the Submarine Telegraph Company, the Anglo-American Telegraph Company, and the Eastern Extension, Australasia and China Telegraph Company, have all been active securities. The Eastern and Eastern Extension shares alone no important change. The latter system has been strengthened by arrangements for the duplication of the Australian section under a colonial subsidy. The Eastern Company has laid lines to Cyprus and Constantinople, and acquired the cable between Odessa and Constantinople. The question of establishing telegraphic communication with the South African Colonies is under the consideration of the Imperial Government, the Colonies being expected upon giving liberal subsidies. The receipts of the Atlantic lines continue satisfactory, and four cables are doing the work with remarkable regularity. Yet a fresh attempt seems on foot in France for raising capital for two new cables to New York. The highest price of Anglo-American was 65, the lowest was 54; similarly Direct Cable touched 141 and 112.

The Great Northern Telegraph Company has declared a dividend for the past half year at the rate of 5 per cent. per annum on its share capital of £1,500,000.

M. Linckens, of the Netherlands telegraph service, has been deputed to examine the results of the "urgent" message system which has been tried there since last October. He finds that while one-half of the Bourse messages are "urgent," hardly any come from private sources. M. Linckens is of opinion that the total number of "urgent" messages is not high enough to delay the ordinary traffic, and that these "urgent" messages render inconstatable secrecy to their senders.

According to the *Cologne Gazette* the Imperial German Government intend, during the present year, to push forward the works of the subterranean telegraph. It is proposed to lay the line between Cologne and Metz, which will cross the Moselle and the Sieg. The bridges of Coblentz and other places will be utilized for this purpose, but a river cable will be laid across the Sieg at Siegburg. The subterranean cable will be constructed to correspond with those already existing between Berlin and Halle, and Berlin and Frankfort-on-the-Main. The Reichstag will be asked to vote the necessary funds.

A telegraph line is being erected from Durban to Bungee, South Africa, a place about twenty miles from the Zulu border, and near the coast.

The *Journal Telegraphique* states that on taking possession of Dobrudscha the Roumanian Government established eleven telegraph offices, forming a permanent service open to international correspondence. The Russians, however, would not permit them to open an office at Sulina.

The *Japan Mail* is responsible for the statement that telegraphic insulators made at the village of Imaseki, in the province of Hizen, Japan, are so good that they find a large sale in Europe.

M. Blavier has been nominated director of the Paris Superior Telegraph School, during 1879. M. Mercadier is Professor of Physics, and M. Bontemps is Professor of Telegraphy.

The French Government recently presented to the *Corps Législatif* a project for laying a cable between Australia and New Caledonia.

M. de Lesseps is urging the French Government to extend the telegraph wires from Algeria across the desert of Sahara to the French colonial dependency of Senegal, in Western Africa.

The New Central Telegraph Station at Berlin, Prussia.

We learn from the *General Telegraphique*, of Berne, that the new central telegraph office at Berlin was formally opened for service on the 30th of November last. The inauguration took place under the presidency of the Postmaster-General in presence of the Director-General, the Councellors, a large number of officials of the Central Administration of Posts and Telegraphs, all of the employés of the central office, and including also a number of foreign savans and other persons of distinction. Doctor Stephan, in a happy and appropriate speech, welcomed the employés, and congratulated them upon the occupancy of the new building. He also referred in fitting terms to the many illustrious men whose names will ever be remembered in connection with the inception and growth of the telegraph. The following is a brief description of the operating department: The space forming the ground floor of the new building is about 110 feet long and 80 wide. It is composed of a central hall lighted by skylight, and forming the principal portion of the whole, and three latteral galleries running north, west and south. The central hall is nearly 23 feet high and the galleries over 12. Communication between the former and latter is established through double rows of richly decorated columns. The whole interior, besides, is fitted up with much taste and elegance, and forms a very pretty effect. The central room is principally reserved for the Hughes apparatus, of which it now contains 36, and 10 Morse sets, but the space is so large and the arrangement of the present apparatus has been such that the number of instruments can be doubled in case of need. The switch connecting with the Hughes apparatus is placed in the portion of the building, as are also the pneumatic tubes connecting with various outside points, and the slightly elevated desks for the use of the chiefs, from which they can command a complete view of the floor.

The galleries are principally devoted to the Morse apparatus, of which 169 sets are in actual service. They also contain two large groups of lightning arresters and the general switch, as well as a smaller one for the accommodation of the city lines. A number of electric clocks, ten in all, and controlled by a single regulator, are placed at various points about the rooms, so that the employés on any part of the floor are enabled to ascertain the hour without the slightest inconvenience.

The central station contains 250 lines, which are supplied by some 6,000 cells of battery placed in the basement, beneath the operating department, and all the wires leading from the instruments to the batteries and to earth are covered with gutta-percha protected by an outside covering of lead.

An Artist Telegraphist.

Mr. Geo. Cochrane of the Western Union main office in this city, has a picture in the Water Color Exhibition at the Academy of Design called "Color Glow," a continuous rectilinear spectrum. It possesses not only an artistic but a scientific interest.

THE PROPOSED TELEGRAPH THROUGH CENTRAL AFRICA.

It has been very difficult for any one to gather from the expressed opinions of the exponents of this scheme any clear idea as to the means they propose to adopt in order to carry it into effect. One estimate gives as the cost £500,000, but the principal speaker in the deputation to the Colonial Secretary on the 18th February gave as the cost £700,000. We can hardly suppose that any really scientific estimate has been made, but what has thus been stated is the outcome of a casual glance at the subject. The engineering difficulties in the way of such a work are enormous, and when these have been surmounted, as they can be, *at a cost*, electrical difficulties must be encountered, and how these are to be overcome has not yet been satisfactorily explained. According to Captain Mayes, for hundreds of miles over part of the proposed tract the tropical vegetation holds sway, and if a road of twenty feet in width be cut and the roots of the trees grubbed up, in a few months, unless there is a constant stream of traffic, the whole is again covered with an impenetrable jungle. Then all the materials, posts, wires, insulators, tools, and even the food, or merchandise wherewith to obtain food, must be carried in some parts by the aid of coolies. Electrically, the insulation of the line would be about as bad as one can suppose a line to be. Portions of its course being in two tropics, there would be a double rainy season to be guarded against; and be it remembered that rain in England is one thing and rain in the tropics another. It would be extremely difficult to send messages during a tropical downpour over long lengths of land line—and, if we consider the effect of the luxurious vegetation probably coming into contact with the wires, we should say almost impossible. We are glad to see that Mr. Donald Currie, the able advocate of the West Coast cable, has no word to say for the land scheme, but says if there is greater difficulty in laying a cable by the West Coast than by the East Coast, by all means let us have the latter. He believes, as must every one who has studied the subject, that telegraphic communication with the Cape by means of a cable is essential—essential commercially, essentially politically. Mr. Young, in a communication to *The Times*, says:—"I am interested in a scheme of laying a telegraph to the Cape through Central Africa. I consider such a project to be altogether impracticable for some years to come, for the following reasons:—A great portion of the country through which it is proposed to construct this line of telegraph is altogether unexplored, and only with the greatest difficulty have travellers penetrated to those parts which are better known. How, then, could the requisite material be transported thither? Supposing even this objection to be overcome, the elephants, which abound nearly everywhere and delight in uprooting even immense trees, would speedily lay every post level with the ground. The poles, which the climate would render dry, in six months would be totally destroyed by the fires which every year entirely consume the grass and bush. It would be impossible to keep the line in repair; most of the native tribes, instead of so doing, would soon be using the wire for ornaments."

We trust that after these statements have been considered we shall hear no more about a scheme which, upon the face of it, bears no stamp of practicability. According to a casual statement of Mr. Donald Currie, made on the occasion of the departure of the Dublin Castle with troops for Natal, the Government has practically decided to give the required support for the laying of the East Coast Cable, from Aden to Zanzibar.

USE OF "EARTH" FOR COMPLETING A TELEGRAPHIC CIRCUIT.—According to Mr. John Finlaison, Prof. Aldini, about the year 1802, sent the current from a battery of eighty cells across Dublin Harbour through a wire supported on the masts of boats, using the sea for the return circuit. It was not until 1837 that Steinheil perfected his telegraph, and showed that the return wire between two stations might be dispensed with; whilst the experiments of Mr. Alexander Bain, at the "Serpentine River," in Hyde Park, in which water and metal cards were made a portion of the circuit, did not take place until 1842.

SOUTH AUSTRALIA.—This colony has nearly 5,000 miles of telegraph line in actual operation. This includes the line, 2,000 miles in length, through the continent, in connection with the submarine cable system to India, England, and other parts of the world.

JAPAN TELEGRAPHY.—We learn from the *Journal Telegraphique* that Japan has joined the St. Petersburg Telegraph Convention, having adopted the extra-European rules and tax per word, without conditions as to minimum of words. The cost of a message in Japan is fixed at 40 Mexican cents, or about a shilling per word.

THE International Telegraph Conference will meet on June 10 in London, and not on June 2 as at first arranged.

FOR three years the German Telegraph Administration have published statistics of the faults on their air lines, a plan which is worthy of imitation by all other telegraph managements. In 1878 some 382 posts were broken on 17,700 kilometres of wire, 1,097 broken wires on 15,700 kilometres, 2,251 leakages on 24,000 kilometres, 1,342 damaged insulators on 25,000 kilometres, and 242 loose wires on 19,800 kilometres. These figures show a remarkable reduction of mishaps as compared with the previous two years.

TASMANIA has 850 miles of telegraph line connecting 46 stations, besides being connected by cable to Australia.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—Subject to the audit of the accounts, the directors propose paying a dividend of 15 per cent. (£1 16s.) per share, in addition to the *ad interim* dividend of 5 per cent. already paid, making 20 per cent. for the year 1878.

Bamboo poles, for use as telegraph posts, are being sent to Natal from Madras.

The Telegraph.

ANNUAL MEETING OF THE DOMINION TELEGRAPH COMPANY.

THE report of the directors of the Dominion Telegraph Company for the year 1878, presented at the annual meeting of the company, held at their office in Toronto, February 12th, was as follows:

The directors beg to report that the gross revenue of the company for 1878 has amounted to $167,807.31, as compared with $177,086.88 for 1877, showing a decrease for the year of $7,244.55; while the working expenses for 1878 have been $122,215.23, against $121,297.58, or a reduction of $2,082.39 on the previous year's total.

The net revenue for the year has amounted to $47,592.08, leaving, after payment of interest on bonds, the sum of $35,257.97 available for dividend, from which the directors have declared an interim dividend of 3 per cent. for the half year ending the 30th June, and a further dividend of 2½ per cent. for the closing half year ending the 31st December, making for the year a total dividend of 5½ per cent., and leaving at the credit of profit and loss account a balance of $1,891.47.

The directors have to congratulate the shareholders on the completion of their connecting lines in the Maritime Provinces, and feel warranted in assuming that the extension now consummated will prove a valuable boon to the public and a profitable acquisition to the company. The Dominion is now the only telegraph company transmitting public business over its own wires between the Upper Provinces of Ontario and Quebec and the Lower Provinces of New Brunswick and Nova Scotia. Its lines, moreover, form the shortest as well as the only direct communication with the Atlantic cable, connecting Canada with Great Britain, thus affording to Canadians the independent national telegraphic communication with the mother country, so long desired. The directors confidently hope the public will not fail to appreciate the advantages and facilities thus possessed by the Dominion Company, especially when it is known that the transmission of the telegraphic business between the Maritime and Upper Provinces and between Canada and England, and the whole of Europe, by any other line than by the Dominion, necessitates a foreign and hostile operation. Such an objection does not exist against the Dominion Telegraph Company. Moreover, its cable traffic from Canada by any other route involves the transfer and repetition to an intermediate telegraph company in New Brunswick, over whose lines it has to be retransmitted to Cape Breton, where a further retransmission has to be made by cable to Newfoundland before it is finally despatched by the trans cable. In the case of the Dominion line no transfer to intermediate company is involved, as the trans Atlantic cable is reached directly by their own wires at Torbay.

Since the last report was submitted the pole multiage of the Company has been increased to 4,618 poles, and the wire mileage to 8,982 miles, and the number of offices now open is 402.

A conference having been proposed by the Montreal Telegraph Company to the Dominion Company, through Captain Mayne, R. N., C. B., to discuss the subject of a division of the gross earnings of the two companies, with a view to enable them to reduce their expenses and minimize the effects of the diminished traffic by the general and serious depression in commerce which unhappily continues to prevail, your directors appointed to enter into negotiations for the accomplishment of so desirable an object; it being first distinctly stipulated that both companies should maintain their independent legislation, and that the public should have continued to them the option of using whichever line they preferred. Under this arrangement it was proposed to establish joint offices at all those places where one telegraph office would amply suffice, but where duplicate offices were now maintained at heavy cost to both companies. The agents at these joint offices were to be equally the servants of both companies, acting under the instructions of a Joint Committee and not under separate authority, except in matters appertaining to the routine business of each company. While this arrangement would have continued to the public, a first-class and independent service by either company's line, as the use thereof might be chosen, it would have acted to both companies the expense of many superfluous offices which have been the natural offspring of keen rivalry. The business of both companies having fallen off, and there being little prospect of a speedy reaction, your directors deem it proper and wise to try the means which appeared to them to be most practicable and effective to conserve all interests. It seemed to them that, in the case of keenly competing companies, as in the case of railway companies, the means mainly existed in the ability possessed in the companies to bring about, by agreement with each other, the largest possible reduction of expenses, and so keep up the net earnings, while any attempt made to maintain an increase of earnings by raising rates, in the present depressed state of business, would be strongly opposed by popular feeling, and productive so little, if any, benefit to the companies themselves.

The directors, under the circumstances, felt it their bounden duty to take the whole matter into consideration, and decided to recommend their shareholders to accept of the division of gross earnings which both parties had agreed upon, with each an administration for the management of the joint offices, as they believed it would be greatly beneficial to the interests of both companies and through with the least possible inconvenience to the public. A difference having arisen between the parties, it was mutually arranged to refer the matter to the arbitration of Captain Mayne, whose decision it was agreed should be binding on both companies, subject to the approval of the shareholders. The directors, however, regret to have to announce that the negotiations were eventually terminated by the Montreal Company declining to carry out Captain Mayne's award.

During the past season the company's entire system of lines has been thoroughly overhauled by repairing and renewal gangs, and put in condition to make transmission of business reliable, and to afford every facility and promptness of despatch.

The directors trust that by these means, and by the addition of such important premises as New Brunswick and Nova Scotia to their system, whereby the resources of the company have been much augmented, they will be enabled to offer such commercial facilities as will enable them to retain their old business generally, as well as secure the shareholders permanently satisfactory results, more particularly when trade revives and public confidence is restored.

The directors find it desirable to obtain some amendments to their charter, and will submit, for the shareholders' approval, the bill they propose to introduce to Parliament.

The following is a general statement showing the liabilities and assets of the company on the 31st December last:—

LIABILITIES.	
Share capital authorized	$1,000,000 00
Share capital paid up	713,700 00
First Mortgage bonds issued	200,000 00
Balance on account, and bills payable	74,372 92
Due connecting lines, unpaid dividends, &c.	10,351 66
Dividend now payable on six months ending 31st December, 1878, at 2½ p. c.	17,760 17
Balance at credit of profit and loss account	1,891 47
	$1,018,076 22
ASSETS.	
Capital expenditure account	$1,009,324 53
Plant and stock on hand	63,186 48
Accounts due from railways, governments, connecting lines, agencies, &c.	58,264 86
Cash on hand and in Bank	10,272 61
	$1,141,048 31

Respectfully submitted,

THOS. N. GIBBS, *President*.
THOS. ROBINSON, *Managing Director*.
F. BOURN, *Secretary*.

Toronto, 12th Feb., 1879.

The report was adopted.

The managing director then read the draft of a bill proposed to be submitted to the Dominion Parliament, asking for an extension of powers of the company, which was approved, and the directors fully authorized to promote its passage; and empowered to deal with any alterations that may be found necessary.

A resolution was also adopted "that, with reference to the bill now proposed to be submitted to Parliament, the directors be requested to obtain the following amendments to those 10 of the company's Act, 34 Vic., cap. 32: The powers of the company shall be managed by a Board of Directors, to consist of nine members, and each such director shall be the proprietor of at least ten shares in the stock of the company, or such other increased number of shares as the shareholders shall by any resolution from time to time determine, and the said Board of Directors shall be elected and hold office as hereinafter provided."

The Executive of the company also sustained in the course pursued with the Montreal Company.

A vote of thanks to the President, Managing Director and the members of the Board for their course in the discussion of the scheme for pooling receipts of business rendered by them, and for the efficient manner in which they have conducted the affairs of the company during the past year, was also carried.

A ballot for the election of directors for the ensuing year was then proceeded with. At the conclusion of the ballot the scrutineers reported that the following gentlemen had been unanimously elected directors of the company for the ensuing year: Hon. Thos. N. Gibbs, Hon. Wm. Cayley, Hon. Frank Smith, Messrs. James Michie, Thomas Swinyard, John Smith, James Cooderham, Wm. Ramsay and H. S. Northrup.

At a subsequent meeting of the new Board, Hon. T. N. Gibbs was elected President; Mr. James Cooderham, Vice-President; Mr. James Michie, Treasurer, and Mr. Thomas Swinyard, Managing Director.

The following gentlemen were appointed honorary directors: Messrs. John J. Mackenzie and Anthony Cope, Hamilton; Sheriff Waddell, Colborne; M. H. Gault, Montreal; A. Joseph, Quebec; James Taylor, St. Catharines; J. S. Maclean, Halifax; and C. B. Fairweather, St. John, N. B.

Do the good you can in the world, and make as few enemies about it as possible.

FEBR 66

THE TELEGRAPH IN DENMARK.

By CARL HANSEN, Frederick, Jutland.

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TWENTY-FIVE years have passed since the first Danish electrical telegraph line was opened for public correspondence. It was on the 1st of February, 1854, that a line 180 miles long was opened between the two terminal points, Elsinore and Hamburg; but, besides these two terminal stations, there were intermediate stations at Copenhagen, Corsoer, Nyborg, Fredericia, Flensburg, Rendsburg, and Altona, besides three postal stations of a certain importance. On the 1st of January, 1855, a Danish controlling station was established at Helsingborg, in Sweden, to control the Swedish correspondence that passed through Denmark; a cable having in the meantime been laid out from Vedbek, near Elsinore, to Helsingborg. A wire was then put up from Helsingborg through Sealand, Fiona, and the two duchies to Hamburg, where the messages for Germany and England were exchanged. In the year 1858 a new line through the eastern part of Jutland was built between Fredericiahavn and Hamburg, and at the same time a short wire was put up from Copenhagen to Frederickberg. On the new line in Jutland, which was 270 miles long, stations were established in all the greater towns of the east of the Peninsula in the following year, and in Sealand and Fiona two new lines were erected, with a station at the town of Odense. In 1858 the controlling station at Helsingborg was removed to Copenhagen as a new line had been erected for the Swedish traffic. Private companies were very active in erecting telegraph communications, and Denmark is indebted to those companies for the many stations that were opened during a short period. These lines were from Nyborg to Svendborg, Ruddkjöbing, and Nastad—the two last towns, which are situated on the islands of Langeland and Aarce respectively, being connected by cables—from Hobro to Skive, Viborg, Nykjöbing on Mors, and Thisted, and the lines from Aarhus to Silkeborg, and from Fredericia to Middelfart and Assens. In 1859 Flensburg was put in direct connection with England via Tönning and Vesterveste. A line from Copenhagen to Helsingborg, with a branch to Landskrona, in Sweden, was opened in 1860, so as to have means for the increasing traffic with foreign countries. In 1861 a new line of a length of 138 miles was built, which connected all the towns of western Jutland from Flensburg to Lemvig; and many new private companies got a license to erect stations, of which the westerly towns of Sealand were the most important. All these private lines and stations were bought by the Government on the 1st of February, 1871.

The loss of the duchies of Schleswig and Holstein diminished the total length of the Danish telegraphs by about 400 miles, and the stations by 16, including the two great stations at Flensburg and Hamburg, which were in direct connection with Copenhagen as well as the most important Swedish towns, and forwarded all the traffic abroad from Denmark, Sweden, Norway, and in part also from Finland. Sweden had then no other connection with Germany. At present it has a line from Trelleborg to Saigen, one from Gothenburg over the northern extremity of Jutland (and wire) to Newcastle, and one from Landskrona (Stockholm) to Elsynd Fiuland—the two last belonging to the Great Northern Telegraph Company.

The war of 1864 with Germany for some time kept all development of the Danish telegraphs at a standstill; but a few years after, in 1869, they were commenced again by connecting Bornholm into the system. Meanwhile, cables were laid down to England (Newbiggin, near Newcastle) in 1868, and to Norway (Arendall) in 1869. In 1869 the Great Northern Telegraph Company connected Russia (Libau) with Prussia via Memel, and with Gothenburg and Fredericksham. New lines between small towns had also been built, and the three following semaphoric stations were installed: viz., Hirshalm (Skagerak), Hanstholm (North Sea), and Hornsrevhuus on Bornholm, as well as four stations, which are only open in severe winters for ice-boats—viz., Nienodd, Sprogö, Knudshoved, and Slipshavn.

Copenhagen has a great local traffic, but is of little importance as a transit office. It is Fredericia that must be regarded as the most important of all the telegraph stations in the Northern Europe, from an international point of view. Some towns it is as far as 3 hours, connected with all the railway foreign countries through cables as this very little Danish town. For this reason the employés must know and speak several languages to a certain degree of perfection, for they correspond with Paris, six Calais; with Nice, via Novaggio; with Russia, via Libau; with Stockholm, via Gothenburg; with Norway, via Arendal; and, finally, with Germany, via Hamburg, Flensburg, and several other towns. Most of the telegraphic traffic between Russia, Libau, Sweden, and Norway (the Danish route) passes on one side, and England, France, and a portion of the United States' traffic to China on the other side through this town, which is unknown to the world at large. At Fredericia there are about 20 clerks, and 30 to 40 messengers, of which the most part are boiveiture of Siemens-Halske's improved system.

The Danish telegraph lines occupies 1,870 English miles, including 4,990 miles of wire, of which 1,870 shall at the end of last year numbered 30, of which there are ten engineers; 17 managers or superintendents, who generally are large stations; 21 clerks-in-charge, of clerks, divided into 1st, 2nd, and 3rd beginners; and 20 postmasters or other persons who have a station to take care of, but have other business.

The Swedish telegraph, including land lines and cables, amounts in 1872 Swedish miles to 10,673 Swedish miles of wire. The total number of Government stations and railway stations is 301, of which 179 are Government, and the remainder are railway stations.

vaneur général de l'Inde, se trouve à Simla, dans l'Himalaya, en communication constante avec le cabinet de Saint-James.

Le réseau des États-Unis de Colombie

Le *Journal télégraphique de Berne* fait remarquer que, sans l'héliotrope des États-Unis de Colombie, l'extrémité du Sud serait reliée télégraphiquement à l'Amérique du Nord, d'une façon anormalement coûteuse.

Le *Journal télégraphique* ajoute, que le gouvernement attend la fin de la guerre civile pour relier les lignes qui existent dans ses États. Nous n'avons que ces bonnes intentions seront certainement suivies d'exécution.

Mais cet incident soulève une question théorique importante.

Jusqu'à quel point une nation a-t-elle le droit de faire obstacle par guerre ou autrement à l'extension du réseau universel?

Le bureau central de Berlin

L'inauguration de la grande salle d'en haut le nouveau par un discours dans lequel M. Stephan, directeur général, a célébré la gloire de l'empereur et de l'empire, après avoir dit quelques mots des grands inventeurs au nombre desquels nous devons reconnaître qu'il n'a point oublié Jacquard.

Le nombre des télégraphes Hughes réunis dans la partie centrale est de trente-six, auxquels on a associé dix-huit Morse.

Dans les *Annales* il y a trente-cinq Hughes et trente-neuf Morse. Le nombre des appareils Morse est donc supérieur à celui des deux autres réunis. Les batteries se composent de cinq mille éléments, où on voit bien longtemps on ne remplit d'un nouveau, analogue à celui du bureau de Genève. Martin-de-Fonvi (voir la description que nous en avons donnée). Mais nous ne craignons point de dire que si la télégraphie hélicoïdale brille par sa simplicité, elle n'est point encore qu'elle ne donnait point cet contact de tout progrès, qui se trouve le souvenir.

Les poteaux du télégraphe électrique placés le long du Southern-Pacific Railway étaient construits avec des morceaux de bois tordus qui ont pris racine, de sorte qu'une magnifique ligne d'arbres donne de l'ombre aux voyageurs se servant de cette nouvelle artère transaméricaine.

Le câble écossais qui traverse le golfe, au fond duquel se trouve la ville d'Edimbourg, a été victime d'un accident fort peu ordinaire. Il a été mis hors de service par un incendie.

Pour comprendre comment cette catastrophe a pu se produire, il faut savoir que le bout de terre traîne amarrés à alimenter en feu de jolie.

Le caoutchouc et la gutta-percha n'ayant pas tardé à fondre, les six fils de cuivre ont perdu leur isolement.

Les comptes du *Western-Union* prouvent que, depuis 1868, le prix moyen des messages a diminué de 0,09 par les lignes de la Compagnie, tandis que de 0,09 par les messages envoyés à quadruplé. Si le nombre des messages envoyés a diminué des prix de revient de chaque message a diminué de 0,09, un employé le salaire des employés ait été augmenté. Actuellement la longueur totale des lignes est de 120,000 kilomètres; celle des fils, de 320,000; le nombre des bureaux, de 8,000, et celui des messages, de 22 millions.

CHRONIQUE

Le "Western-Union" a donné ces très-curieux détails de l'apparition de flammes électriques au fils Salsi-Elmo, qui donnent une preuve de l'énergie de la tension positive possédée par la terre.

Le 17 décembre dernier, M. Mac Nab traversait le pont l'on de Stockton à Tolgomouth (Angleterre), lorsqu'il s'aperçut que les deux côtés du pont étaient illuminés régulièrement de distance en distance par des lueurs pâles ressemblant à celles que donnent les becs de gaz de temps de brouillard. La première impression fut naturellement de s'imaginer que la corporation avait fait allumer le gaz pour avertir les barques circulant sur le canal, mais en examinant de plus près ce qui se passait, il n'eut point de peine à se convaincre que cette illumination singulière était produite par des phénomènes naturels et qu'il voyait sous forme lumineuse l'électricité, du sol qui s'élançait dans l'atmosphère par les masses métalliques dont ce magnifique pont est formé. En effet, chaque pointe de fer portait sa flamme d'environ deux pouces de haut, composée d'une multitude d'étincelles accompagnées d'un sifflement aigu, signe incontestable de l'existence d'une décharge d'une *tension positive*.

Pendant qu'il admirait cette illumination étrange, un passant le héla et lui dit : Monsieur, prenez garde, vous portez une flamme au bout de votre parapluie. — « C'est précisément comme vous », répliqua M. Mac Nab à son interlocuteur qui, sans en deviner, servait également de pôle pour l'écoulement de l'excès d'électricité positive de la terre.

Une municipalité intelligente

Nous apprenons à l'instant que le maire de New-York vient de signer une ordonnance autorisant une compagnie télégraphique à établir un réseau souterrain à condition que deux fils servant exclusivement à la ville, et mis gratuitement à sa disposition pour le service municipal. Les fils devront être enfouis à 4 pieds au-dessous du sol à plus d'un mètre des trottoirs, et disposés de manière à ne pas gêner les conduites d'eau et les conduites de gaz.

Nous recevons d'Italie la circulaire par laquelle M. Capparoni nous apprend que l'*Electricista* cesse sa publication et qu'il le remplacera en prenant le nom du *Nature*. Tout en félicitant nos habiles directeur de l'extension prise par sa publication, nous ne pouvons échapper à un sentiment de tristesse lorsque nous voyons diminuer le nombre des organes spéciaux consacrés à l'électricité. Si nous regrettons ce mouvement instinctif, nous irions presque jusqu'à appliquer à M. Capparoni le mot de Cormier lorsqu'il apprit qu'après avoir remporté la victoire de Marengo le premier consul allait se faire proclamer empereur : « Je ne comprends pas

Tribune.

18

The Telegraph Construction and Maintenance Company.—Cables Manufactured in 1878.

The report of the directors of the Telegraph Construction and Maintenance Company, submitted to the meeting of shareholders, held in London, March 6th, states that the principal operations carried out by the company during the year 1878 were as follows: The laying of two sections of the Western and Brazilian Company's cables on the coasts of Para and Maranham in the Brazils, amounting to 553 nautical miles, in accordance with the terms of a contract entered into with that company; an endeavor to repair the Anglo-American Company's cable of 1869, which proved unsuccessful, the decayed condition of portions of the outer covering rendering it impossible to raise the cable, except in short lengths. Two of the company's ships were employed on this operation between the 25th of May and the 27th of June. The manufacture and laying of a cable for the Eastern Telegraph Company between the Island of Cyprus and Alexandria, and the manufacture of certain lengths of cable to enable that company to duplicate and connect up portions of their system with the islands of the Levant and Constantinople. The manufacture of 280 miles of cable for Her Majesty's Government. The total quantity of cable manufactured during the year was 2,651 miles. To replace the steamship *Hibernia* the steamship *Scotia* has been purchased, and she, together with the *Galatea*, is undergoing extensive alterations and improvements, which, when completed, will place the company in possession of four large and efficient vessels, equal to the performance of any cable-laying operations that may offer.

Nous avons déjà fait connaître à nos lecteurs que l'administration des télégraphes en Allemagne a fait des essais pour immerger en ligne souterraines la plupart de ces lignes télégraphiques aériennes.

Les essais ayant réussi, on a étudié un plan du futur réseau souterrain. Celui qui a été conçu par le directeur général des postes et qui a été approuvé par une commission, devra être terminé en dix-huit mois. Deux lignes diagonales, traversant l'Allemagne du nord-ouest au sud-ouest et du nord-est au sud-est, relieront alors Konigsberg et Strasbourg, Hambourg et Bâtiber. Ces deux lignes se croiseront à Berlin.

En outre, à l'ouest, un câble souterrain formant arc reliera Strasbourg et Hambourg par Cologne, et à l'est un autre câble formant également arc reliera de Bâtiber à Konigsberg.

Enfin, un câble traversera toute l'Allemagne du Sud, de sorte que toutes les villes de commerce importantes et toutes les forteresses seront reliées entre elles par sept fils souterrains à toute perturbation atmosphérique. La ligne la plus ancienne, celle de Berlin à Berlin, a été soumise à un examen des plus rigoureux, et n'a donné lieu à aucun signalement même au temps des violents orages.

Cette remarque s'applique aussi aux câbles. Les travaux du télégraphe souterrain à l'est n'offrent pas de grandes difficultés, car le sol n'est presque nulle part montagneux, et les anciennes chaussées de Berlin à Stettin et à Konigsberg forment pour de courtes. Le passage du câble sous les rivières se fait aujourd'hui facilement, grâce à l'expérience acquise, par des procédés analogues à ceux que l'on emploie pour la traversée des bras de mer.

General Science.

The Brooks Underground Telegraph system, the details of which, though familiar to telegraphic engineers, have received but little publicity, appears during the past two years to have been quietly establishing its claims as a simple and effective solution of the problem of underground telegraphy; and, from the developments of the last few days, it is very probable that it may soon come into general use, in this country at least, as the statement is made, apparently on good authority, that the exclusive right to the use of the system has been purchased in the interest of the Western Union Company.

The system of Mr. Brooks differs from all others in the fact that the material employed for maintaining the insulation of the line is a liquid—paraffine oil, which is known to possess, for this purpose, a higher specific inductive capacity than, in being in the wire—thirty, forty, or fifty, as may be required—covered with cotton binding, are placed in a lead pipe, continuously located, and the pipe line filled with oil, allowed to run in until full, the maintenance of the supply being assured by providing an elevated vessel of the material at intervals, so that a constant pressure will be kept within the pipe. This is practically all there is about it, and its extreme simplicity appears to be not the least of its merits, as one of the great objections advanced by the advocates of the past system has been the great expense of laying and maintaining underground lines.

Upon the question of its practical working we now have very good testimonials, which we are pleased to be able to state, is unqualifiedly favorable. The first line constructed upon this system, and which was actually put to work, was laid about two years ago. It was about a mile in length, and is reported to have been successful beyond all expectations of its inventor at the end of two years having imposed rather than delayed. H. Railroad, a submarine line being laid across the Schuylkill. It gave good results, and has ever since been in operation, its insulation, like that of its predecessor, having increased. Since first time, a number of lines the Pennsylvania Railroad west of the passenger depot in West Philadelphia; another across the Christina and Brandywine creeks at Wilmington; negotiations are pending, awaiting your authority, for connecting Camden with Philadelphia by a line across the Delaware, for the laying of a line across the Hudson at New York, and for a line between New York and Philadelphia. The advantages of a meritorious and reliable system of underground telegraph over the old aerial system have been so often pointed out in the JOURNAL that their repetition here would be useless. We have simply to record the progress of events from week to week, a task in the case of this item that we perform with peculiar gratification.

On a essayé, paraît-il, d'établir des lignes électriques à Sumatra, mais les singes, les tigres et les éléphants paraissent être des ennemis irréconciliables des câbles. Leur acharnement est aussi grand que celui de MM. Cézmencau, Blanqui et consorts contre notre jeune République.

Depuis que la ligne a été établie pour la première fois, les pachydermes insurgés l'ont renversée à plus de trente reprises différentes. Les ingénieurs espèrent parvenir à les empêcher de nuire en diminuant le nombre des poteaux et en les rendant plus solides; mais il sera plus difficile d'empêcher les singes de venir se balancer à des lianes d'un nouveau genre qu'ils trouvent bien préférables à celles que leur offre la nature. Peut-être pourra-t-on employer l'électricité d'induction qui a protégé les poteaux de la ligne de Kemberley et de Natal au Cap contre les Hottentots et les Cafres.

Subterranean and Aerial Telegraph Lines.

THE *Odeport* (Germany) *Gazette* says:—"The storms which have lately raged have demonstrated in an unmistakable manner the superiority of subterranean to overhead telegraphs. During the heavy storms in 1876, for instance, telegraphic communication in Germany was frequently interrupted, sometimes for long periods, and immense inconvenience was thereby occasioned. This winter, however, long reports of the debates in the Reichstag have been sent by the subterranean tele-graph from Berlin to Cologne, and, in spite of snow and storm, not the slightest interruption has ever taken place in the service. Throughout the winter the telegraphic communication between the two towns has been regular and unbroken. Nothing has had to be spent in repairs, while with the overland wires large sums have constantly to be expended in making good damages occasioned by inclement weather or other causes. Ultimately, therefore, the subterranean telegraphs will, there is every reason to believe, prove cheaper than the ordinary system, despite their greater original cost."

TELEGRAPHIC.—A Parliamentary paper has been printed giving the agreement, dated May 9th, 1879, entered into by the Government with the Telegraph Construction and Maintenance and Eastern Telegraph Companies for establishing telegraphic communication with the South African colonies. The route decided upon, as already announced, was the one submitted by Mr. Pender on behalf of the two companies—from Aden to Natal, touching at Zanzibar, Mozambique, and Delagoa Bay. The Government subsidy was fixed at £5,000 per annum. The tariff was fixed at 9s. a word between Aden and Zanzibar, and 5s. a word between Aden and Mozambique, Delagoa Bay, or Natal; and neither these charges nor the present charge of 3s. 9d. a word between Aden and London are to be altered without the concurrence of the official director. The cables are to be capable of transmitting fourteen words a minute. The Governments of Victoria and New South Wales concur in the postponement for a short period of the duplication of the Australian line, in order that the cable already manufactured for that purpose might be used in laying the Cape line.

Aluminium for Aluminum.

The value of aluminium in telegraphy has for some time been well known, and has lately attracted special attention. This metal possesses double the conducting power of iron, and can be made into extremely thin wires for various purposes.

The high price of aluminium, however, and the difficulty of large production, have proved very considerable obstacles in the way. But the statement is now made in the *Alls. Tel. Zeitung*, that it can easily be produced in quantities sufficient to give an alloy with iron suitable for use as telegraph wire, and thinner and better conducting than the ordinary iron. Owing to its light weight, such wire must be well specially adapted for military telegraphy, since great lengths can be carried on one bobbin. With regard to the production of aluminium, it is thought that the tolerably abundant cryolite found in Greenland might furnish the raw material, and that the reduction of it in smelting works, by means of silicious iron or zinc-ore, might be practicable.

TELEGRAPHIC INVENTIONS ADOPTED AND APPRECIATED.

The Americans are an eminently practical people. This is forcibly shown in the readiness with which electrical and telegraphic inventions and improvements are brought into general use. The activity of inventive genius is stimulated by the free competition which exists and the prompt utilization of any invention which will increase the facilities for business and social purposes.

The duplex and quadruplex telegraph improvements were perfected and first brought into general use in this country, as is well known, and after their practicability had been fully demonstrated here, are being adopted in Europe. The quadruplex is as yet used elsewhere to but a very limited extent, but is gradually overcoming the obstacles and prejudices which it has had to encounter. In this country it was promptly welcomed and adopted as a most valuable addition to telegraphic facilities.

The telephone, although of very recent date in a practicable form, has already entered into general use, and the demand for it bases severely the ability for their manufacture. The Telephone Exchange system has already attained a deserved prominence among the telegraphic facilities offered to the public use. It supplies at a moderate cost to individual subscribers the means of general telegraphic communication, and although of so recent origin, they have become indispensable to the communities where they have been established. Even comparatively small places afford an adequate support for these institutions, and it is scarcely possible to meet the large and growing demand for their introduction.

The enormous development of the telegraphic interest in this country, and the load which it has taken in practical telegraphic inventions, is undoubtedly due in no small degree to the fact that it has not been hampered and restricted by government control and management, as it is almost everywhere else throughout the world, but has been left to private enterprise and competition. Under such circumstances it is essential to the success of any such enterprise that all real improvements shall be promptly adopted, and for this reason inventions, instead of being repressed and discountenanced, have been encouraged and stimulated. The result of this policy is seen in the universal application of electricity to the service of the public. The adaptation of electrical apparatus to special service, as in the fire alarm, the distribution of commercial reports, and private telegraph lines by the Gold and Stock Telegraph Company, the American District Telegraph Company, and other minor arrangements, and lastly in the telephone, are so well known that they now attract but little attention, and are regarded as matters of course. Yet each has in turn been hailed by the press and people as wonderful developments of inventive genius and scientific study. In fact, so much has been accomplished in this direction that people are ready to give credence to claims of invention for new discoveries, however improbable they may seem, until they are shown to be unfounded and impracticable. Another element which has contributed to the development of inventive genius in this country is our liberal patent system, which is intended to throw no unnecessary impediment in the way of securing to the inventor the fruits of his labor. Although of the multiplicity of patents granted, but a small per centage prove of value, yet to restrict the right to obtain patents would probably prove more injurious in the end than the granting of applications for those which are not shown to be of value or importance.

It is now generally conceded that in telegraphy the United States are in advance of the rest of the world, and this lead will undoubtedly be maintained, so long as the conditions of private ownership and management of telegraph interests, and a liberal patent system are maintained.

Natural Enemies of the Electric Telegraph.

There is, apparently, no apparatus so liable to be interfered with by what we may call natural causes as the electric telegraph. Last week we saw what perils from vermin and fungus environ the subterranean wires. Fish gnaw and mollusks overweight and break the submarine conductors; while there is at least one instance of a frolicsome whale entangling himself in a deep sea cable, to its utter disorganization. It is stated that within the three years ending 1878, there have been sixty serious interruptions to telegraphic communication, in Sumatra, by elephants. In one instance, these sagacious animals, most likely fearing snares, destroyed a considerable portion of the line, biting away the wires and insulators in a cane brake. Monkeys of all tribes and sizes, too, in that favored island, use the poles and wires as gymnasia, occasionally breaking them and carrying off the insulators; while the numerous tigers, bears, and buffaloes on the track render the watching and repair of the line a duty of great danger. In Australia, where there are no wild animals to injure the wires, which are carried great distances overland, they are said to be frequently cut down by the scarcely less wild aborigines, who manufacture from them rings, armlets, and other varieties of barbaric ornament. It has been suggested as a means of protection in this case, that the posts should be constructed of iron, which the battery could be used to astonish any native climbing them with felonious intent.

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Congrès universel de Télégraphie

Paris 1879

Il est intéressant de faire connaître à nos lecteurs quelles sont les compagnies sous-marines qui ont l'honneur de faire partie du Congrès international de Télégraphie tenu à Londres le 15 de ce mois, et le nom des délégués à qui a été confiée l'importante mission de les représenter.

D'après les renseignements que nous avons fait prendre, nous sommes en mesure de donner la liste de toutes les compagnies électriques qui seront représentées et des personnages qui auront l'honneur de faire entendre la voix de l'industrie libre, indépendante, au milieu des délégués des états civilisés.

Anglo-American Telegraph Co. — H. Weaver Brazilian Submarine. — T. Fuller Cuba Submarine. — T. Buchen D.C. — Direct Spanish. — C. Gerhardi. — Direct United States. — Captain R. Mayne, R. N.; and J. W. Fuller. Eastern, Eastern Extension, Australasian, and China. — John Pender, M. P.; *sir James Anderson*, Col Colaver, Lewis Wells, and Jules Despeches, Blue Sea. — Jules Bert, German Union. — H. Louard, Great Northern. — H. A. Prideaux, Captain E. Swanson, and Captain W. von Hedemann, Indo-European. — Mediterranean Extension. — E. A. Tombs, Submarine. — Sir Gilway, M. P.; and S. M. Clare. West Coast of America. — R. S. Gray Western and Brazilian. — Major Wood.

C'est avec plaisir que nous avons appris que la France devait être représentée dans cette haute assemblée par le ministre des postes et télégraphes; mais nous fesons avec peine dans les journaux anglais que l'honorable M. Cochery n'a pu se rendre de l'autre côté du détroit.

L'administration française est représentée par M. Richard, directeur-ingénieur des télégraphes, et par M. Ferdinchet, chef de section au ministère des postes et télégraphes.

Parmi les notabilités présentes, nous devons citer M. Nielsen, directeur-général des télégraphes de Norwège; M. Frey, directeur-général des télégraphes suisses; le directeur du bureau international, M. Gardesci; son secrétaire et le député-gérant-comptable du bureau.

C'est le premier congrès dans lequel la Roumanie, puissance si nouvellement constituée, a l'honneur d'être représentée.

On a admis également des délégués de la colonie de Victoria, de l'Australie du Sud, de la Nouvelle-Galles du sud et de l'Inde anglaise.

Parmi les délégués des compagnies sous-marines, nous voyons des Danois, des Anglais, des Allemands et des Américains. Il n'y a pas un seul nom français. N'est-ce pas facheux à plus d'une sorte de la décadence dans laquelle notre industrie électrique est incontestablement tombée?

C'est une puissante considération pour savoir gré à la Compagnie transatlantique, dont la création vient faire cesser pour les sociétés de l'avenir l'exclusion dont la France se trouve frappée.

La première séance s'est ouverte, sous la présidence de lord John Manners, directeur-général des postes à Grosvenor Place, le 18 juin. Lord Manners a prononcé quelques mots de bienvenue auxquels il a été répondu par le général Lefebvre, directeur-général des télégraphes russes.

Lord Manners s'étant retiré, la session s'est ouverte sous la présidence de M. Patey, délégué anglais.

Le soir, les délégués se sont réunis dans les salons de Willis Rooms où lord John Manners les a invités à un grand banquet.

CHARTER TELEGRAPHY.

[*Washington Correspondence of the Hartford Times.*]

One very important piece of legislation, connected with the Army bill as an amendment—that which gives the railroad companies the right to use their wires for general telegraph business—has escaped public attention. It is also true that was blocked up about the There must be a reason for this neglect, for the Western Union Telegraph Company has been exerting its efforts of influence to get the provision in conference report. It is a matter of great moment to the business interests of the country that the question in connection with the Western Union Telegraph Company be fully investigated before it is finally settled. The Baltimore and Ohio, the Pacific, and other companies, and have no bill to offer to-day to do a telegraph business of their own. It will be worth while to have a month or no will be settled in the interests of the people.

SPEECH OF HON. RAY AND OTHERS

Machine for Testing Telegraphic Poles.—The French Commission appointed in 1879 to study the question of employing iron poles on telegraph lines, have designed a new machine for measuring the bending stress on these poles when in an erect condition; It has been constructed by M. Thomasset, Paris, and consists of an erect iron frame for stressing the upright pole by means of a horizontal rope, and a mercury manometer for measuring the stress.

A "South Jersey Telegraph Company" is also being organised at Camden, N. J. United States.

The Telegraph in Arizona.—The railroad wire (leased by the Western Union) has been extended eastward through Arizona. It is now reached beyond the Gila river, 80 miles east of Fort Yuma, which latter is said to be the best point on earth, to the place known as Mericopa Wells in the centre of Arizona, and communication has been suspended during the last season, until cooler weather in the fall. Within a fortnight or so, it is anticipated that the overland and all-rail trip can be made by this southern route.

Telegraph Posts in Cochin-China.—For temporary lines bamboo is sometimes employed, but they cannot withstand the long-continued action of the dry and wet alternations of climate in these regions. The best posts are made of "tien" (white and red), a wood which is remarkably durable in water and moist earth. It is a kind of eucalyptus, but instead of being a febrifuge it is said to cause fever when growing in masses, and is known as fever-wood. The "chay" is excellent for poles set in damp places; the "son," the "ten ten," which endures for over fifty years in dry soil, and the "thee." These last three furnish posts from thirty to sixty feet long.

Cape Telegraphy.—The *Kangaroo* had not begun to lay the first section of the Cape cable, from Durban to Zoutfiver, up to June 17. The *Standard* correspondent, writing from Landsman's Drift, June 15, states that the land wire, as laid by Major Hamilton and Lieutenant M'Gregor, and the C. Troop Royal Engineers, will be completed very shortly to Dundee. The work has been carried out with great zeal and activity; but the company must now, so far as regards the further laying of the telegraphs, remain idle, the War Office, having, with its usual precidence, sent out a well-organised body of officers and men, with plenty of working material, but omitted to send sufficient wire. He also reports that the demand was made by the corps for 100 miles of semi-permanent wire, which, if laid, would have stood the whole campaign. The field wire has now joined the colonial wire at Osgorp's Kraal, through Dundee and Landsman's Drift to Dsoenberg. These places will be in telegraphic communication by signals, with a party of Royal Engineers, Lt. M'Gregor, R.E. Engineer, and Chelmsford's headquarters. Had the home authorities sent sufficient wire from Europe we should have been direct communication to Chelmsford with all stations throughout the country. The men of the Royal Engineers, working the telegraphs, have had very heavy work, owing to the quantity of Government and Press work telegraphed.

SOUTH AFRICAN TELEGRAPHY.

Telegraphy is making great strides in South Africa. Early in January last the line from Durban to Port Pearson was opened. In February the grand trunk line from Maritzburg, inland to Pretoria was commenced, and it was completed and opened as far as Utrecht in the Transvaal in the middle of May. The telegraphic communication is now complete from the Zulu border at its two extreme points, the south-east and the north-west to Cape Town. The advantages accruing in a military sense from such a fact are self-evident; they cannot be over estimated. The credit of this most useful work is due to the untiring energy and able organising power of Mr. Siversright, in whose hands is now vested the general management of South African telegraphs in both the Cape Colony and Natal.

The *Natal Mercury* on this subject says:—Mr. Siversright may be regarded as the practical harbinger of Confederation, as he has done more to unite the erstwhile separated communities of South Africa, and to identify their interests and concerns, than any living man. Most effectively aided by his indefatigable constructor, Captain Fraser, he has brought the Cape and Natal, the Diamond Fields and the Cape, Natal and the Transvaal, Zululand and Natal, within speaking range of each other. He has done this in spite of apathy, sloth, and division amongst ourselves, and he deserves all the credit and thanks that we can accord him for valuable services zealously and successfully rendered.

South African Telegraphy.

Telegraphic Journal and Electrical Review, June 15, 1879

The latest specimen of telegraphic enterprise, styled the American Union, appears to be having a lively time in the construction of its lines through the State of New Jersey. The laws of that State have some stringent requirements upon the construction of lines, especially through the cities, to which proper attention seems not to have been paid by the managers of the Asiatic Union. In consequence they find themselves in trouble when they attempt to build their lines through the cities and villages, in Newark, Bordentown, Rahway and other places their poles have been cut down, and the company prohibited from putting up its lines, until all the legal conditions are complied with. The officers of the Continental Telegraph Company, a company having lines between New York and Philadelphia, are zealous in insisting upon the enforcement of the legal conditions upon the new company. The result has been that the construction of the new line has been temporarily, entirely or partially suspended.

In Jersey City orders have been issued to the police force, by the Chief of Police, to prevent the setting of poles by the company anywhere within the corporate limits, until proper authorization is obtained, and to arrest summarily any persons who may attempt it.

The new Imperial Telegraph Office of Berlin is a very fine structure, admirably appointed. The underground telegraphic system, now nearly completed, has been attended with great cost and difficulty. The cable laid, in places, to be embedded in rock or mortar, depended in rapid flows, and carried beneath the walls of fortresses. Germany has now 1,118 telegraph offices.

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Telegraphic Excitement in New Jersey. — A Row.

Journal of Telegraphy, June 1, 1879

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The Work of the Telegraph Construction and Maintenance Company.

At the half yearly meeting of the Telegraph Construction and Maintenance Company, held in London, July 22d, the chairman made the following statement in regard to the work the company now have in hand: "There being no accounts to present, the proceedings resolved themselves very much into telling the shareholders shortly what the company was doing with regard to cables. At the last meeting some questions were asked about the cable to the Cape, and he then stated that they were negotiating at that time, and were unable to give any information further than that negotiations were going on; since that the negotiations had been completed, and they were now laying that cable. One of their ships had been on the ground for some time, and he had no doubt had laid the cable, and the *Seine* was also on the ground now, and he hoped by this time had also laid her portion of the cable, or was just about laying it. The remainder of the cable had been constructed and would be sent off, and, he hoped, laid before the end of the year. They had also made a contract with the Eastern Extension Company for duplicating the cable from Penang to Australia. That cable was partly laid, and, as the *Seotia* also had left with the second portion of the cable, 600 miles, on board of her, that cable, he hoped, would be finished before the end of the year, or very early next year. Then they had also made a contract with the Spanish Government for a short cable of 650 miles, and also for a short cable from Norway to Germany."

No Authority to Allow Telegraph Lines on the Canals.

Journal of Telegraphy, July 1, 1879

The Superintendent of Public Works of this State having referred to the Attorney-General the question of his authority to authorize the occupation of the berme bank of the canals under his charge by a telegraph company for its poles, he replied as follows:

In answer to your communication of July 1st, inst., requesting the opinion of the Attorney-General "as to your power to grant a permit to a telegraph company to construct a telegraph line on land owned by the State on the berme bank of the canals," I have the honor to say that in my opinion the Superintendent of Public Works has no power to grant a permit of that character. The Superintendent of Public Works like other public officers, has only the powers conferred by law, with such as are incidental to the due execution of his duties. Conceding the advantages which may arise from the use of a telegraph line upon the property of the State along the canal, with stations at convenient points, and free use of the line for the business of the State, it does not follow that the Superintendent may authorize its construction. The Legislature alone has authority to authorize the use of the property of the State by private corporations or by individuals, except in cases where that authority has been delegated for specific purposes to some public board or public officer.

Telegraphs in China.

Journal of Telegraphy, July 15, 1879

Mr. J. Hannaman, Superintendent of the Great Northern Telegraph Company, in a communication to *The Electrician*, corrects the erroneous statement which has been copied in the *Journal* and the Telegraphic Journal as well as in the press generally, "that the first telegraph line in China to be opened for public correspondence in China is now in construction between Tientsin and Taku, a distance of about thirty miles," etc. This line which he says has been "in construction" a little over three years, according to the newspapers—is not the *first*, but the fourth telegraph line in China opened for public correspondence. The three older lines were built and opened as follows:

1. Between Shanghai and Woosung, a distance of about ten miles, built by the Great Northern Telegraph Company, and opened for public correspondence in September, 1873. This line is still working, and carries three wires, two for the Company's cables and one local wire.

2. Between Foochow and Pagoda Anchorage, a distance of a little over eight miles, built by the same Company, and opened for public correspondence in July, 1877. This line was sold to the Chinese Government a year later, and has since been worked by native operators united by the Company. It is in operation still, and has been open to the public all through its existence.

3. Between Tamsuifoo and Takoe au Formosa, a distance of nearly thirty miles, built in the summer of 1877 by native engineers, and worked by native operators trained by the Company. This line was opened for public correspondence somewhere in September, 1877, and has been so ever since.

I am, he says, of course, only taking into account *overland lines*, to which I suppose your contemporary refers, as it is well known that the Great Northern Company has connected the ports of Shanghai, Amoy, and Hong Kong with cables since 1871.

Ocean Telegraphy.

Journal of Telegraphy, July 15, 1879

The Canadian Government has let the contract for the construction of the new shore line for the maritime provinces to connect lighthouses on promontories with the telegraph system of Canada, in aid of which the Canadian Parliament last session voted a bonus of 20,000 dols., has been awarded to the Dominion Telegraph Company. The construction of this line is the first step toward the completion of the scheme for connecting the island of Anticosti and Magdalen Islands with the shores of the St. Lawrence by telegraphic communications, and for which purpose Parliament has voted a subsidy of 15,000 dols., to be continued annually. This system has been inaugurated by the government with a view to rendering timely assistance to vessels in distress, thereby lessening loss of life and destruction of property.

The Russian Special Telegraphic Commission has recommended a large extension of lines throughout the Empire in three classes. The first class, 21,340 versts and 400 stations, to be finished in five years, at an outlay of 840,000 roubles yearly; the second class, 16,485 versts and 139 stations, costing 2,565,620 roubles; and the third class, 12,822 versts and 99 stations, at an outlay of 4,845,959 roubles, for completion as found practicable. These lines are very distant, little used, but important for the Government.

American United States Cable Company.

Journal of Telegraphy, July 15, 1879

The directors report that the revenue for the half year ended the 30th of June last, was £37,706, as against £39,849 in the corresponding half of 1878. Working expenses, interest, &c., took £30,573, leaving £67,183 as net profit, to which falls to be added £3,323 brought forward, making £71,416 in all. The cost of repairs for the half year came to £8,952, and has been charged against the reserve fund. Two quarterly dividends, the second of which is now due, absorb £30,355, and £31,705 is carried to reserve, increasing it to £100,000, after writing off a further £1,000 from preliminary and arbitration expenses, £2,243 is left to be carried to the new half year.

The agreement with the Dominion Telegraph Company, of Canada, referred to in the last report, has been completed, and came into operation as from the 1st of January, 1879.

The break in the company's main cable, which occurred on the 4th of January last, was repaired on 20th of March, and the interruption on the 22th of February last, of the short section, was repaired on the 22d of April. Both sections of the cable are in good working order.

The New French Atlantic Cable.

A DESPATCH to the Liverpool *Post* from London, says, that up to the 11th inst., the steamer *Faraday* had laid successfully *upwards* of a thousand miles of the new French cable.

The French Atlantic Cable Repaired.

The Atlantic cable—St. Pierre to Brest—which was broken February 22, 1879, has been repaired. This restores direct communication between the United States and France, and through France with the rest of Europe.

The Caspian Cable.

The correspondent of the London *Times* at St. Petersburg gives the following information relating to the cable intended to be laid across the Caspian, recently manufactured for the Russian Government at the Silvertown Works: Six large mooted barges, towed by three steamers, lately arrived in St. Petersburg from Cronstadt heavily laden with the cable destined to be laid between Baku and Krasnovodsk, and orders have been given to hurry it to its destination. The wire, which measures about 147 nautical miles, including the expenses of insurance and sinking, will altogether cost about £62,000 sterling, and has been specially manufactured for the Russian Government by the Messrs. Siemens and Gatts Persha Telegraph Works Company in London, and has been conveyed to Cronstadt in the Great Northern, a vessel specially constructed for laying cables. The little fleet of barges and steamers will proceed by the Empress Maria Canal from the Neva to the Volga, whence it will descend as far as Astrakhan, where the cable will be transshipped into a large steamer and sunk in the Caspian at its narrowest parts between Baku and Krasnovodsk.

Engineer Aug 1 1879

Aug 16 1879

Extension of Telegraphs in Uruguay.

The following short description of telegraph lines in this country will given an idea of the persistency of the Anglo-Saxon to have some connection with progress wherever and whenever it is to be found. Uruguay boasts of two principal telegraph companies—(1), the *Platino-Brasilera*, the greater portion of which line is owned in England, and quite recently the direction has been transferred to London under the presidency of Mr. J. Fowler, M. P., who has shown so much energy and ability in all that concerns telegraphy. The line is about 200 miles long, following a westerly direction from Montevideo to Santa Rosa, the latter place being close to the Brazilian frontier. The company also possesses a submarine cable line from Montevideo to the river Chui, half way between Montevideo and the river Grande. (2). The *Oriental Telegraph*, extending from Montevideo in an easterly direction to the river Yaguaron on the Brazilian frontier. This line has little or no English capital involved in it. (3). The *River Plate Telegraph*—This valuable property is entirely in English hands. The land line extends a distance of 150 miles from the city of Montevideo to Colonia, their submarine cable to Punta Lara (twenty-seven miles) on the opposite Argentine coast. There is, moreover, a direct submarine cable line from Montevideo to Lara (120 miles), and from thence to Buenos Ayres per land line. The total length of the River Plate Telegraph Company's land lines is about 177 miles, submarine cable line about 120 miles.—*The Electrician.*

At the recent meeting of the Direct United States Cable Company, Mr. John Pender, M.P., the chairman, said they had purchased from the dissentients in the reconstruction of the company, shares and debentures of the nominal value of £90,550 for £73,055. Alluding to the new French cable, he said he believed it would meet the fate of the old Direct United States Cable Company, and that it would ultimately be purchased by one of the existing Atlantic Telegraph Companies for half its price.

It is reported that the French and Belgian Governments have requested that a complete set of the American quadruplex apparatus be placed at their disposal for quadruplexing the line between Paris and Brussels.

1873. Electric Telegraphs, *Sir C. T. Bright*—Dated 25th November, 1878. 6d.

In type printing telegraphs between the stations for which is to be employed a single line wire, the transmitting instrument is placed in the sending station. At the receiving station one of the elements of a differential relay is placed in circuit with the line and with one pole of a battery (called the line battery), the other pole of which is connected to the ground, and a second coil of the relay is connected at one end to one pole of the line battery, the other end being connected to the ground. The relay actuates two magnets, and the coils are so connected to the line battery that when the current through one coil is stronger than the current through the other coil the armature of the relay is attracted, and, whereby a circuit is brought into connection with a local battery, causes the movement of a shaft on which the type wheel is fixed. The paper is impressed against the type by an electro-magnet in the local circuit, which is actuated by a suitable contact in automatically transmitting commutator. In a modification the type wheel is replaced by a perforated paper. The type wheel is caused to move in either direction, instead of in one direction only as hitherto.

Specification No. 1,873, A.D. 1878.

IS A TELEGRAPH DIRECT, or is it known chiefly as secondary battery, composed of chloride of lead and sulphuric acid, allows weak currents to pass, while stopping those of high tension. Prof. MacLeod therefore inserted a secondary battery of platinum plates between the line and the telephone, but this stopped both the induction and the vocal currents. When platinum wires were substituted for the plates, however, the induction currents were stopped, while the vocal currents could be feebly heard.

THE TELEGRAPH IN NORWAY.

The Journal Aug 11 1879

By Th. Bowtz.

Among the nations of the earth Norway occupies but a subordinate position. Even with the modern facilities for rapid travel, measured in time, its distance from New York is about fourteen days.

Since regaining its independence in 1814, Norway has been exclusively engaged in the development of its home interests. Although its resources are limited as compared with most European countries, the advantages of modern improvements and inventions are appreciated and their benefits are earnestly sought to be secured for her. Among these the telegraph is recognized as one of the most important. The first telegraph line constructed in Norway was between the capital, Christiania, and Drammen. This was built in 1854, and was only four Norwegian (about 28 English) miles long. Now the net-work of lines extends all over the country. At the present time the Norwegian telegraph system includes 124 Government or public, and 105 railroad telegraph offices. The latter are employed mainly in railway service, and are not connected with the Government telegraph system.

The electric telegraph is in operation in most generally used lines from railroad trains, although no extensions the Morse register is employed. The operators in these railroad offices are boys and young girls. Their telegraphic knowledge and experience is small, and their salaries are in proportion thereto.

Of the 124 offices controlled by the Government telegraph system, 16 are open only during the winter to accommodate the sporting and social interests, and one (Oscar, near Christiania), if merely a semaphore office. Christiania, the capital, is the only city in Norway that has more than one office, and in her case, for only a portion of the year. There, in addition to the central office, during the sessions of the Storthings, or Norwegian Parliament, which, commencing February first, continues four or five months, a branch (Storthing) office is maintained.

Only in Christiania is there continuous day and night service, where it is necessary on account of the connection with the International telegraphic system. Of the other offices 7 are kept open from 7 or 8 o'clock, a.m. (according to the season), until midnight; 41 until 9 o'clock, p.m.; 53 to 8 o'clock, p.m., and from 5 to 9 o'clock, p.m.; and 5 offices have full day service during the fisheries season, about three months.

Norway is telegraphically connected with other countries by lines from Christiania and Trondhjem to Sweden, by submarine cables from Arendal to Denmark (Jutland), and from Egersund to Scotland.

The Morse register is principally used, although at a few of the offices, and upon the cable to Scotland, the Wheatstone apparatus is employed. At Christiania and Bergen duplex working has been established.

A new apparatus invented by the Norwegian electrician, Mr. Obere, of a system somewhat similar to the Hughes, is being tried at Christiania. The use of the register is reliable and expeditious, as the paper-tape is preserved for the rules of inspection. In case errors that may occur. The majority of the operators, however, are able to receive by sound. Every office of course has its signature, as "C" for Christiania, "D" for Drammen, "Td" for Trondhjem, etc. The International alphabet is used, as on most European lines. After sending a message the sender gives his signature, and the number of the message, and a collation of the cipher and the signature of the receiver are exchanged.

All the offices are well furnished, that of Christiania splendidly, as it was formerly the mansion of one of the richest merchants of Norway.

The Astronomical Observatory at Christiania has a line connecting it with the telegraph office, and twice a week, Tuesday and Wednesday, it is for a short time put in circuit with all the offices of the country, and the standard time is transmitted. The time at all offices is thus regulated to correspond with Christiania time.

Four hundred and fifty persons are employed in the telegraph service. Of these one is the director, one intendent, 11 are inspectors, with 284 male and 88 female operators. The salaries of the employés is fixed by the Storthing and is paid at the end of every month. The director submits to the Ministry of Postal and Naval affairs, in which department the telegraphs belong, a budget for the year, which includes everything connected with that branch of the service; and on this basis the estimates are submitted to the Storthing for its action thereon.

As the early years of the telegraph the pay of the employés was small, and those who competed for telegraphic employment were, some of them, possessed of but little learning. At present the salaries are better, and the requirements in reference to the knowledge and ability of candidates more strict.

It might interest the reader to know some of the salaries paid.

The Director receives about	.....	1,030 dols
" Intendants	.....	1,080 "
" Inspectors	.....	870 "
" Managers	.....	650 "
" Male Operators (second class)	.....	520 "
" Female "	.....	250 to 350 "
" Pupils (ladies)	.....	190 "

For managers, and for male and female operators who are not managers, there are some intermediate grades of payment. The salaries paid are not high, it is true, but, on the other hand, the country is not wealthy, and the cost of living is moderate.

Promotion of employés from a lower to a higher grade is based exclusively upon seniority in the service.

In the organization of the service, the director is the chief executive authority, subordinate only to the Postal and Naval Department. This position has been held from the first establishment of the system by the present director, Mr. Carsten F. Gulleen. This gentleman, who is much esteemed and loved by his subordinates, and who is a knight of several orders, was originally a lieutenant in the Royal Navy. Indeed, in 1854, the establishment of the telegraph in this country was discussed, he furnished to the Storthing the plans and estimates therefor, and was appointed to superintend its construction and management, which duty was performed so efficiently and satisfactorily as to insure his retention in the position.

The intendant, Mr. Jonas Collett, has co-operated with the director, Mr. Gulleen, from the first, and is a most efficient official. The inspectors are superintendents of a certain number of offices. The managers of the offices in the towns to which they belong.

Once or twice a year a school for pupils is opened at an office in a town where an inspector resides. The director advertises in the newspapers when and where the school will be held, how many pupils will be admitted, and the qualifications required of the applicants. The number of pupils admitted is usually 12 to 15. The qualifications requisite are that, if a male, the candidate must be from 17 to 25 years of age; if a female, from 20 to 25 years; must be in good health, which fact is certified to by a physician's certificate; must have passed at least an examination in a lower school (in such schools arithmetic is taught, also German, French or Latin, mathematics, history, geography, physics, etc., etc.). It is expected that applicants for admission into the telegraphic service as operators shall understand the English, German, and French languages, and they must be of good character and reputation, which latter must be certified to by responsible parties. The successful applicants for admission into the school receive three months' instruction in a theoretical and practical course, under the direction of the inspector. The latter delivers a lecture of an hour's length daily to the pupils, who are also required to practice six hours daily. At the end of the course the inspector gives each pupil a certificate which specifies their order, exactness, diligence, and progress, and they are then appointed to fill vacancies as they occur.

A pension fund has been established to which all engaged in the telegraphic service are required to contribute, and to the benefits of which all are entitled. To this fund the men are required to contribute one and two dollars and the women about one dollar per month. On the record from the service on account of disability or old age, each employé is entitled to a pension from this fund.

The male operators have, besides, a voluntary pension fund, through which the widows of deceased members are provided for. To this fund they contribute 1½ per cent. of their monthly salary. Hitherto the widows entitled to the benefit of this fund have received *yearly* an amount equal to the entire amount contributed thereto by their deceased husbands. It has been possible to pay this high pension, as the operators enter the service at an early age, and generally remain unmarried for several years.

JOURNAL OF THE TELEGRAPH.

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The male and female operators work in the same office, and as they are gentlemen and ladies the effect of their association has proved beneficial and elevating to the tone of the profession. Occasionally such business association results in a more intimate relation being established for life. In one case only are both of a married couple in telegraphic service. The lady operators are all highly educated, and belong to families of distinction. The men employed as operators are most of them graduates from the Royal University, and some of them have other subordinate employment, such as assistants in offices of advocates, banks, or as teachers, editors, &c. In a few instances the telegraph and post offices are combined. Two of the operators are Stortlingsmand (Members of the Parliament, which consists of 111 members.

A telegraphic situation was for some years not particularly coveted by, but since the salaries have been raised, the posts have grown to men, the intellectual standard has been elevated and made more uniform, and the service has become an object of public consideration and aspiration.

The telegraph service has been of great importance to the industrial emancipation of females. The first employment of ladies in the service was in 1859. Two women, the Misses Bech, paved the way. Previously women were not employed in any public position, now they are found as clerks in the offices of the Ministry, executive house offices, teachers in public schools, &c. Their admittance in the telegraphic service gave the first shock to the prejudice against their employment with their brethren in public positions; and women are not yet admitted to the privileges of the university.

Operators employed in the day service are on duty from 2 to 9 o'clock a.m., and from 2 or 8 o'clock a.m. to 2 o'clock p.m., the next day. They are then free from duty until 2 o'clock p.m. the following day. In some cases, however, when the operator engaged in the day service has other employment, a special arrangement is made so that their service is only required in the forenoon or afternoon.

This is, in brief, the situation of the telegraphs and telegraphers in this little country. We do not flatter ourselves that we can teach much in the telegraphers of a country where the electro-magnetic telegraph was invented, and has been so highly developed. It would, however, give us pleasure to know that a little interest is felt, by our telegraphic brothers and sisters in America, in such distant members of the fraternity.—*Journal of the Telegraph.*

EXPERIMENTAL RESEARCHES INTO MEANS OF PREVENTING INDUCTION UPON LATERAL WIRES.

BY PROF. D. E. HUGHES.,

(Concluded from page 249.)

"We have seen by the preceding experiments that should have perfect freedom from induction if employed a return wire at equal distance from inductive wire, and instead of a metallic circuit we have seen might serve, it would be best to employ two separate gutta-percha covered wires, and in order that each wire should have absolute equal effect, a slight twist of these two wires should be given, this twist would then successively bring each portion under equal influences.

Since making these experiments we have learnt that Mr. David Brooks, of Philadelphia, suggested a closed double wire as above described as a preventative against induction, and that it has also been patented by Professor Bell.*

A more perfect solution of this question than that of using a double wire with one as a return, giving double resistance to that of an ordinary wire, would be to use a double wire having a slight twist, each wire acting as an independent line with its own earth at each station, and its own separate battery at the transmitting station. The transmitting instrument should be so arranged as to send simultaneously positive to one line and negative in the other—these, if of equal force, would exactly balance each other as regards induction on other lines. The receiving electro-magnet should be wound differentially, or what would be still better, should have two separate wires wound together. The external end of one of these wires should be to one line, and the internal end to earth; the other wire should, on the contrary, have its internal extremity to the other line and its external extremity to earth.

The effect of this would be, that if any current of same polarity passed both wires at the same instant, no effect whatever would be felt on the balanced electro-magnet, but if two currents, each of opposite polarity, passed through the coils or electro-magnet, then it would work at its maximum effect; we should then have a double line wire with less resistance than the single wire, with complete freedom from earth currents, dynamo-induction, and from all extraneous disturbing causes.

If two ordinary metal lines are thus used, they should have the twist given to them wires by crossing their position relatively to other wires from vertical to horizontal, and *vice versâ*, at each pole or station, thus if we had two lines A and B they should make—thus if we had two lines A and B they should have these four relative positions repeated as often as possible, viz.:—A B, then $\frac{A}{B}$, then B A, and $\frac{B}{A}$.

We have tried to find a theoretical remedy by means of which a single wire would be free from the disturbing influence, and we have found that there is no possibility of a perfect solution of this question, provided that we send and receive on alternate wire at the same end, but if all the wires send in one direction during a stated period only, or work constantly in one direction only with one set of poles, receiving by another series of set of poles, then the resolution of this question becomes positively theoretically possible, but, I believe, practically impossible, for the lines are, as in France, all arranged in one plane, or nearly so—but only diagonal wires for vertical ones are available in the wires being alternately strung on each side of the poles—and this is perfectly followed by the commencing statement I have the honor to present this evening for the first time to general notice.†

Suppose three or more parallel lines A, B, and C, now, A indicates a current, an N and C proportional to its force of battery power and the several distances of these wires from the inducing wire. If we can send into the wires B and C an opposing current of very little more strength and duration to that of the indicated current, we evidently reduce the induced current to zero, and have consequently no disturbing effects on those wires.

After numerous experiments, I have found that if coils of wire be so placed in relation to each other, that their relative distances represents the relative distances of the wires from each other, and if each line at its transmitting station be joined to earth through these coils, then in passing the battery current through one of these coils to its line, it would exert through one of these coils to its line, it would induce a current whose direction would be contrary in itself; and as this would be exactly what takes place on the line itself, we should (supposing the coils to have equal inductive force to the lines) simply double the inductive force to the lines) and thereby double the inductive effects that they were before the use of the coils; but if at the same instant that we put battery to line we reverse the terminals of the coil in relation with it, then the induced current sent by the coil will be in the same direction as battery current on the primary, and this would neutralize every current on the primary, and this would neutralize the contrary direction of the induced current, reducing it to an absolute zero.

I have embodied this idea in the instrument which we present this evening, consisting of a series of coils of insulated iron wire. There are two of such coils, 10 centimetres diameter, 190 metres long, connected together so as to form a single line; these are placed at a distance of 10 centimetres from two similar coils, and between them, at the distance of 5 centimetres, is a single coil. We have thus two long lines, and one intermediate short one. The induction of these coils on each other represents the

* Professor Bell has lately written to me, stating that the date of this patent is Nov., 1877.

† Mr. Chas. H. Wilson, of Chicago, devised a plan for a series of induction coils permanently received in relation to each other. The induction coils thus be neutralized between two wires.—"Speaking Telephone," by O. D. Tuscott, 1878, page 203.

same distance as the aerial wires; the effects, however, are much greater with coils than on straight wires, and the last allows us to reproduce, with a hundred metres of wire only, the full amount of induction on a line of a hundred miles or more. The reason why having a shorter intermediary coil is, as I represented at a we have found, the most difficult problem of the problem.

The mathematics for the induction on three lines, as above there small No. 22 copper (covered) coils; these are so arranged on a graduating scale that they can be gradually approached until the exact balance for each line is found; and this is found very rapidly, for we have only to strike it until complete balance is obtained. Since the induced currents passing through each wire, these coils have no necessary relation, as to length or power to that of the battery, but simply the force by approaching them, as we said before, to the wires, and consequently to the force of intermediary wires, and also current wires of many or unequal length, the coils should have a definite ratio to the length of line, viz: the number of copper coil to 100 miles of line; but, from the powerful effect I obtain with the short lines, I have not yet, with 1 believe that 100 metres per 100 miles of line would be amply sufficient.

Each coil should be reversed by the key of the instrument at the instant of putting on the battery, and with this the disturbance the commutation is now perfect, and lines that were full of powerful induced currents all become perfectly free from them, whilst by the methods as we say utilizes the induction of the battery current on its own line. But as our object this evening is not to bring forward as our object this evening is not to bring forward new instruments, but to discuss the question generally, I will at once sum up my conclusions.

There are three points on ordinary telegraph line or lines where we may attempt a solution of the difficulty by experiment or other nominating effects, namely—the receiving, intermediate, and transmitting stations.

At the *receiving station*, ordinary induction coils, or the compensating coils I have described, would be injurious, as they could not be reversed in relation to each other, and would thus increase the induction.

Voltaic currents, direct or by derivations from the primary line, would answer only where the battery consisted of a dot or a short signal exactly equal in duration and force to that of the induced current.

Polarization batteries, direct on the line, or where the induced current to pass, and if used as a derivation, would require a very great resistance, and would allow the entire current from the working electro-magnet to affect all the rest.

Condensers would be similar to the polarization or secondary batteries. Resistance coils would reduce the induction, but also in equal proportion reduce the voltaic current needed. Magnetic condensers would absorb the induction, but also absorb that first part or the part most needed of the voltaic current.

At the *intermediate station* all these would give con-

Brooks' Underground Telegraph Wires.

The Silvertown Works Company have been carrying out some experimental trials of the system for insulating underground telegraph wires, devised by Mr. Brooks, and already described in these pages. It is found that all qualities of paraffine oil do not answer for this purpose, and there was great difficulty in finding the right kind of oil. When, however, this was secured, the specific inductive capacity was found to be very low; but it is also stated that electrification is greater than with any known insulator. Several lengths of wire insulated on this system are being worked in America.—*The Electrician.*

Telegraphing Without Wires.

Prof. Loomis continues his experiments in the mountains of West Virginia, to demonstrate the theory that at certain elevations there is a natural electric current, by taking advantage of which telegraphic signals may be sent without the use of wires. It is said that he has telegraphed a distance of eleven miles by means of kites flown with copper wires. When the kites reached the same altitude, or got into the same current, communication by means of an instrument similar to that of Morse was easy, but ceased as soon as one of the kites was lowered. He has built towers on two hills about twenty miles apart, and runs the tops of them has run up steel rods into the region of the electric current.

Anglo-American Telegraph Company (Limited).

At a meeting of the Directors of the Anglo-American Telegraph Company, held Sept. 25th, it was resolved, (after placing 47,500 to the credit of the renewal fund) to declare the following dividends, all free of income tax and payable on Nov. 1, 1879, leaving about 27,000 to be carried forward to next quarter's account:—1. An interim dividend of 1½ per cent. upon the ordinary consolidated stock for the quarter ending Sept. 30, 1879; 2. An interim dividend of 1½ per cent. upon the deferred stock for the same quarter; and 3. A balance dividend for the year 1879 of 1½ per cent. upon the six per cent. preferred stock. No further dividend will be payable upon this stock for the year 1879.

Brief Mention.

The Cleveland Electrical Society will resume its monthly meetings, Tuesday evening, October 21st, at the usual time and place.

The Sydney International Exhibition was opened on Wednesday, September 17th, by Lord Augustus Loftus, the Governor. The Governors of the Colonies of Victoria, South Australia and Tasmania were present, together with the Foreign Commissioners. There are 800 British industrial exhibitors and 151 fine art entries, including photographs. Germany has 635 entries, including 168 fine arts; Austria, 170; France, 350 industrial and 168 fine art; Belgium, 236 industrial and 50 paintings; America has 150 industrial collections.

At ten o'clock Saturday night, the 11th inst., the Cincinnati Industrial Exhibition closed. A chime was rung, all the bells were sounded, while the steam whistles joined in a deafening scream. The total attendance was 122,622. The cash receipts will meet all expenses and leave a surplus of about $10,000.

L'ELECTRICITÉ

REVUE SCIENTIFIQUE ILLUSTRÉE

BEAUX-ARTS — INDUSTRIE — MARINE — ART MILITAIRE — MÉDECINE

2e SÉRIE — N° 16

20 AOUT 1879

Dans son prochain numéro, l'Electricité *rendra un compte-rendu de la partie électrique des séances de l'Association britannique à Sheffield, où, seule des puissances européennes françaises, elle sera officiellement représentée par un de ses rédacteurs.*

Le lecteur verra plus loin qu'un intérêt spécial s'attachera cette année à ces grandes assises de la Science britannique, dont malheureusement les travaux de l'Association Française pour le progrès des sciences ne sont qu'une pâle copie.

ACTUALITÉS ÉLECTRIQUES

Notions générales sur le service télégraphique

Nous voyons avec plaisir que l'Administration supérieure s'est rendue au désir que nous avons exprimé, et a publié des notions générales sur le service télégraphique, qui confirment en substance les indications que nous avons déjà données. Nous ne reviendrons point sur les renseignements que nous avons déjà donnés, mais nous trouvons dans ce travail quelques détails sur lesquels nous devons appeler d'une façon spéciale l'attention de nos lecteurs. Ce petit volume, orné d'une couverture jaune, se vend dans tous les bureaux télégraphiques de Paris pour la somme de 50 centimes.

Nous apprenons que l'article 1er de la loi du 29 novembre 1850 donne à chaque employé du télégraphe la faculté d'exiger du tout expéditeur de justifier de son identité.

Heureusement, les employés ne paraissent user que d'une façon tout à fait exceptionnelle d'une faculté qui doit paraître d'autant plus exorbitante que cette loi, si prématurément conservée à travers tant de révolutions, a omis d'indiquer les modes légaux de faire ses preuves.

Nous sommes donc les interprètes du public en soumettant respectueusement M. Cochery d'indiquer quelle doit être la manière légale de satisfaire à une pareille exigence, si elle se produit inopinément.

Nous prendrons même la liberté de suggérer la photographie légalisée, ce passeport si facile à se communiquer et dont l'usage général répondrait à un besoin si universel.

Il n'est pas inopportun d'ajouter qu'une disposition très-vague de la loi accorde à chaque expéditeur la faculté de faire constater son identité. La taxe exigée dans ce cas est très-peu élevée. En effet, on n'exige que le paiement du numéro de mots nécessaires pour indiquer l'accomplissement de cette formalité souvent nécessaire.

Ce libéralisme est assez rare pour que nous devions lui accorder notre approbation sans limite.

Nous voyons avec regret qu'il n'est pas fait mention dans la circulaire des articles de loi punissant d'une peine soit afflictive, soit infamante, les personnes faisant usage d'un faux nom dans l'expédition d'un télégramme. Il y a dans cette omission une lacune des plus graves, montrant combien les rédacteurs du *Guide sommaire* sont encore peu au courant de la nature de leurs devoirs.

Une des absurdités fiscales que le *Guide sommaire* met involontairement en lumière est la suivante :

Le service international admet le *collationnement* ou *répétition*, moyennant le paiement d'une taxe égale à la moitié de celle du télégramme.

Mais le service intérieur n'admet que la *reconnaissance* qui donne lieu au paiement d'une taxe égale à celle du télégramme, c'est-à-dire double de la première, toute proportion gardée.

S'ils soient collationnés ou recommandés, les télégrammes donnent lieu au remboursement quand le texte a été altéré dans la transmission.

Nous engageons les chambres de commerce à ne point s'en rapporter au zèle souvent bien tiède de l'administration, et à adresser au Gouvernement les représentations les plus vives, les plus pressantes en

AYRTON'S METHOD OF COVERING WIRE FOR ELECTRICAL PURPOSES.

AN improved method of covering wire used for electrical purposes, has been patented by Prof. W. E. Ayrton, of Cowper-street, E.C., which is of especial value where several wires are arranged alongside one another. In many industrial applications of electricity it is desirable to lay a large number of wires, either covered or uncovered, on a narrow space alongside of each other, and much inconvenience is experienced by reason of the difficulty in discriminating the different wires, and of the mutual induction caused by the several electric currents. In other cases, as in resistance coils, it is desirable to lay several convolutions of the same wire side by side in such a way that the whole has no external magnetic action and no self-induction. Professor Ayrton's invention insures the easy recognition of any individual wire at any point by its distinctive position in the web or ribbon, provides an easy and certain means of destroying mutual induction when there are several conductors, as well as a simple method of constructing a coil of a single continuous conductor which has no external magnetic action nor self-induction. He finds that the relative insulation of the several wires from one another, or of the different layers of the same wire from one another, as well as of the whole from any metallic surface laid down on the web, to be as good as when the ordinary method of covering with silk, cotton, or other similar insulating material is employed. Further, the fixed arrangement of the conducting wires obviates crossing or twisting, thus rendering induction currents controllable, and therefore avoidable. This fixed arrangement also offers exceptional facilities for destroying external induction by surrounding a sending wire with the return wires of the same circuit, the simplest form being that in which the sending wire has one return wire on each side of it in the ribbon or web. The web, whether composed of a warp of wires and a weft of insulating material, or a warp of threads of insulating material and a weft of wire, may, if desired, be steeped in or passed through a bath of bitumen or melted paraffin-wax or of other similar liquid, and an extra security of insulation and solidity is thus secured. It may be rolled or twisted up sideways to be placed in the bath. The web or ribbon, in the flat state as woven, can be very easily painted with any fluid compound if desired, an ordinary paint brush being employed for the purpose, or the web or ribbon may be covered with guttapercha, or with some similar substance, by being passed through a die where the compound is under pressure.

The practical applications of the invention are numerous and advantageous for simplicity and economy, as for instance:—In the present methods employed for communication by telegraph or telephone, the use of the ribbon will be extremely advantageous for enabling each wire to be easily discriminated at any part of the circuit, and for improving the working by enabling the mutual induction of wire on wire to be totally destroyed. Again, it is extremely important at the present time to be able to manufacture cheap and accurate resistance coils for schools and general laboratory purposes, which can be done thus:—The wire, which may be German silver, platinum, silver, &c., or simply copper or iron, if great cheapness of construction be desired, is wound bare on the shuttle and used as the weft, being woven backwards and forwards between parallel fibres of silk, cotton, or any suitable material employed as the warp. A sufficient length of such a ribbon having been cut off to give the resistance required, it is first brushed over with a flat brush dipped in melted paraffin wax or other suitable liquid, and then placed flat between a strip of paraffined paper, silk, or cloth rather longer than the ribbon, and of such a width that after having been folded double along its length it is a little wider. The whole is then placed in a strip of thin copper, brass, or other metal, a little longer than the paraffined paper, silk, or cloth, and of such a width that after having been folded double along its length it is a little wider than the paraffined paper, silk or cloth. Two short pieces of ordinary guttapercha or indiarubber-covered wire having been soldered to the two ends of the wire contained in the woven ribbon, the edges of the doubled strip of metal are then soldered up all round, except just where the two leading wires protrude, at which places, by means of guttapercha indiarubber, or some adherent cement, the openings are closed up watertight. The whole strip may now be rolled up into any convenient shape without the employment of any bobbin, and from the the resistance scratched or otherwise marked on the thin metal case of the instrument above referred to. If then, whenever the coil is used, it be always put into a water bath of known temperature, and which, as above explained, is from the mode of construction rapidly acquired by the wire itself, its resistance, even when tolerably strong currents are passing through it, will be more accurately known than that of resistance coils as hitherto constructed, and its cost will be very much less. When the resistance coil is used for approximate measurements, or with not very strong currents, it will not be necessary to place it in a water-bath, since the temperature of the air will be sufficiently nearly that of the wire to enable the temperature of the air near it being employed in any estimate of the resistance of the wire. Or for the manufacture of resistance coils the wire may be used as the warp, and after a sufficient length of the ribbon has been cut off to give the required resistance, the ends of the first and second wires are joined together, also the ends of the third and fourth wires respectively, and the ends of the fifth and sixth, and so on, while at the other end of the ribbon it is the ends of the second and third, the ends of the fourth and fifth, &c., that are respectively joined together, so that all the separate wires forming the warp now constitute one continuous conductor. The strip of ribbon is then treated as before, in both cases no bobbin being necessary to wind the ribbon on.

When the ribbon is employed in the construction of the coils of galvanometers, electromagnets, &c., where the direction of the electric current in every convolution must be the same, the wire is used as the warp, and the ribbon may be so woven that at one end it turns at right angles to itself in the plane of the ribbon without discontinuity of any wire. This right angle piece is placed with one end slightly projecting, parallel to the axis of the bobbin if one be used, or parallel to the axis of the coil about to be formed, if no bobbin be employed, and the slightly stiff ribbon wound over it. After sufficient length of the ribbon has been wound on, the two ends of the ribbon are brought together, and a joint is made between the first wire at one end of the ribbon and the second at the other end, and between the second wire at the first end of the ribbon and the third wire at the second end, also between the third wire at the first end and the fourth wire at the second end, and so on. In making such a set of joints, Prof. Ayrton has found it convenient, after slightly solidifying each end of the ribbon with melted paraffin wax, or other solidifying adherent, to cut each end of the ribbon obliquely, using a templet, so that the ends of the ribbon are cut symmetrically. He then scrapes off a small portion of the insulated silk or cotton, also obliquely and parallel to the direction in which the ribbon was cut, so that at each end of the ribbon there are a number of short ends of bare wire each of the same length; these bends at right angles to the direction in which the ribbon was cut, in order, as the length of the cut is longer than the breadth of the ribbon, to separate somewhat the bare ends, and make the subsequent jointing easy to perform. The joints are then made in the order described above. When in the construction of galvanometer, electromagnet, or other similar coils, he uses a strip of ribbon which has not been woven so as to turn at the end at right angles to the length, he merely folds the end (which would otherwise be straight) at right angles to the length, and proceeds as before.

In induction coils the wooden or ebonite separating discs or checks may be dispensed with, each section of the secondary coil being narrow and rolled on from a narrow tape containing a comparatively small number of wires, and each such section being separated from the next by a thin disc only of some thin insulating material, such as paraffined paper. In all telegraph instruments in which coils are used the application of the woven ribbon, instead of the ordinary covered wire, will greatly economise cost of construction, and facilitate after unwinding for examination or repair, since, even when the tape is quite narrow, the additional strength introduced by the group of wires composing it will prevent any one of them, even when they are quite fine, being broken in the winding or unwinding, whereas at present such breakage not unfrequently occurs from the strain in winding or unwinding being only on one wire. Again, when a break is found (from a flaw in the metallic wire or otherwise) to have occurred in a finished coil, the coil need not be unwound, but only the single wire in the ribbon in which the break has occurred, disconnected at its two ends, and cut out of the electric circuit. The invention is equally applicable to ... arrangement makes an excellent artificial submarine cable when the tin-foil is connected electrically with the earth. For the winding of the armatures of dynamo-electric machines and of the inducing electro-magnets, the ribbon may advantageously be employed.

JOURNAL OF THE TELEGRAPH.

VOL. XII. NEW YORK, OCTOBER 16, 1879. WHOLE NO. 287.

ANNUAL REPORT OF THE PRESIDENT OF THE WESTERN UNION TELEGRAPH COMPANY FOR THE YEAR ENDING JUNE 30, 1879.

To the Stockholders:

CAPITAL STOCK.

The capital stock of the Company is $41,073,410, of which there was in the treasury, belonging to the Company at the beginning of the year, $6,004,835. From this there was distributed to the stockholders $5,960,608, leaving the amount in the treasury $44,227, and the amount outstanding on the 30th of June, 1879, $41,029,183.

BONDED DEBT.

The bonded debt at the close of the year was as follows:

Bonds due March 1, 1900, 6 per cent	$ 971,514 00
Bonds due May 1, 1900, 7 per cent	3,920,000 00
Bonds due May 1, 1902, 7 per cent	1,373,000 00
	$6,264,514 00
Less amount of Sinking Funds and accrued interest thereon, held by the Union Trust Company Trustees	126,347 53
	$6,138,166 47

During the year £2,000 of the Sterling Bonds, due March 1, 1900, were redeemed by the Trustees of the Sinking Funds.

BUSINESS OF THE YEAR.

The revenues, expenses and profits (after reserving amount sufficient to meet the claims of the Atlantic and Pacific Telegraph Company under existing agreements; were as follows:

Revenues accruing to this Company,	$10,078,897 79	
Expenses chargeable " "	5,809,119 46	
Net profits		$4,269,778 33

From which there was applied:

For four quarterly dividends	$2,295,304 50	
For interest on bonds	430,528 25	
For Sinking Funds appropriations	40,056 81	$2,765,889 56
Leaving surplus of net revenue for the year over dividends, interest and Sinking Funds appropriations	$1,503,888 77	

From which surplus there was appropriated:

For construction of new lines and erection of additional wires	$138,319 50	
For purchase of sundry Telegraph Stocks, Patents, etc	145,134 83	
For payment of balance unpaid July 1, 1878, on account of purchase of Atlantic and Pacific Telegraph Company's stock	537,166 44	$820,620 77
		683,268 00
Balance		$4,269,774 33

GENERAL STATEMENT.

The balance of $683,268.00, together with the balances of previous years, is represented in the following exhibit of the profits and disbursements of the Company, for thirteen years, from the date of the general consolidation, July 1, 1866:

The surplus of Income Account July 1, 1866, was	$275,357 24	
The net profits for thirteen years, from July 1, 1866, to June 30th, 1879, were	40,203,602 03	
Making an aggregate, June 30, 1879, of		$40,478,959 27

During this period there was applied:

For dividends to stockholders (including cost of Western Union stock distributed, and cash dividend payable July 15, 1879	$19,823,206 86	
For interest on Company's bonds, etc	5,018,498 61	
For amount reserved for Sinking Funds, and for interest on bonds, accrued to June 30, but not yet payable	106,086 64	
		$24,947,792 11
Leaving a surplus of		$15,531,167 16

which is represented as follows:

Construction of new lines, erection of additional wires, etc		$6,518,962 87
Purchase of telegraph lines, and stocks of companies controlled by the Western Union Company, upon which interest or dividends are paid as rental		1,643,693 12
Western Union Telegraph Company's stock (442 shares)		25,705 67
Atlantic and Pacific Telegraph Company's stock (72,010 shares)		1,806,250 00
Gold and Stock Telegraph Company's stock (47,810 shares)		1,176,009 00
International Ocean Telegraph Company's stock (10,383 shares)		961,606 42
Brooks' Underground Telegraph Company's stock (1,000 shares)		95,000,00
Sundry other Telegraph and Railroad stocks and bonds		50,075 60
Western Electric Manufacturing Company's stock (500 shares)		50,000 00
Western Union bonds redeemed and cancelled		1,329,443 96
Sinking Funds (portion not yet used for redemption of bonds, exclusive of interest allowed by Trustees)		110,827 60
Broadway and Dey Street building	$2,295,639 52	
Less amount provided from the proceeds of bonds	1,802,202 00	
		493,437 52
Real estate other than above		343,844 12
Supplies and material on hand unissued		153,841 37
Surplus June 30, 1879		772,469 91
		$15,531,167 16

RECAPITULATION.

Recapitulating this general exhibit in round figures, it appears that of forty and a half millions of net income in the past thirteen years, a little less than twenty millions have been paid in dividends to stockholders; six and a half millions paid for interest and principal of bonded debt; over thirteen millions added to the plant, in the construction and purchase of new lines and stocks in other companies and real estate, all of greater value for the uses of the Company than their cost; and three quarters of a million remain as surplus in the treasury.

STATISTICS.

The following table exhibits the amount of lines operated, number of offices, number of messages sent, receipts, expenses and profits for thirteen years respectively, showing the steady growth from the date of consolidation of the telegraph companies in 1866, increasing nearly three-fold its miles of wire, nearly fourfold in number of offices, and nearly fivefold the number of messages sent, whilst the gross and net earnings have each been nearly doubled. The expenses have been steadily reduced since 1873, and were less last year than for any year since 1872; and though over twenty-five millions of messages were sent during the last year, the expenses were less by $415,000 than for the year ending with June, 1873, in which year only fourteen and a half millions of messages were sent.

INTERNATIONAL OCEAN TELEGRAPH COMPANY.

Of the capital stock of $1,500,000, the Western Union owns $1,038,500, the Company itself owns $97,300, and other parties own $364,200.

The net earnings of this Company for the year ending June 30, 1879, were $220,275.50. During the year there was paid regular quarterly dividends at the rate of eight per cent. per annum, and $73,900 of the bonded debt; leaving a surplus at the close of $77,062, which was more than sufficient to meet the remaining bonded liabilities falling due October 1, 1879, amounting to $57,600, which at this writing has been paid as far as presented, leaving the Company without debt, and a handsome balance in the treasury.

GOLD AND STOCK TELEGRAPH COMPANY.

This Company has a capital stock of $2,500,000, of which it holds in its treasury $54,450, and the Western Union Company owns $1,195,250, or a little less than one half the stock outstanding.

The net earnings of this Company for the year ending June 30, 1879, were $260,629.65, out of which were paid quarterly dividends, amounting to six per cent., to stockholders, $35,000 in interest on bonds, and $45,000 for construction and purchase of lines and patents. The surplus of $30,500 has been invested in the American Speaking Telephone Company, of which latter Company the Gold and Stock Company owns a two-thirds interest, and has the control and management.

The Gold and Stock Company has a bonded debt of $500,000, maturing May 1, 1885, of which it owns and has in its treasury $65,000, and the Western Union Company holds $100,000.

GENERAL REVIEW.

The surplus earnings of the fiscal year were over one and a half millions above what was required to pay dividends, interest and sinking fund. Of this,

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FIELD TELEGRAPHY.

A German paper gives a detailed description of the apparatus designed by Captain Buchholtz, of the Prussian railway regiment, and recently adopted in the German army, for providing telegraphic communication between the different fractions of an outpost line, or between the outposts and the main body of an army in the field. The whole apparatus consists of two small Morse's receiving instruments, a Siemens' and Halske battery, and a cable about three millimeters in diameter. It being impossible with a movable apparatus to use the earth to complete the electric circuit, a return wire is provided in the cable. An ingenious but extremely simple arrangement has also been devised for joining lengths of the cable together, the operation being rendered so simple that it can be performed by any one without any previous instruction or practice. The cable itself is manufactured in lengths of 500 metres, each being provided with a loop for attaching a harness, in such a way that as the men carrying it walks forward, the wire unrolls itself behind him. The cable can therefore be laid as quickly as a man can walk. The receiving instrument is fitted in a small box, on the outside of which is the sending key and a bell. The weight of the box, which also contains a small galvanometer, is about 8 lbs., and it can be carried in front of a man by means of a strap across the shoulder. The battery is carried in another box, and consists of ten elements, the whole weighing about 22 lbs. It will act for months without the materials being renewed, all that is necessary to keep it in order being to add to it occasionally a few crystals of sulphate of copper and a little water. The whole apparatus is to be carried in time of war on one of the wagons accompanying the battalions of infantry, and, when required for use, will be given to the men who are to employ it in exchange for their packs.

Sc. Amer.

Aluminum Telegraph Wires.

German telegraphic engineers have lately been experimenting with aluminum as a material for telegraph wires. This metal can easily be drawn out to a very much finer gauge than is possible with iron, and its conductibility is twice as great as that of iron wire. Its excessive cost has hitherto prevented its use for the purpose indicated, but it is found that an alloy of aluminum and iron can easily be made, which will produce a wire both finer and stronger, and less susceptible to atmospheric changes than iron wire, while it is much superior as a conducting medium.

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Telegraphe

COURANTS ACCIDENTELS

SUR LES CIRCUITS AÉRIENS

Lorsque, en 1841, on installa en France les premières lignes télégraphiques, on voulut reconnaître sur les fils métalliques qui les constituaient des traces de passage des dépêches, et je me rappelle encore certaines personnes douées cependant de quelque intelligence, qui s'étonnaient de ne pas voir courir les dépêches sur les fils; d'un autre côté, on trouvait extraordinaire que les oiseaux perchés sur les fils ne fussent pas foudroyés par les charges électriques transmises; enfin, quand on entendit ces bruits souvent si intenses produits par les fils télégraphiques dans certaines conditions d'installation des lignes, on crut y voir la manifestation de la transmission du fluide électrique. Bien que toutes ces idées soient évidemment absurdes, il est cependant un fait certain, c'est qu'une ligne télégraphique, par suite de sa disposition elle-même, et, en dehors de tout effet électrique qui lui est communiqué par une pile, subit une foule d'influences perturbatrices qui entravent considérablement le service des transmissions, et qui proviennent de beaucoup de causes différentes. Ce sont ces effets dont nous allons nous occuper aujourd'hui.

Une ligne télégraphique étant un conducteur d'une grande longueur exposé aux différentes actions atmosphériques, à des effets calorifiques très-variés et aux effets magnétiques du globe terrestre, doit nécessairement être impressionné dans divers sens par toutes ces actions, et, de plus, comme ce conducteur est en rapport à ses deux extrémités avec la terre que l'on peut regarder comme une sorte d'électrolyte, il doit se trouver impressionné par tous les effets dont il a été question dans un de mes précédents articles, et qui sont la conséquence d'un circuit complété par un conducteur humide. Si l'on joint à ces causes perturbatrices celles qui résultent de l'influence des charges électriques sur les objets extérieurs, celles qui sont la conséquence des effets d'induction des fils les uns sur les autres, des courants de retour et des courants induits provenant des appareils télégraphiques eux-mêmes, on pourra voir qu'une ligne télégraphique est toujours sillonnée par des courants étrangers à ceux que l'on envoie, et dans l'étude est importante pour le régularisation du service télégraphique.

D'après ce simple aperçu, on voit déjà que les courants perturbateurs dont nous venons de parler peuvent être classés en plusieurs catégories : 1° les courants atmosphériques; 2° les courants dus au magnétisme terrestre; 3° les courants thermo-électriques; 4° les courants permanents dus à une action voltaïque et généralement désignés sous le nom de courants telluriques; 5° les courants induits. De ces différents courants, nous n'indiquerons aujourd'hui que ceux qui sont dus à l'action tellurique et thermo-électrique.

Courants telluriques. — Si on plonge dans un milieu humide quelconque deux plaques métalliques d'un métal différent réunie l'une à l'autre par un fil conducteur, un semblable par le fait un couple voltaïque dans lequel le métal le plus attaquable par l'humidité représente le pole négatif. Or, la terre étant un conducteur relativement humide et d'une résistance très-minime, comme on l'a vu dans un précédent article, doit fournir à travers un fil télégraphique mis en communication avec elle par deux plaques de métal différent, un courant qui sera dirigé de la plaque la moins attaquable à la plaque la plus attaquable; et ce courant sera naturellement d'autant plus énergique que l'une des plaques sera plus

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AN IMPORTANT INVENTION.

A Progressive Development in the Method of Constructing Telegraph Lines.

Mr. A. B. Turner, a prominent citizen of Saugerty County (Md.), rustling at Mount Savage, has just taken out letters patent on a very important invention, and one that, in all probability, destined to work a speedy, remarkable in the method of constructing telegraph lines. Mr. Turner has long been connected with railroads, and the nature of his occupation has given him the fullest opportunity for observation. His invention is an arrangement for an underground telegraph line, and consists of a system of apertured insulators, with the apertures extending longitudinally through them. The insulators may be made of glass, furnace-slag, or any other non-conductor of electricity having the requisite strength and capable of resisting the effects of air and moisture. They may be made of any desired length, and range in diameter according to the number of wires to be accommodated. These sections are provided at one end with a projection and a pin or tenon, and at the other end with a socket or recess, which receives the correspondingly shaped projection and end or tenon, so that any number of the sections may be united and formed into a continuous tube, water-tight at the joints and side. The pin or tenon regulates the position of the longitudinal apertures in the different sections, so that a wire may be pushed through a long distance or withdrawn at pleasure without meeting with any obstruction or coming in contact with the other wires.

The tube is laid in a prepared ditch in the ground, and rests upon a bed of concaved blocks of any suitable material.

At certain intervals risers are provided between the insulator-sections. These consist of ordinary insulators secured upon a crosspiece upon an upright post planted in the ground, and carry the wires from one insulator section to another. They serve to detect a breakage or any defect that may arise in any of the wires, and provide facilities for testing the wires and for turning corners or forking angles.

By this method each wire is separate from the others and thoroughly insulated, without the additional heavy cost of inclosing or covering the tube that has heretofore been found necessary. It can, and we believe all, instances, and which is objectionable because of the difficulty experienced in withdrawing or removing the wires from insulator-sections underground. In this case the wires can be inserted or removed with facility. On the whole the invention is perfect, and just what is wanted.

The advantages of this invention are numerous. One of these is the comparatively small cost of construction, which will be much less than that incurred in erecting the pole lines or putting down underground lines by the methods heretofore employed. Another is that it does entirely away with the unsightly poles, which are often a serious nuisance in the cities, and links in opposite sections by fire and storm. Another is in safety. The disconnect of the lines by wind and rain, as often occurring in the pole lines, is avoided, and numerous drawbacks are overcome.

It must be a matter of pride to all the people of this county that one of our own citizens has worked out the important invention, and we sincerely hope he may reap the reward his genius and enterprise so richly deserve.

Already he has received from prominent telegraph officials in several cities letters of congratulation and expressive of the highest praise of his invention, which, we have no doubt, will ere long begin to take up place of the unsightly cisplosions [illegible]

EDISON'S TELEGRAPH SUIT.

WASHINGTON, Feb. 16, 1875.

The suit of Thomas A. Edison and George Harrington against the Western Union Telegraph Company for an injunction against the use of the duplex and quadruplex telegraph transmitters, which Edison invented in 1874, was argued in the Supreme Supreme Court, before Judge James, to-day on the bill, answer, replication, and proofs. Ed. Ord, Esq., and Messrs. Dickerson and Dyer, of the firm of Dickerson, Brown & Dyer, of Philadelphia, appeared for the complainants, and Messrs. C. C. Lemoyne and W. D. Mooney for the defendants. The former argued that the patent granted to Edison entitled him to have and exercise every right which the law gives to inventors, and cannot be followed that two suits were necessary, being for infringements of his patents in different years. The latter argued that the patent was conditional to sell the patent for Edison and Harrington on such circuit to the company, on which no royalty was to be paid, and that the Western Union having used in a particular way which he had consulted with Herrington in 1870, he had agreed not to sell his invention without the latter's consent. The company had also transferred the transmitters from one circuit to another, which was a violation of the agreement to purchase the contract. The Court took the papers and reserved its decision, after giving the defendants leave to file the record of the New York suit in this case.

THE TELEGRAPH SET SCREW.

The decision of Judge Blatchford sustaining the Page Electrical Patent was noted in our issue of March 6.

April 4 Judge Blatchford heard motions by the American Union Telegraph Company, the Wabash, St. Louis and Pacific Railway Company, and the Union Pacific Railway Company, praying to have the decision referred to so modified as to exempt them from the payment of royalty to the Western Union Telegraph Company, on the grounds that they have always used the machine and device invented and patented by Prof. Morse, and that it could be proved that the original Morse instrument on exhibition in the office of the Western Union Telegraph Company was made by Prof. Morse as early as 1835, and contained all the essential parts of the apparatus and devices set forth in the eleventh, twelfth, and thirteenth claims of the Page patent.

The petitioners allege further that the defense in the previous suit could have proved (though they did not) that the testimony of Page in the suit of French against Rogers related to these essential parts of the Morse apparatus and devices; they could have proved by Thomas Hall of Boston that in 1847 he manufactured a machine under the Morse patent, which contained a device and combination for setting or regulating the length of the vibration at the armature of an electro-magnet by means of a set screw as described in the fifth claim of the Page patent; they could have produced an affidavit of Mr. Page himself, taken in 1866, in the suit of Morse against O'Reilly; also, the defendants could have proved by the Rev. S. Irenæus Prime that Mr. Page wrote to the Hon. Amos Kendall in 1848 that he had never claimed the invention of the receiving magnet used in the Morse telegraph; and the defendants could have made use of the depositions of Professor Morse, taken in 1850, in the suit of French against Rogers, and of Leonard D. Gale in the suit of Morse against O'Reilly.

The petitioners further asserted that they were ready to produce before the court one of the machines now and for many years past used by them in telegraphing, and the machines used by Mr. Hall, and if aided by the process of the court they will cause to be produced by the Western Union Company the machine used by Prof. Morse and presented to the company after his death; upon a comparison of which it would be seen that the machines now used by the petitioners and that made by Mr. Hall and that used by Prof. Morse are alike in their essential parts, and that all of them have the designs and appliances mentioned in the eleventh, twelfth, and thirteenth claims of the Page reissued patent.

Two weeks were allowed by Judge Blatchford for the plaintiffs to make answer. When the case was called the counsel for the Western Union Telegraph Company stated that due diligence had not been used in obtaining evidence in the previous trial, and produced the original model of the Morse telegraph instrument, to show that the disputed set screw governing the play of the armature was not there and never had been. It was held by the opposite side that the original screw had been removed and another substituted, whereat an excited colloquy ensued between the opposing counsel; but no evidence could appear to have been brought to show the real function of the screw which the model now carries.

The arguments of the counsel being undinished for lack of time, the case was carried over to Monday April 26, and again to April 30.

TESTING THE POSTAL PNEUMATIC LINES.

WHEN Mr. W. H. Preece, the chief electrician of the Government postal telegraphs of this country, paid an official visit to the United States a few years ago in order to report upon the working of the telegraph apparatus there, and note any improvement that might be introduced with advantage into the British system, one of the novelties which he inspected from America was the method of testing the wires by "received currents" or currents received at the end of the line.

He has adopted this plan to the telegraph system under his superintendence with very great success, thanks mainly to the professional ability of his assistant, Mr. H. R. Kempe, who at a recent meeting of the Society of Telegraph Engineers, gave an interesting account of the method now followed in testing the inland lines throughout the country in this way.

Mr. Kempe began his remarks by disputing the observations of Mr. Latimer Clark, published in the Indian Telegraph Service, in his recent book of instructions to Indian electricians, to the effect that a system similar to that in use in India would be suitable to England. The speaker pointed out that a system admirably adapted to the long Indian lines through a barbaric country, would be unnecessary in a populous country like the United Kingdom, where the lines are divided into testing sections of twenty miles. The system followed in each of the two counties was, he contended, best adapted to that country.

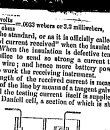
The old method of testing the lines consisted, as is well known, in measuring as stated above the resistance of the line in ohms; the new method consists in measuring the strength of current in webers, or rather in millionthers, or thousandths of a weber, as proposed by Mr. W. H. Preece. A standard received current is fixed upon for the particular line to be tested, and if the line is in good order the received current actually measured should be equal or nearly so to the standard current. The percentage of deviation from the standard value shows the faultiness of the line. The falling-off from the normal condition is thus observed, and obviously this is all that is practically necessary.

The standard received current for a particular line is chosen as the current which flowing through the proper resistance of that line will work a Morse instrument. For example, the current from a two-cell Daniell battery, giving an electromotive force of about 10 volts, and flowing through a line of wire resistance of 3000 ohms, will work a Morse instrument when the insulation of the line is perfect. Now the current in this case is

10 volts
3000 ohms = .0033 webers or 3.3 millwebers,

or 3.3 millwebers is the standard, or as it is officially called, the "undisturbed current received" when the insulation is perfect. When the insulation is defective ten coils will not suffice, and it would be strong a current to the end of the wire; and hence more battery power is required to work the receiving instrument.

The strength of the received current is measured at the end of the line by means of a tangent galvanometer; and the testing current itself is supplied by a standard Daniell cell, a section of which is shown



in the figure. The vessel is a square box of ebonite divided into two equal compartments by an ebonite partition. The right-hand compartment contains water, and is merely a receptacle for the porous pot containing the copper plate C and the sulphate of copper solution and crystals when the cell is not in use. The water keeps the pores of the pot from choking up with crystals, while the advantage of placing the sulphate of copper classifier there when the cell is out of use is that the exposure solution will not go on diffusing itself in the sulphate of zinc liquor or left-hand compartment. The latter compartment contains a zinc plate Z, which is the negative element of the cell, and a piece of zinc rod Z' which lies on the bottom. The solution of sulphate of zinc is half saturated, and when the cell is out of use only reaches to the bottom of the zinc plate. The function of the separate piece of zinc Z' is to decompose any sulphate of copper solution that may diffuse into the sulphate of zinc solution from the porous pot when it is immersed for working amidst the sulphate of zinc. Metallic copper deposits on the zinc rod, and the cell is then purified when not in action. The above set may be arranged from time to time and thus rendered efficacious again. To put the cell in use the porous chamber is removed from the right-hand compartment and immersed in the sulphate of zinc solution in the left-hand one. The latter solution then rises till the zinc plate is covered and the cell is ready for use. When done with, the porous chamber is withdrawn from the left-hand compartment, and replaced amongst the water in the right compartment. As the standard battery is only required for a few minutes at a time it keeps constant for a long time. The electromotive force is 1.079 volt.

The tangent galvanometer devised by Mr. Kempe for these tests deserves a passing notice. It is designed to give a current of a millionthers when one standard cell is passed through it. The electromotive force of such a cell being 1.07 volts, the resistance of the galvanometer is 1070 ohms, made up of 320 in the instrument itself, and 750 added to it for the purpose of practically lengthening the line being tested, in case a fault should exist very near the end of the line next the instrument. This galvanometer has four grades of sensibility.

Elaborate tables have been calculated by Mr. Kempe to facilitate the working out of these reciprocal current tests, so that as little time as possible is consumed in the process. Official returns have also been drawn up for registering lines from day to day and month to month, the form being tested twice a day and once a month. The monthly tests are for insulation resistance and continuity of the wire. The insulation tests are taken with the zinc current on the line. The conductivity tests are taken as usual with the Wheatstone balance, both zinc and copper currents being applied to the line. A novel arrangement of the switch for changing the currents permits that the deflections of the galvanometer in the "bridge" wire shall always indicate plus or minus resistance in the same direction, whether the current be positive or negative.

The British climate is very unfavorable to telegraph lines, but notwithstanding this fact, such is the excellent efficiency of their management, that out of the whole 1200 circuits in constant work, consisting of 120,000 miles of wire, there are rarely ever more faulty circuits at a time; often there is only one, and some time none at all. This remarkable success is largely due to the new system of testing by received currents, which proved of special service during the recent general election.

81 88

NEW BATTERIES.

THE ELECTRICIAN, AUGUST 21, 1880

The action of batteries and the conditions governing it are so little studied that the following results of M. D'Arsonval are very welcome. According to that savant, the chemical action in batteries with two liquids when the circuit is opened is never entirely stopped. This effect pertains to cells in which the liquids diffuse into each other across the walls of a porous chamber, or by actual contact without porous separators, as in the Callaud cell.

To remove this defect M. D'Arsonval has devised the two following plans, which, he says, succeed very well :—

The first means is founded on the absorbant properties of animal charcoal, and is applied to all batteries wherein the liquid diffusion cannot diffuse itself over the zinc. For this purpose he deposits a layer of pulverised sulphate of copper, covered with clean animal charcoal in powder. The zinc is placed at the upper part of the vessel, and is, consequently, separated from the sulphate of copper by a layer of animal charcoal. The voltaic element thus constituted resembles a Minotto cell, in which the sand has been replaced by animal charcoal.

In these circumstances the zinc remains completely unaltered. For over three years already M. Gaiffe has employed this cell of M. D'Arsonval's without experiencing the least change in its power.

The only inconvenience of this form is the increase of internal resistance which arises from the presence of the animal charcoal, an inconvenience that soon also brings with it, without the corresponding advantages. M. d'Arsonval has, it is said, M. Gaiffe, to manufacture porous vessels of agglomerated animal charcoal, but hitherto he has not succeeded. M. Carré, who at M. d'Arsonval's request undertook to try, was not more successful. But, even as it is, the form of cell is very serviceable for producing constant currents.

The second method followed by M. d'Arsonval for getting rid of waste action in batteries is of much more general application than the first, and consists in taking as a depolarising body a liquid which gives a precipitate by its mixture with the liquid attacking the zinc. The diaphragm separating the two liquids is in this way rendered impermeable. The precipitate formed in the pores of the vessel ought to satisfy two conditions; 1st, it ought to be a conductor of electricity, and 2nd, it ought to be electrolysable.

The combinations satisfying these conditions are exceedingly numerous. M. d'Arsonval recognises at least twenty, the chief of which are—

I. *Precipitate formed by the mixture of two salts. Nitrate of silver battery.*

This battery is constituted in the following manner. In the exterior vessel there is a zinc plate and chloride of zinc solution; in the porous vessel there is a platinum plate, a mixture of nitrate and a silver plate. These two liquids can mix, and thereby give rise to a precipitate of chloride of silver, which fills up the pores of the porous vessel and renders it impermeable. This precipitate conducts electricity very well, and is moreover electrolysable. Such a battery has very little resistance; its electromotive force is equal to 1·1 volts, whilst the same pair with chloride of silver only gives 0·9 volts. The high price of silver salts renders the method only applicable under particular circumstances, as in medical electricity or the charging of electroscopes, and, M. D'Arsonval might have added, in cable testing.

A more practical combination is the following. Zinc sulphate solution surrounding a zinc plate, and nitrate of lead surrounding a lead plate. The electromotive force is, however, very feeble, being 0·6 volts to 0·75 volts.

II. *Precipitate formed by the mixture of a base and a metallic salt.*

In this case the zinc is attacked by a base, potash, soda, or ammonia. M. d'Arsonval has tried the following combinations :—

First—Soda and sulphate of copper, which gives an electromotive force of about 1·2 volts.

Second—Soda and perchloride of iron, which gives about 2·5 volts.

Complex with potash have an enormous resistance, probably because the carbonate of potash, formed by the air, disengages its carbonic acid in contact with sulphate of copper, and the gas bubbles collect in the pores of the diaphragm, and destroy its conductivity. The solution of potash can, however, be made more conductive by the addition of sea salt or of sulphate of soda.

Scientific Notes.

Among the exhibits at the recent Daveldorf Exhibition, the wire manufactured Messrs. Felten and Guilleaume were conspicuous. Specimens of telegraph wire were shown to suit five specifications, amongst which was that of the English Government, the conductivity required being unusually high. There might be observed also a huge reel dressed in the colours of the Imperial German post office, and wound on this reel a length of underground telegraph cable from the Imperial German underground lines. The conducting wire is a strand of 7 iron copper wires, covered with a thick covering of gutta-percha. Seven of these conductors are twisted into a strand and then covered with tarred jute yarn. To shield the conductors against being mechanically disadvantageously affected, three of the galvanised wires is put on and then a waterproof coating of hemp and asphalte. All the telegraphic main lines of the German Empire are provided with cables M 7 conductors, and only the branch lines have cables M 4 conductors. The telegraphic underground lines of the German Empire are to have a total length of more than 5,000 miles with altogether 19,000 miles of conductors, as they are intended to be completed before the end of this year. By their means nearly all the principal towns of Germany are put into telegraphic communication with one another and with Berlin. The last larger underground telegraphic line was built by Siemens, Felten and Guilleaume, 4 years ago, from Berlin to Halle.

ENGINEERING NEWS.

The Chicago exchanges has 844 miles of trunk wires, 1,000 miles of branch wires, 250 miles of wires on the roofs of buildings. There are 1,033 telephone stations actually connected. The exchanges are seven offices in different parts of the city, having a capacity of 2,381 wires. The exchanges make an average of 7,691 connections or conversations per day, which requires including trunk line connections, an average of 1,000 employés. During the first 24 months of 1880 1,420,600 of these connections were made by the Chicago exchange. The cost of making a long distance at Chicago for the 40 minutes was 4·16·3 cents a piece. This result was not satisfactory to the telephone men, who considered such connections not likely to be profitable.

Early on a recent morning, "on the storm of a fire in the Whitehall-road, Leeds, being alarmed, the foreman of the *Leeds Mercury*, [illegible] engines, and in its passage along Whitehall-road the escape caught the wires stretched across the road in connexion with the telephone recently [illegible] by the Leeds District Telegraph Company with as much force as to [illegible] the wires were stretched [illegible] the roof of the building [illegible] and the appliances rapidly extending, it would be well if [illegible] were [illegible] to place the wires in the safest possible positions." Some time since the Post-office authorities in London put the telegraph wires under ground, but telephone wires are now getting so thick in the air that fires [illegible] would be facilitated to examine as to see if we had wings in order to learn whether the overhead wire nuisance was to keep on at home.

It is reported that the Chinese are about to construct a land line of telegraphs from Tatcnsin to Pekin with a cable across the Tongtsee. The Great Northern Telegraph Company have offered to supply the material at cost price, and to work the line. One of their staff has already surveyed the line down the Yellow River.

Marshall, Sands & Co., of Hongkew, have lately made a contract to supply the necessary machinery for the local [illegible] near Tatcnsin, and to work them. The machinery consists of a portable engine, which can be worked at high pressure a pitband chain, shafting, connecting gears, drums and baskets. Packing gear will not be used.

A new survey is to be made by the Siamese government for a telegraph line. The line will be put into service.

Railways are being rapidly built in Japan. Col. Crawford is building on the line which is to connect Yokohama with Suppore at the rate of a mile a day, and as the distance is only seventy-five miles, it will soon be ready for traffic. Such rapidity of construction is now practically unheard of in Japan.

It would seem that the telephone has been a real boon to the merchants of Gensan (Japan), who, we are told, were overworked by the process of communicating orally, which necessitated many a weary tramp. They now feel relieved.

The survey o the rail from Tokio to Jakaseki is completed, but it is yet uncertain whether the 10th National Bank (Japan) undertakes its construction.

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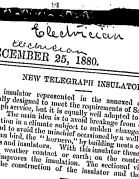
Important Telegraphic Discovery.—We learn from the *Journal de Genève*, 25th August, that the Swiss Federal Council has just received a communication from Messrs. Hipp, Bürkli & Co., of Cortaillod, in Neuchatel, Switzerland, which announces that they have made a highly important discovery in practical telegraphy. After a long and expensive series of experiments they have succeeded in discovering a method of laying cables whereby the Indiarubber insulation of the electric current from one wire to another, although *the wires are in juxtaposition*, is prevented. This discovery, it is asserted, entirely removes the last obstacle in the way of the widest possible extension of facilities for telephonic communication.

Electricity at the Brussels Congress.—At the recent Congress of Commerce and Industry held at the Brussels Bourse in connection with the International Exhibition, the first discussion of electricity, namely, telephony, electric lighting, and the transmission of motive power, were the subjects of three [illegible] delivered by Professor of the Liege University, in treating of telephone exchanges, strongly recommended the use of phosphor-bronze for wire instead of [illegible] for the electric [illegible] as it has a greater than that of [illegible] while [illegible] four times greater than that of steel. Aërial wires are more easy of execution than underground ones, but they are dangerous to life and property, and M. Hulz very justly remarked that the inventor who would devise a cheap mode of constructing underground lines, permitting of rendy of receipt, would render a great service to telephonic progress

DECEMBER 25, 1880. 69

NEW TELEGRAPH INSULATOR.

The insulator represented in the annexed engraving was originally designed to meet the requirements of South American places. The main idea is to avoid breakage from expansion and contraction in a climate subject to sudden changes of temperature, and to avoid the mischief occasioned by a well-known South American bird, the "bottero," by building nests of mud on the brackets and insulators. With this insulator these nests cannot be made, as a weather crotch, or curb, on the contrary, the nest rather improves the insulation. The accompanying figure shows the construction of the insulator and the manner of

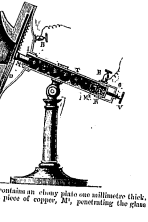


fastening it to the cross iron or bracket. A rubber ring is placed between the upper end of the porcelain insulator and the cross arm, and another similar ring is placed between the head of the suspending screw and the bottom of the insulator. It will be noticed that with the construction the insulator cannot be broken by the construction of the screw or by the swelling of the cross-piece. The insulator can be used on an iron bracket and in connection with either iron or wooden posts, and is in every way more secure than the insulators in common use. The first cost of these insulators compares favourably with the cheapest in the market, while it is less liable to breakage, lasts longer, and gives better results.—*Scientific American.*

NEW MICROPHONE.

BY M. BOURBOUZE, OF PARIS.

This microphone, with multiple contacts, as shown in the accompanying figure, is composed of a mouthpiece, B, affixed to the end of a glass tube, T, one centimetre in diameter, itself fixed on a pointed stand, thus enabling the whole apparatus to be moved at any inclination.



The mouthpiece contains an ebony plate one millimetre thick, on which is fixed a piece of copper, M, penetrating the glass

Phosphor Bronze Telegraph Wire.

M. E. Bene, formerly Professor at the Liège University, has recommended the use of phosphor bronze for wires instead of iron, phosphor bronze having four times the conductibility of iron, and being from three to four times as strong as steel. Aerial lines had the advantage of being easily inspected, but the disadvantage of being liable to accident, while underground lines are almost free from accident, but difficult of inspection. That inventor would render great service to telephonic communication who should devise a cheap method of constructing underground lines that should at the same time permit of easy and complete inspection.

PHILADELPHIA newspapers report that the American Union Telegraph Company are about to try in that city the experiment of putting their wires underground. The plan works well enough in European cities, and there would seem to be no reason why it should not succeed here, save the indisposition of the companies to bear the first cost of working the change. For some months the Western Union Telegraph Company has had the matter under consideration, and probably will await only the result of a rival company before it undertakes the work. Almost all the wires in the forest of Fontainebleau, the shortest line to Paris, are buried to such a depth that the ploughs of cultivators cannot reach them. Sooner or later the poles and wires must come down, and it is altogether probable that a change will be beneficial to the companies in the long run, owing to the immense cost of maintaining a pole-and-wire system. It will certainly be an advantage to the community.—*Scientific American.*

Evening Telegram
Aug 25 1881.

A Telegraph War in New Jersey.

The officers of the State of New Jersey are beginning to realize the importance of keeping their records in safe quarters. Many valuable documents are destroyed each year by fire, and the State House is not a fireproof building, yet as all the documents of importance are kept there it is considered best to keep them in safe quarters, and accordingly the Secretary of State, Gen. Stryker, has given notice to the Legislature that he will not provide for the rent of any more rooms in the State House, and that after the present year all documents and records will be removed to some other building. The Legislature will probably provide a fireproof building for the purpose.

Sun. Aug. 7. 1881.

POLES CHOPPED DOWN.

A War in Montclair for the Defence of a Historical Grove.

The Postal Telegraph Company, consolidated with the Baltimore and Ohio, is now in operation near Montclair. The right of way has been secured between Montclair and Jersey City. In Montclair, however, the company's poles encountered opposition when they were put up. In the centre of the town is Church Grove, about half a mile long, shaded in places by old and beautiful trees, while young trees have been set out in the vacant spaces and these are already becoming shade trees. The residents of Montclair are very proud of this grove of trees, and have always objected to the cutting of their trees limb of their house, although it was necessary to trim the trees in order to keep the wires clear. Among the property owners were Samuel Dyer, J. Van Cott, Dr. Bogert, Jacob Crane, Jr., F. H. Van Blarcom, John J. Merritt, E. Brady, F. Sutton, A. J. Crane, and Mrs. Cornelius Crane.

These gentlemen held a love on the evening the telegraph line appeared on the avenue and decided to take immediate steps to protect the shade trees. A committee was formed consisting of the first three named gentlemen and Mr. Dyer was appointed chairman. Mr. Bogert then drew up a formal remonstrance against the cutting up of the poles in front of their homes, and the document was signed by every property owner with only two exceptions. Mr. Bogert, who was president of the Montclair Railroad Company, and who was formerly in business with Jay Gould, had left town on the morning before the poles were put up, and Mr. Merritt, who was also interested with Gould in the Manhattan Beach Company, was out of town at the time.

The remonstrance was presented to the Common Council on the evening of the 15th inst., and the Council at once passed a resolution directing the Street Committee to notify the Postal Telegraph Company to remove the poles from the avenue. The Street Committee, consisting of Messrs. Bogert, Merritt, and Crane, met on the following morning and served the notice on the company. The company refused to remove the poles, and the Street Committee then directed the Chief of Police to have the poles removed. Chief of Police Hall detailed Officer Hoffman to the duty, and he, with a force of men, proceeded to the avenue and began to remove the poles. The men had not proceeded far when they were arrested on a warrant issued by Justice Bedle, charging them with malicious trespass. They were taken before the Justice, and were released on bail to appear for trial on Monday next. At the request of Mr. Bogert, Officer Hoffman left a police guard during the morning to watch the poles before they arrive. A lawyer was employed by the company to defend the suits brought against the officers. In the meantime the poles are up to stay, to the regret of the property owners who had hoped to be successful in preserving the shade trees.

Sun. Aug. 28
1881.

MONTCLAIR'S TELEGRAPH WAR.

The Question of Setting Up Poles in Claremont Avenue Taken into Court.

The armistice in the telegraph pole war in Montclair continues in force. This is an extension of the temporary injunction obtained by Street Commissioner Stephen Merritt, Chairman, and by certain the Bloomfield Turnpike Company from planting poles in front of their residences. Many other residents in Claremont avenue, most of whom are New York business men, are also about to join the alliance of the shade trees in front of their beautiful shade trees and their New York gentlemen. When Overseer Decalmes and his workmen set some poles along the avenue about three weeks ago the poles were mysteriously cut down. The residents in the avenue in the east day handed themselves into an organization to protect the property of the citizens. The officers of the Postal Union Telegraph Company, who have the contract for putting up the line they had not intended to run the proposed line through the avenue, or any other shade trees in Montclair, but to keep on the property owner. The action of their agents had, they said, been hasty and ill-advised. However, as the question of the right of way had been raised the latter he applied for an injunction to take the matter to court.

Mr. Thomas S. Purdy of the Postal Union Telegraph Company said yesterday that the injunction papers had been served on the Chief of Police, and that the case in question will probably be considered at the same time. The telegraph company has a contract with the Bloomfield Turnpike, of which is through Claremont avenue. This is the most direct line to Newark, whereas the telegraph line is longer and on the company preferred the way through Claremont avenue. The line will be run through the upper route will be accepted. This telegraph line is a branch of the main line, and runs only to Newark.

The Sanitary Engineer, Aug. 25. 1881.

The Philadelphia *Times* states that the National Underground Electric Co. are arranging to lay telegraph wires from the public buildings to the Delaware, a distance of about one mile. The wires are to be insulated, and placed in terra-cotta pipes, "pierced longitudinally with nine holes."

Inland from the promenade *Bizarre*, at the law offices for the erection of the poles. The property owners said last evening that written permission had been given to the company from only one man on the avenue.

The law of New Jersey concerning the putting up of telegraph lines declares that after the line is located the company may proceed to construct it so long as the legality under the charter, despite all opposition, except such as is based on their offices in New York on Monday last. At the request of Mr. Bogert, Officer Hoffman left a police guard during the morning, three hours before they arrive. A lawyer was employed by the company to defend the suits brought against the officers. In the meantime the poles are up to stay, to the regret of the property owners who had hoped to be successful in preserving the shade trees.

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Telegraph, Telephone, and Cable Wire, &c.—For the marvellous success which has attended the adaptation of the discoveries of electricians to practical uses the world is indebted in no small degree to such firms as that of Messrs. William Cooke & Co., of the Tinsley Steel, Iron, and Wire Works, near this town. The requirements of the age in this matter have been with them a close and practical study, and as a gratifying result they have distinguished themselves in the manufacture of wire for telegraph, telephone, cable, and kindred purposes. Mr. William Cooke, the founder of the firm, has been for the last forty years intimately associated with our heavy industries, and has taken an active and important part in their development to their present great proportions. He had for many years the management of the Swinton Works, which now belong to Messrs. John Brown & Co.; and in 1859, while still in that position, he discovered and brought into successful issue the manufacture of steel-iron. Under the old process of "piling" there were blisters and stratification in the iron, but by the new process those defects were entirely obviated, and steel-iron came rapidly into use. In 1866 Mr. Cooke entered into partnership with Mr. John Cooke and Mr. T. A. Mann, and they were the first to break ground in the hitherto purely agricultural district of Tinsley. On the six acres of land they had purchased they erected puddling-furnaces, steam-hammers, rolling-mills, and other machinery specially adapted to the production of steel-iron, which was then largely used in the sheffield trades—especially in the manufacture of heavy railway springs and similar goods. In 1873 the concern was converted into a limited company, and the business assumed a position in the world of trade. The area was extended to 16 acres, and the company put down new puddling-furnaces, steam-hammers, forge trains, a 10-inch and 16-inch merchant-mill, a mill for rolling steel and iron hoops, three charcoal fires for the purpose of making charcoal iron for wire, mills for rolling Bessemer into wire rods, drawing-blocks, and so forth. There were also erected two blast-furnaces, which are capable of turning out 250,000 tons of pig iron per year, the use for the smelting of which is drawn chiefly from the mines belonging to the company in Lincolnshire. When the company had been established about two years an outlay was thrown upon them, and a change of front had to be made, such as had not been anticipated. Then came the extraordinary expansion of the Bessemer steel trade, and the result of the experiments of the inventor and the improvements introduced in the manufacture of that material. In the course of a short time Messrs. Cooke used very largely supersoded steel-iron, for it was cheaper and of a considerably higher degree answered the same purpose. To meet these altered circumstances the company's plant had to be altered to an appreciable extent, especially as a new one. Since that time the company have given their attention more particularly to the manufacture of wire for telegraph, telephone, and similar uses, and they have brought to such a degree of perfection as to more than meet the severest tests demanded of it. By way of illustrating the capabilities of their Bessemer rod-mill, it may be stated that they recently rolled one rod which weighed 2½ cwt. The average weight of the rods rolled under ordinary circumstances is 120 lbs., and they measure 300 yards in length. As the result of prolonged experiments, and after an expenditure of much time and trouble, they have succeeded in producing steel for telegraph wire with remarkably high resisting-power per statute mile—a prominent advantage, arising from the use of which is that in great distances less battery-power is required to send the current of electricity along it. In the tensile strength of the wire is seen in the fact that 0·075 will bear with ease the required strain of 22 tons to the square inch. At the same time, this wire has also to stand a very severe torsion test. It must twist round its own diameter four times, and return to the straight without breaking. It is comparatively easy to make wire that will stand either the strain or the torsion test; the difficulty is to combine the two without either breaking. The wire that is intended for telegraph purposes is tested in another way. A length of it inches has to stand the strain of being rolled not less than 18 times round its own axis without breaking, and a defective wire will not do that. Messrs. Cooke & Co. have exceptional facilities for subjecting the wire they produce to these and all other tests required, as well as for ascertaining the resisting-power of the wire to the utmost extremities. Another rod-mill belonging to the firm is occupied almost entirely in the making of best charcoal, best puddled, and bending rods, for which there is a large demand for the colonial and South American markets. In the iron-wire mill they have recently introduced improvements by which they are able to roll considerably longer lengths, and finish the wire at a higher temperature than was possible under the old process. The mill is now capable of turning out on an average 150 tons of wire per week. All the subsequent processes necessary to the making of wire—such as annealing, galvanising, and so forth—are also conducted on the premises. During the past year they were favoured with some exceedingly good orders both from home and foreign markets. They have also just received an order for upwards of 1,000 tons of Bessemer wire for the American market. Iron and steel rods they produced nearly 11,000 tons, and finished wire for telegraph, telephone, cable, and fencing purposes, several thousand tons. This is a branch of their business they intend steadily and persistently to cultivate, as, for the making of wire for all the purposes indicated, they believe they have special facilities. Since the reconstruction of their mills Messrs. Cooke have been very successful in producing a brand of iron specially adapted for the use of agricultural engineers, and by them it has been received with much favour. Their output of merchant iron last year amounted to many thousands of tons. The firm have established a laboratory on their premises, under the care of an experienced chemist, and specimens of the raw material as it goes into the works, and of the finished goods before they go out, are carefully analysed and tested, that their precise temper and quality may be ascertained. At the present time Messrs. Cooke have good orders on their books, and their works are in full operation. It might be added that the firm have been very successful when placing their productions in competition with those of other firms. They received a first award for their goods at the Sydney Exhibition, and a similar honour has been conferred upon their exhibits at Melbourne.

Hoddinott's Record
Remembered!!!

THE telegraph system in Japan, which dates from 1871, comprised at the beginning of last year 3923 miles of line, with 8245 miles of wire. The number of despatches during the year was 1,227,236, of which about 25 per cent were in Japanese, while international messages numbered 21,693. The Japanese have now a system of telegraphy of their own invented by the telegraph superintendent from a combination of Morse characters to represent the sound of the syllabary known as the Kiritsu. This is now affected by using the letters of the international code, supplemented by others formed of dots and dashes (figures excepted), to produce a total of forty-seven signs, and the alphabet thus established is stated by Mr. Morley of the Japanese Department, to have given tolerable satisfaction during the nine years that have passed since its introduction. A telegraph school has been started for training Japanese youths as operators, and during the last year two hundred and twenty-seven were appointed to the offices—of course not to the exclusion of foreigners, forty-seven under million. They are taught to write and speak English and French, and receive the rudiments of an English education. The average rate for twenty thousand words of the Japanese language for a distance of sixty miles is about three sen, or rather less than a penny, taking the native Hiragana Takio to be worth a penny. The average for shorter distances is higher, but messages between Takio and Yokohama are transmitted for seven sen, or 7d. for twenty miles. In 1878 there were one hundred and twelve offices open for general traffic, local and international, and seventy others connected with government departments. Of these offices thirty-four were kept open day and night. Despatches between London and forty-eight Morse in-circuits in use, twenty-six single needle, three double needle, and nineteen Hughes and Bell pattern. Seventy-one instruments of various patterns are used in the school for the students to practise upon. Including the five submarine cables across the Straits of Shimonoseki, the total receipts for the year were £168,325, and the total expenditure £160,674, leaving the first year in which the revenue exceeded the working expenses. It may be mentioned that when the Satsuma rebellion in 1877 the telegraph was largely used in the field, and greatly contributed to bringing the war to a close. The Satsuma men were particularly skilful in the forest ambushes, but in almost every case they found that the wires were before them, and gave information of their whereabouts in sufficient time to defeat their object. For this purpose five hundred and eleven miles of line were constructed, and fifty-three office opened in the various villages at the rear of the victorious army. The materials employed in construction were light portable poles, rudimentic insulators, and No. 11 wire, every one being made of natural supports in the way of trees, and it was surprising how very few interruptions occurred under the circumstances.—*London Times.*

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Sun. Oct. 30th 1881.

OUR FIRE ALARM SYSTEM.

IMPROVEMENTS IN SUMMONING THE FIRE COMPANIES.

Alarm Boxes and the Telegraph in Place of the Old Fire Towers—Damage Stopped by Saving Time—Eight Hundred Miles of Wire in Use—Importance of the Repair Shops.

The bells that rang out from the lofty wooden towers known as the fire towers twenty years ago drew out to fires, besides the brave, hardy, and alert volunteer firemen, a motley throng that overtaxed the then comparatively undisciplined police and embarrassed the over-numerous, though zealous, firemen. The general alarm from the towers also attracted thieves, who contrived to steal whatever was easily portable from the property rescued from the flames. The alarm of the fire bells is a thing of the past. The towers have, with few exceptions, fallen at the command of the Commissioners of the paid and disciplined Fire Department. Four or five of them still stand in the old parts of the city as a precaution against the failure of the system of telegraphy that moves the present department with the exactness of a machine. This precautionary measure was proved to be a wise one last winter, when for several days the great network of telegraph wires of the city was rendered useless by a storm of sleet that converted each wire into a strand of crystal beautiful to every one but the anxious officials of the Fire and Police Departments and the exasperated operators of the commercial lines. In the years before the introduction of the existing systematized fire service delay was occasioned by the character of the apparatus, and the gathering of the firemen from their homes to reënforce those who were detailed to house duty, that gave the flames headway, and added to the difficulties of the work of extinguishment and to the losses. Nowadays all is changed. The city is gridironed with 800 miles of wire devoted solely to the use of the Fire Department, and kept in a state of usefulness equalled by few systems in the world. These wires are tapped by hundreds of small instruments known as "fire boxes," attached to the poles that support the wires, and distributed throughout the length and breadth of the city, that communicate a fire alarm at a touch even from a novice. By a novel appliance of telegraphy, the alarm from the box, at any hour of the day or night, sounds on the gong of every fire company, and instantly summons every man and horse in the department to the main floor of the companies' houses, ready to dash away to the scene of the fire. The same alarm rings in every police station, and rouses the Sergeant at the desk to alertness. So, within a few seconds, strong detachments of firemen, their horses on the gallop, and of policemen, at their most expeditious pace, are on the way to a fire. Within an average of between two and three minutes water is pouring from half a dozen steam engines upon the flames, and a police line keeps out thieves and prevents a pressure of spectators on the firemen. But in the place of the thousands that once, attracted by the tower bells, crowded and jostled at fires, there are hundreds now, and, except in the instances of great fires that startle by their lurid lights the entire community, the work of the police is easy. All of the great changes from the old volunteer system to the new one may be summed up in the result, of which New Yorkers are wont to be boastful, that New York probably possesses the most efficient fire department in the world.

"The favorite objection of the veterans of the old Volunteer Fire Department to our organization," said a fireman who worked his way up from the ranks to a high command in the department, "is that we are paid for our services, and, therefore, cannot feel the interest that men who ran to fires in the old times did. But this is nonsense. Any man that has blood in his veins feels a 'get there' interest in a fire. This is [illegible] when he is paid to get to the fire as soon as possible, and receives the censure of his superior officers if he does not. But for a healthy man no other incentive than the excitement of the moment is necessary to [illegible] him to do his best. Have you ever ridden to a fire? No? Well, come around our way some night, and I'll give you one of the most glorious experiences of life. There is nothing like dashing to a fire, standing on the ashpan of an engine, at about 3 o'clock on a clear, starry morning, with the big, hearty horses ahead, pounding along at a three-minute pace, and making the sparks fly at every jump! Then you see the light of the flames in the sky, and you think of whether you'll have an opportunity to do something that will merit honorable mention, and bring promotion, or whether you'll beat the fellows of Engine ——, which belongs to your fire district, and ought to be in at the fire a few seconds before you. Talk about incentives! What more does a man want? Then the grumbling relics of the old department speak of there being none of the wholesome rivalry that spurred them to do their best. That's more nonsense. We have the keenest rivalry among us, but it doesn't show itself in pounding each other's heads and fighting over a pump, as theirs too often did. But it stimulates us to get under way, and to adjust our hose and turn our stream on a fire in the least possible number of seconds. In every one of the fire districts into which the city is divided, one engine, on account of being nearer than the others, is expected to reach the fire first. Every other engine in that district tries to beat it, and the engine that succeeds is honorably mentioned in the official report of the fire. Naturally, the defeated company feels somewhat aggrieved, and determines to retrieve its lost position. In this way the healthiest possible rivalry is kept alive. Why, it's so strong that no man in the department goes to a fire nowadays without taking his life into his own hands. The engines dash over car tracks, among vehicles and around corners in a way to imperil the life of every man on the machine. That's pretty warm work for 'hirelings' without 'healthy' rivalry or interest in their business, is it not?"

"I think that we can confidently claim to have achieved results that commend themselves to the approval of the people of New York," Fire Commissioner Van Cott said, while sitting in his cosey private office in the headquarters of the Fire Department, in Mercer street. "The first meeting of the Commissioners of the Paid Fire Department was held on the 4th of May, 1865. The Commissioners had up-hill work before them in laying the foundation of the new department. They had, in the first place, to supplant a system that had driven its roots down into the soil of the public approval for nearly a century. They had, necessarily, to struggle against much jealousy and ill-feeling from the advocates of the supplanted system. That they did their work bravely and well is, I think, amply shown by the results that the records of the department show. The first company was organized under the new order of things on the 17th of July, in the same year. Within a year from that date there were fifty-four companies completely organized. In 1874 the annexed district was added to our charge. The number of companies has been gradually increased until we have now sixty-five companies. But it is a fact that there were more men in the department then to cover the city, comparatively sparsely settled above Fifty-ninth street in those days, without the annexed district, than there are now. In 1865 there were upward of 900 men in the department, but many of the men were not fully employed. They got, when they served above Fifty-ninth street, $300 a year and were allowed to pursue their regular avocations during the day. Now we have barely 700 uniformed men. I mention this to show that there is not much, if any, sinecurism in this department, and give some light upon the statistics of our department that show how steadily the extent of fires and the amount of losses from them have decreased. Then it ought also to be taken into account that the great widening of the territory that we have to cover, and the increase of population, and consequent increase of the danger of fire, has been attended with a multiplication of the uses of the Fire Department. We have subdivisions of our department now that were not dreamed of in old times. We have a fire boat, a fire marshal's bureau, a water tower, a bureau of combustibles, our own repair shops, and hospital stables, and so on. Then we are expected to keep up a theatre patrol, which we gladly do, because we believe it to be an excellent idea, and to do other little extra services for the public.

"I fancy that I ought to be able to speak with some degree of familiarity of fire service. I have had my share of experience in the new and the old departments. I belonged to Hose Company 7 of the Volunteer Fire Department, in the days when James Morris, a partner of ex-Mayor Wickham in the provision business, was foreman, and I am serving my second term as a Commissioner of this department. The records of the department sufficiently show its usefulness. A fire now rarely gets out of the building in which it starts, or, unless it is a particularly frail or inflammable building, completely destroys it. In our report published on the 1st of January, and covering the preceding fifteen months, there are figures that, I think, show the efficiency of the rank and file of the department. Out of 1,783 fires, 1,663 were confined to the buildings in which they originated; 41 extended to other buildings; 9 were on vessels, and therefore necessarily isolated; and 69 were in woods, lots, and streets. In the cases of 607 fires in which the damage to the structures was accurately ascertained, the injury was slight in 508 and considerable in 76, and total destruction resulted in only 23 instances. Then, owing to the promptness with which the men reach fires, the amount of loss in money has very materially declined. In 1866, with 796 fires, there was an aggregate loss of $6,428,000, and the average loss was $8,075.38 per fire. Then, as I have said, there were nearly 200 more men in the department than there are now, the annexed district was not included in the fire limits, and the city, at least the upper portion, was not nearly so thickly settled as it is now. The number of fires per year has increased steadily each year until now it is fully twice as large as it was in 1866, but the decrease in loss shows a retrogression in a corresponding ratio. For instance, in 1880, with 1,783 fires, the aggregate loss was $3,183,440, and the average $1,785.41.

"In addition to putting out fires," the Commissioner went on, "our Fire Marshal and attorney have done something toward preventing those of incendiary origin. The origin of every fire is carefully investigated, and if there is any reason to suspect incendiarism, arrests and prosecution for arson follow. Within the last few years a number of persons have been convicted of arson in the first degree and sentenced to State prison for life, while others, upon conviction of a minor degree of the same offence, have been sent to State prison for various terms. I presume that there are some persons that fancy that we have been endeavoring to train men and horses to get into trim to start for a fire in the least possible number of seconds, mainly for show. But this promptness is the very life of the department. A minute lost in getting to a fire makes all the difference in the world. With this fact in view, the Commissioners have given the battalion and company commanders to understand that they are expected to get the apparatus across the doorsills of their houses in as few seconds as possible. In 1880 the quickest average time in getting an engine ready to start was 3.25 seconds, the slowest, 14.08 seconds; the quickest for trucks, 2.75 seconds; the slowest, 14.17 seconds. The average time of all kinds of apparatus in 1880 was 8.21. This high average was due to the fact that many of the companies had their horses stabled in inconvenient places. We have remedied this as far as possible, and the average will be much lower, I think, this year. But this average compares most favorably with that of preceding years. In 1879, the average was 9.54 seconds; 1878, 10.26 seconds; and 1877, 13.02 seconds.

"I ought not to leave out our horses in speaking of the work of the department. We have some splendid animals in our service. Why, they possess, apparently, the intelligence, docility, and affection of human beings. It is a fine sight to see a pair of these noble animals, with ears laid back, eyes blazing, and nostrils distended, galloping to a fire. They are treated with the utmost kindness by the firemen, and they repay the attentions that they receive with zealous attention to duty. If one of them is injured in the discharge of his duty we take as much care of him as of a human fireman. He is taken at once to the hospital stables in Chrystie street, and treated with the utmost care. We have, as a rule, sixteen horses in the stable at once. Our price for our horses is $500 a pair. If we could pay more, we might get even a finer class of animals. But the brewers and expressmen outbid us for the largest and most spirited horses that come to this market.

"But a matter of the gravest possible consequence in connection with the work of this department is the water supply of the fire plugs. In some parts of the city this is notably deficient. I may point out one region, and that a most important one, in which the lack of water is notable. In the section between Bleecker and Canal streets and Broadway and Chrystie street, where much business is done, there is sometimes no water to be had. We have turned on the hydrants without getting any flow of water whatever. There should be a great reform in the water supply before winter sets in. The upper part of the city, east and west, has become a great manufacturing centre, and the liability to fires has immensely increased. Ex-Commissioner of Public Works Campbell and the present Commissioner, Mr. Hubert O. Thompson, have uniformly shown great readiness in adopting our suggestions, and I have little doubt that we will be able to do a great deal to make the city safer before winter sets in. On the 14th ult., at a meeting of the Board, I offered the following resolution, which was adopted:

"*Resolved*, That the Chief of Department be directed to order an immediate inspection of all fire hydrants in the city below Fifty-ninth street, for the purpose of ascertaining the water pressure, and a test by company commanders, with water pressure gauges of one hydrant of each kind (such as double and single outlet) on each block in their respective districts, such test to be made at different times within twenty-four hours, viz., between 9 and 11 A. M., 3 and 5 P. M. and 10 P. M. and 12 midnight. Reports to be made as soon as such inspections are completed, and forwarded through the proper channels, and the exact location of each hydrant and the pressure taken at each test to be clearly stated therein.

"The necessity for this resolution was, I think, fully shown by the Fourth avenue car stable fire. The scarcity of water there for a while endangered an incalculable amount of property and many lives."

Commissioner Van Cott's first term was by appointment from the late Mayor Havemeyer. He was nominated for his second term by ex-Mayor Cooper. In the interval between the terms he was elected Vice-President of the Ætna Fire Insurance Company, of which Col. Frederick A. Conkling was President. His associates in the Commission are John J. Gorman and Henry D. Purroy. The telegraph bureau of the Fire Department is in the top story of the department headquarters. The instruments are set in slabs of marble, supported by woodwork of the costliest kind. The carvings in the red wood—the wood principally used—of the bases of the instruments, and in the arches and cornices over them, would adorn a Fifth avenue mansion. The instruments are of the finest attainable workmanship.

"We have to keep up with the times here, I assure you," Acting Chief Farrell said. "We must have the latest thing out in telegraphy as soon as it appears, or we would fall behind. If the repair shops are the backbone of the department, our bureau is certainly the nervous system. We have six operators here under Chief J. Elliott Smith, but we ought to have more, for, as you see, though we are only keeping up with the box inspector's morning round, we are on the jump. To begin with our wires, we have seventy-four that come down through that opening in the front of the building there, like the pipes of an organ. They cover eight hundred miles in their ramifications. Here is a map of the city as arranged for our use."

He drew out from its case a map that was peppered with red spots and blotched with blue ones. Near each spot was a number.

"The red spots," he continued, "represent the fire boxes, and the numbers are the numbers of the boxes. The blue spots stand for engine houses. A touch upon the instrument in any one of the hundreds of boxes sounds a gong here. The first note of the gong puts an operator on the alert. He sees a red card, numbered like the box that has begun to ring, rise in the tiny glass case at the top of that switch board. He darts to the switch beneath the number, and, pressing it down—this method is the invention of our chief—brings into play that long bar, which communicates with every circuit, and sends the alarm throughout the department. This is all done so quickly that the second stroke—five strokes is the alarm—is heard throughout the department, and puts every man into position to jump for the fire. Under the old system a good deal of precious time was lost in receiving from the box and repeating to the company houses. I should have said that the first stroke of the alarm box is made to draw the single bolt that confines the horses in their stalls. The pushing down of the switch also starts the indicator, which prints on paper the alarm. The indicator can print the signals for fifty fires at once, and, no matter how many fires occur at once within that number, we are made safe against losing one of them. We have duplicates of all our instruments, so as to guard against accidents. Then every fire box in the same neighborhood is on a different circuit. If one box does not work, the next will. Then we don't trust to our wires being in order. We have here an automatic tester. It tests every wire in the department every ten minutes and if there is the slightest trouble anywhere we can locate it within a few feet by means of this Wheatstone bridge, or galvanometer. We keep our wires 'dead,' that is, uncharged, except when in use, so that no other sound, such as might be made by the falling of a wire across one of ours, than a legitimate fire alarm or department business call can reach department or company headquarters. As an evidence of what can be done in the way of massing engines by telegraph, I may refer to the record of the recent great brewery fire. In that instance fifteen engines, eight trucks, and the water tower were at work on or within a short distance of the fire, inside of ten minutes and a half."

"We make and repair everything that is used in the Fire Department," Chief McCabe of the Fire Department repair shops said, "with two solitary exceptions. We can't make an engine yet, nor can we make hose. But we can repair both. We have fifty skilled mechanics, who, under the supervision of my assistants, James Degnan and George Morris, and myself, turn out, I contend, as fine work as is done in any shop in the United States. Of course, we have the best attainable means of doing everything.

"Commissioner Van Cott, through the carrying out of an idea of his, has paved the way for doubling the efficiency of the department. The fire boat, the water tower, and two engines have already been changed to comply with his new system. The water tower now throws a stream that can take the side out of a house hundreds of feet. Formerly a two-and-a-half-inch hose with an inch-and-a-half or three-quarters outlet was regarded as the acme of water-throwing power. About three months ago an inventor from Boston, who has devoted fifty years of his life to the improvement of fire apparatus, came here to get a test of what he called a 'Monitor' nozzle. Mr. Van Cott accorded the test, which was made on the fire boat. When the old man's nozzle had been tested, Mr. Van Cott brought out one that he had invented. It had a two-and-a-half-inch outlet, and was adapted to three-and-a-quarter-inch hose, and threw a volume of water that would flood a building in a very short time. The old Boston man was overcome. He said that he had never expected to see anything of the kind, and he was done. He died soon afterward. Among the other notable improvements that Mr. Van Cott has devised is the supply wagon. This is to contain everything necessary to equip a fire apparatus, from 500 feet of hose down to a set of burglar's tools modelled after those left behind by the Manhattan Bank burglars, for forcibly entering iron doors or windows. A wagon, as soon as the set ordered is completed, is to be stationed in every battalion district, I believe, so as to be handy whenever a fire alarm is rung anywhere."

Engineering News October 8th 1881.

ELECTRICITY.

Notes

Nearly three thousand miles of telegraph cables have been laid underground in Germany, at an expense of £1,510,548. The first cost is high, but the expense of keeping them in repair is expected to be very trifling.

In an elaborate report to the shareholders of the Central and South American Telegraph Company, Mr. Jas. A. Scrymser, President of the company, states that contracts have been concluded for 3,082 nautical miles of submarine cable of various types, with the India Rubber, Gutta Percha and Telegraph Works Company, limited, of London. The latter company is to lay and guarantee the perfect working of these cables as a whole, and is required to guarantee that the various types of cable shall be of sufficient length, respectively, to properly connect the points required. Twenty-two miles of cable are being completed daily, and it is reported by the company's electrician to be of very superior quality. The provisions of the contract amply secure the company in every particular against loss, damage, or delay. No less than five steamers will be necessary to transport the cable and its accompanying material. The first shipment will clear from London Nov. 15, or pay a penalty of $1,000 per day for each day's delay; the other shipments will follow at fixed dates under heavy penalties for delay. The cable connecting Panama with Callao is to be completed by May, 1882, and it is expected that the whole line will be in commercial operation during the ensuing month of July. Careful estimates of cost have been made, and it is expected the company will have an ample cash surplus and $1,000,000, par value, of its stock in its treasury on closing the construction account. This result will be attained notwithstanding the fact that the company will have about 900 tons of cable more than the original estimates called for, and that it has secured the following valuable exclusive telegraphic rights not included in the original prospectus: United States of Colombia, the exclusive right covering its Pacific coast, inclusive of the Isthmus of Panama, for 25 years; Ecuador, the exclusive right for 50 years, and Peru, the exclusive right for 25 years. All of these rights have been ratified and confirmed by the respective governments, and contain other privileges highly beneficial to the company. J. B. Stearns, who has been appointed electrician and general manager of the company, has secured an experienced staff of electricians to watch over the cable in every stage of its manufacture and laying. The establishment of these cables will connect, telegraphically, the United States with Brazil, via Mexico, Guatemala, Costa Rica, Panama, Colombia, Ecuador, Peru, Bolivia, Chili, and the Argentine Republic; and their geographical position is such as will insure a large and remunerative traffic from the time of opening. This traffic is secured exclusively to the company under the protection of the valuable rights which it possesses.

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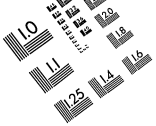

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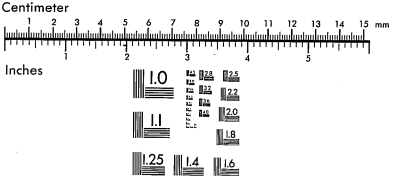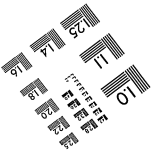
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